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BYTE

JANUARY 1991
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Toshiba's New T1000LE

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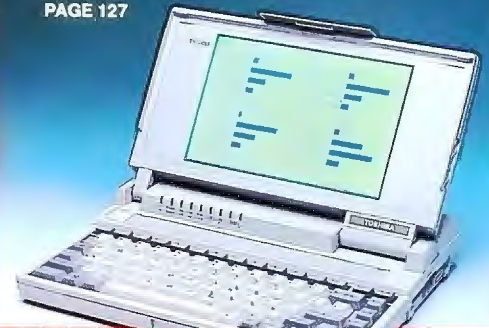

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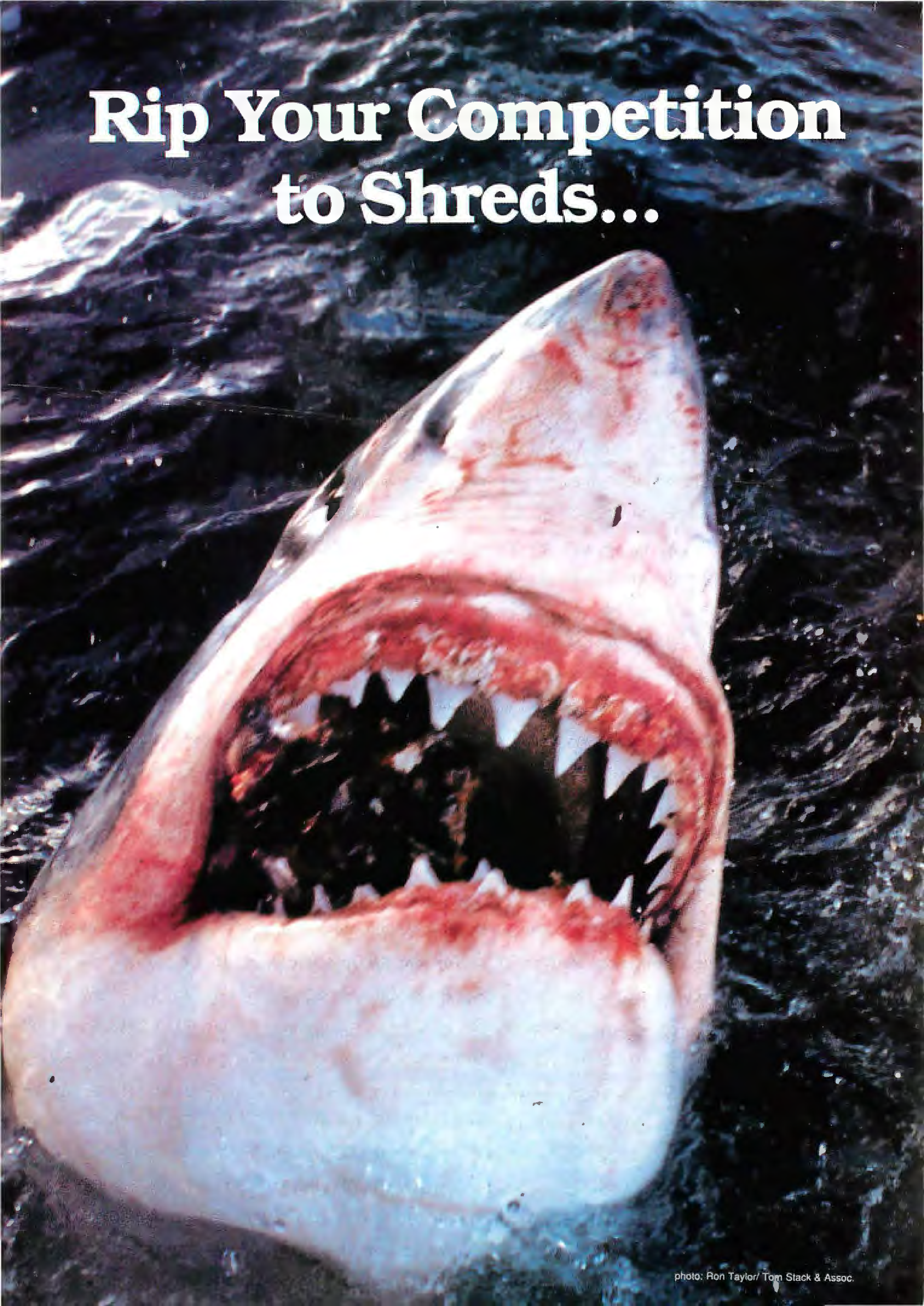
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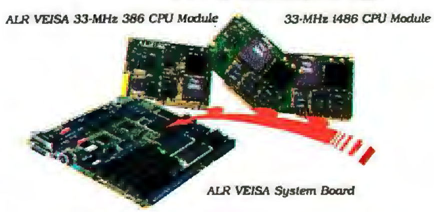

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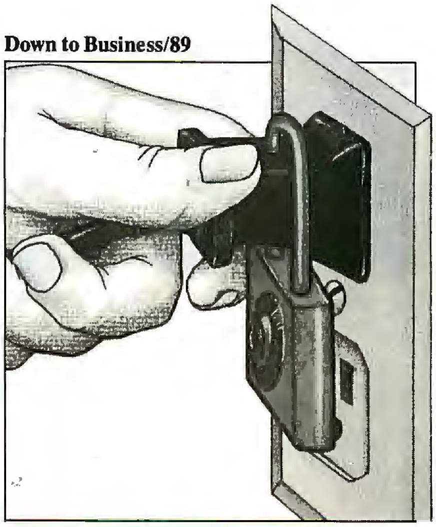

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Gilbert Hyatt

Federico Faggin

Ted Hoff

FATHERS OF INVENTION

From processors and patents to Cabernet and coaxial cable in this month's BYTE

This is a fascinating business. You never know whom you're going to meet, or where you're going to pick up a great story.

Case in point: Jeff Bertolucci is a member of the BYTE news staff, located in San Francisco. Last August, Jeff was attending a software developer's conference, the kind of event that's good for gathering background but generally not where you expect to find hot news.

At one point, a public relations person took Jeff aside and said he wanted to tell him the most incredible story to hit the computer industry in the past 10 years. He took Jeff to a corner of the hotel—far from the other reporters—and showed him a thick document: a recently issued U.S. patent for a microprocessor design. According to the PR person, the patent—which was originally sought in 1970—made an unknown southern California engineer named Gilbert Hyatt the father of the microprocessor.

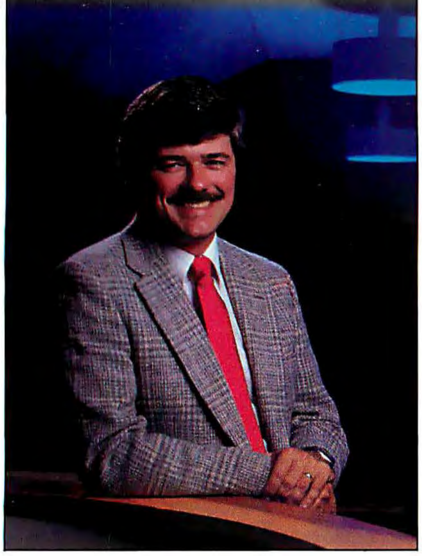
On August 29, Hyatt announced his patent to an amazed computer world. By then, BYTE editors had already begun assembling an article on Hyatt's patent and its possible effect on the computer industry. Later, we interviewed Mr. Hyatt, as well as two of the people historically credited with inventing the microcomputer: Ted Hoff and Federico Faggin. We also talked with industry experts to get their opinions on the patent. You'll find the resulting article ("Micro, Micro: Who Made the Micro?") on page 304. Among other things, it shows that success sometimes requires a great deal of patience.

Of course, the ability to defer gratification for long-term benefit is one thing that differentiates humans from other creatures. It's not always easy. Take, for example, holding onto a fine wine long enough for it to reach its peak. Rich Seifert knows how much self-control that takes. On September 30, 1980, Rich purchased a magnum of Cabernet Sauvignon from Heitz Cellars. That was the day he and other developers completed and signed off on the specification for a new networking standard called Ethernet.

Last September, on Ethernet's tenth anniversary, Rich opened that bottle at a gathering where the development team had reunited to celebrate and to reflect on the evolution of LANs over the past 10 years. Rich tells the story of Ethernet and its subsequent history in "Ethernet: Ten Years After" on page 315 of this issue.

We think you'll find this month's feature articles as fascinating as the people behind them. Stick with us—you never know who we'll run into next. ■

—Kenneth M. Sheldon
Senior Editor, Features



EDITORIAL ■ Fred Langa

THE END OF INTEL'S MONOPOLY?

AMD's clone of Intel's 386 chip has created stiff competition in the U.S. CPU industry—and you and I are the beneficiaries

A year and a half ago, Advanced Micro Devices formed two separate teams to legally circumvent Intel's attempts to maintain its (also legal) monopoly on 386 production. One AMD team worked from a systems analysis perspective, defining the full functionality of the Intel 386. The other team worked on reverse-engineering an i386 chip itself.

In July of last year, the two teams finished their work and merged their results into a single specification. AMD taped out the design in July and sent the chip masks to fabrication. Shortly thereafter, the first sample silicon was ready.

The long, careful preparations paid off. The first time out, at 20, 25, and 33 MHz, the new chip successfully ran OS/2, Windows, DOS, Unix, Xenix, and a variety of operating systems for embedded applications. Physically and functionally, except for the logos, the chips are essentially identical—clock for clock, state for state, and pin for pin.

I saw an Am386DXL demonstration at Comdex: Mike Webb, director of marketing for AMD's Personal Computer Products division, took a pair of off-the-shelf machines (a Compaq and a PS/2 bought at Businessland), pulled out the stock Intel 386s, plugged in AMD 386s, and started the machines. The computers ran exactly as they had before, even running the BYTE benchmarks identically.

What few differences there are between the Intel and AMD chips are all in AMD's favor. For example, the AMD chip is entirely implemented in power-saving 0.8-micron-wide CMOS, unlike the partial-CMOS, 1-micron design of the i386.

This change to an all-CMOS design allows for a much lower power consumption, with enormous implications for battery-powered laptops and portables. For example, the AMD chip uses a scant one-third the power of the Intel 386 at 20 and 25 MHz, and two-thirds the power at 33 MHz. At the lower speeds, the Am386's power consumption is below that of an i386SX!

But there's more: The AMD chip can power down to a sleep mode that requires less than a milliamp of current, compared to the minimum current draw of 133 mA for an i386DX and 60 mA for the newly introduced i386SL.

Besides a true sleep mode, the Am386 offers ultra low-power, slow-speed operation for standby modes: You can slow the Am386 down to as little as 4 kHz (the i386 can't go slower than 8 MHz).

All this adds up to power consumption that's just a fraction of that of the equivalent Intel chips. What's more, the Am386's design protects your data in these low-power modes—the chip's registers and pipelines automatically remain intact. (If you shut down an Intel chip for maximum power savings, you must copy the registers' contents—usually out to expensive static RAM.)

The Am386's simple-to-implement low-power modes offer incredible power management flexibility for laptop designers. No longer will designers have to use the crippled SX chip to bring 386 power to portables: true 32-bit, no-compromise, no-bottleneck laptops with reasonable battery life are now possible. To top things off, AMD will offer its 386 in a plastic carrier ideally suited for space-saving surface mounting. Laptop and portable makers will eat these chips up.

Desktop units will also benefit from AMD's improvements on the 386. Already, AMD successfully has tested its chips at speeds of up to 50 MHz—and up to 40 MHz without special cooling.

Webb told me that he believes a 40-MHz Am386 will be faster in real-life applications than an i486 running at 33 MHz. Yes, some 486 instructions execute in fewer clock cycles, but most common instructions run about the same as on a 386, Webb says. Thus, the 21 percent speed increase to 40 MHz will deliver faster real-life performance to most users. Although pricing for the AMD line is not yet set, a 40-MHz Am386 should cost significantly less than a 33-MHz i486.

Better, faster laptop and desktop machines are the immediate short-term result of AMD's hard work to take on Intel head to head. There are longer-range benefits, too. For example, AMD is actively working on 0.65-micron fabrication, which it believes can be worked down to 0.25 micron with its current facility.

Sizes this small open up the opportunity for extremely high transistor-count devices—chips of unparalleled subtlety, power, and complexity, containing perhaps as many as 5 million transistors and operating at 50 or 60 MHz.

AMD is not the only CPU maker working at the frontiers of manufacturing—and that is the point. Intel's attempts to block production of legal clone 386 chips prevented healthy competition, delayed the performance increases and cost reductions users have come to expect from the computer industry, and forced too many of us to accept deliberately crippled chips, such as the SX, simply because there was no alternative.

Now, thanks to AMD, there are alternatives. Users everywhere will benefit from this competition. For more information on the Am386, see this month's Microbytes on page 19.

—Fred Langa
Editor in Chief
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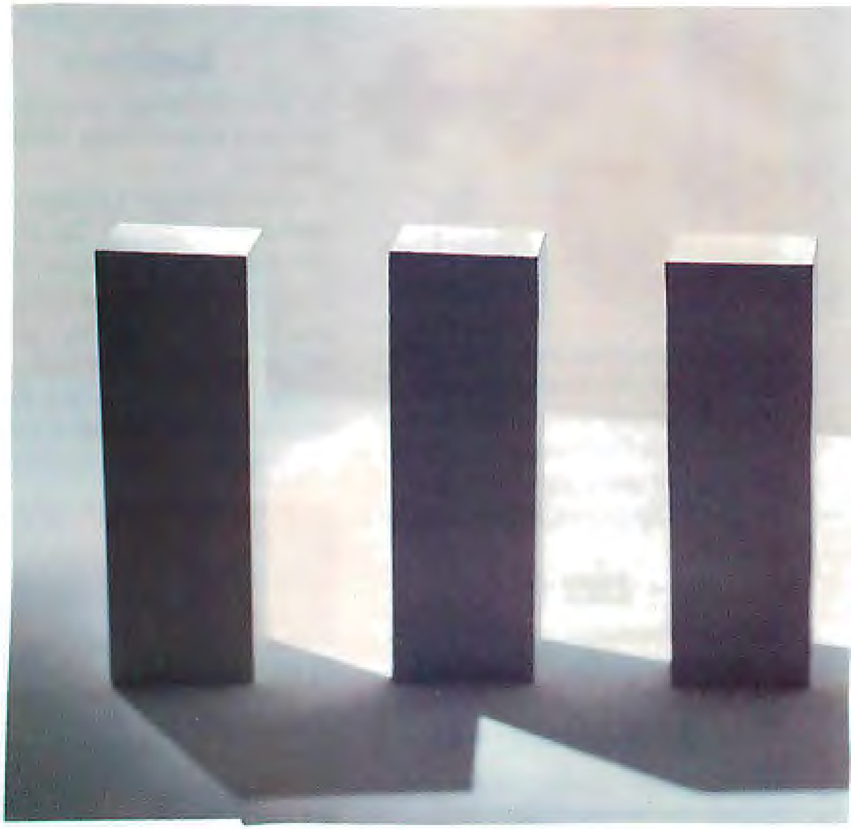

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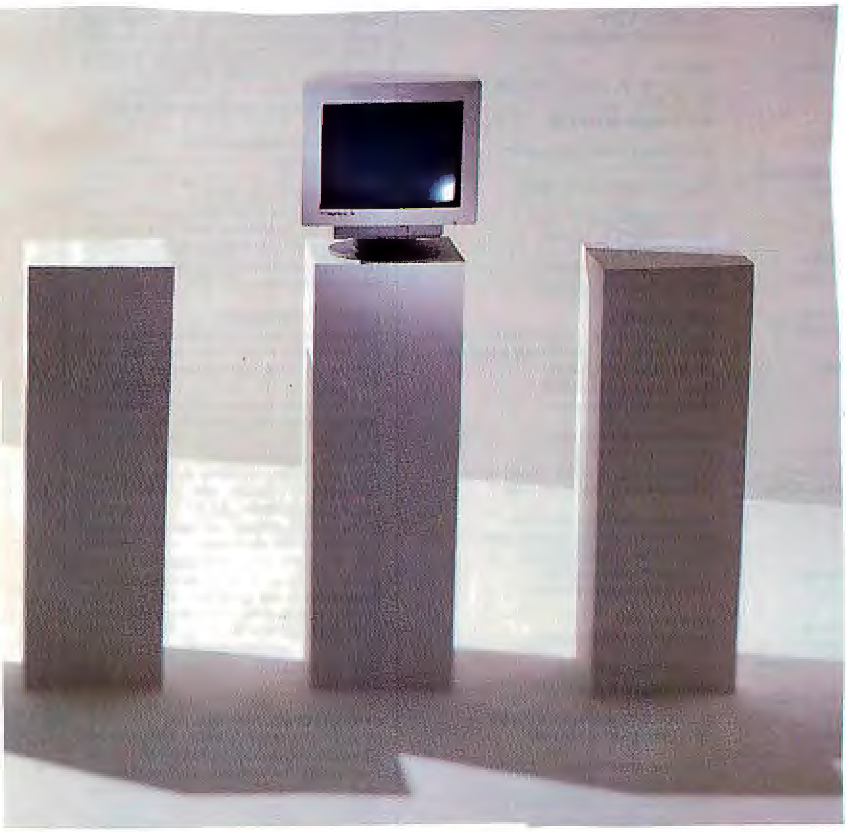

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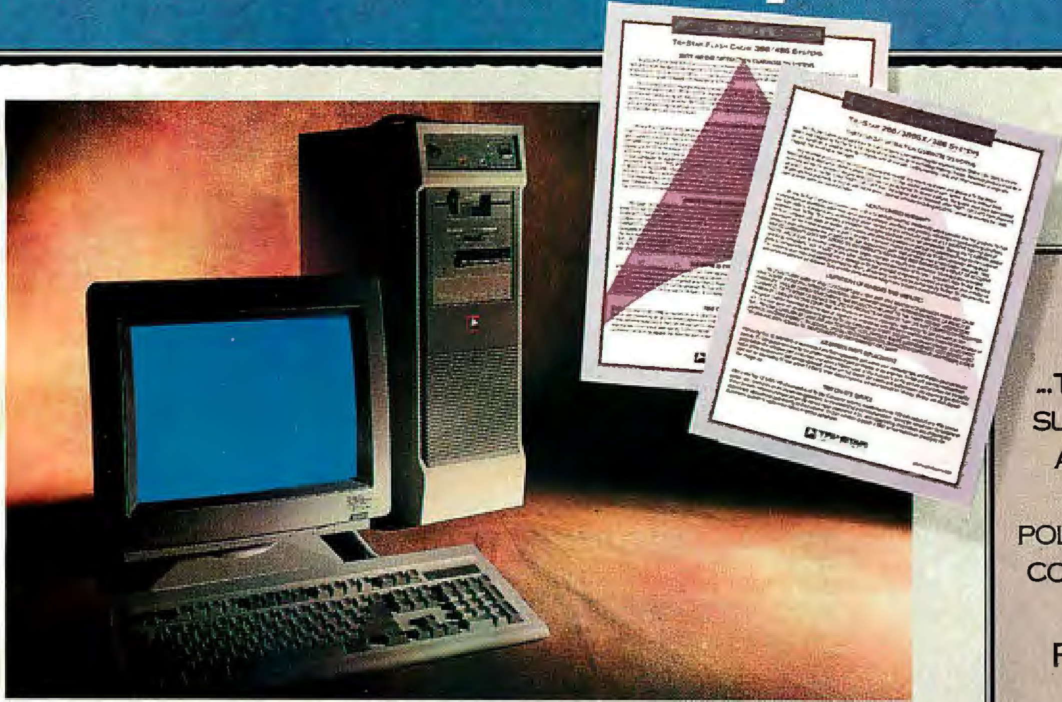

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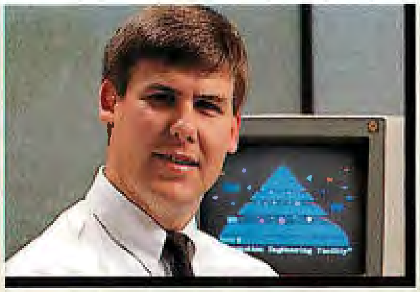

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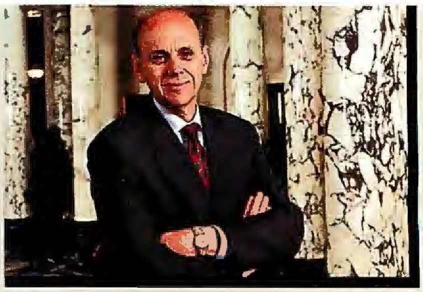

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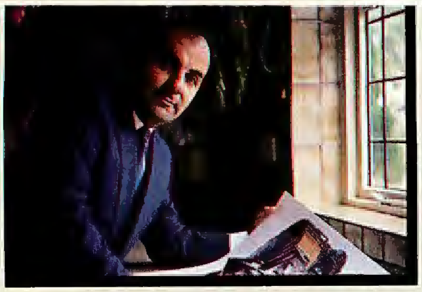

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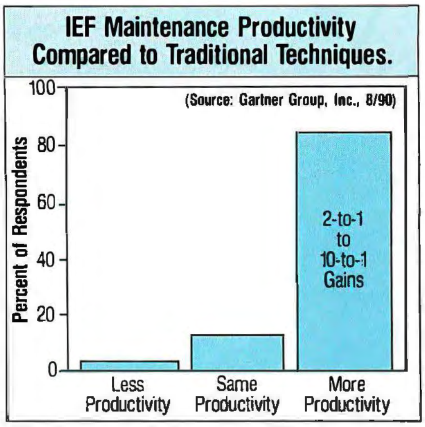

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AMD's Replicant 386: It's Alive, It's Compatible

After what seems like years of negotiation, litigation, and speculation, Advanced Micro Devices (Austin, TX) has at last demonstrated its version of Intel's 386 processor. The company says its Am386DX, which clocks in at 20, 25, and 33 MHz, is completely pin- and instruction-compatible with Intel's archetype. AMD is also working on a version of the 386SX but said it's about three months behind the DX. If AMD can overcome legal and manufacturing difficulties, its replicant CPU will be the first real alternative source of Intel's popular, profitable chip.

AMD designed the processor by reverse-engineering the Intel 386 and then implementing its logic in a static CMOS design, company officials said. AMD made no changes to the instruction set or performance characteristics of the Intel chip but did try to build a device that consumes less power. Ben Oliver, product-line director for AMD's Personal Computer Products division, said Intel's design for the 386 minimized transistor count, often at the cost of raising power requirements. AMD implemented its design in 0.8-micron CMOS rather than Intel's 1-micron CMOS. The Am386DX consumes 69 percent of the power needed by the Intel 386DX, Oliver said.

Greater power savings will be possible using the Am386DXL, which has a zero-clock-rate standby mode, reducing power consumption to under 1 mA, Oliver said. An Intel 386 running at 8 MHz, its lowest speed, consumes 133 mA. AMD officials said the DXL chip will be a natural in the portable computer market; Intel has a low-power version of the SX, but not of the DX.

AMD plans to offer its 386 in a surface-mountable package as well as in the pin-compatible standard grid array package. The surface-mountable part is 40 percent smaller than the standard part, making it attractive to designers working on notebook and other diminutive computers.

During private meetings with BYTE, AMD showed engineering samples of its 386 running in two off-the-shelf systems: an IBM PS/2 Model 70 and a Compaq Deskpro 386/33. AMD officials said they had been testing the chips, with coprocessors, for over a month and had not yet hit any compatibility snags with software. To ensure compatibility, AMD tested the pin-out values of all the pins on its chip, for every clock cycle of every instruction, against the Intel 386. The company said its engineers were also very careful with timing tolerances to make them more conservative than even Intel's.

BYTE's initial tests indicated that AMD has indeed developed a processor compatible with Intel's. The Am386 ran BYTE Lab benchmarks at exactly the rates expected from the Intel processors of the same speed. The Am386DX has run DOS, Windows 3.0, OS/2, Xenix, and several real-time multiuser operating systems without any problem, AMD officials said.

The other big question is whether AMD will be legally allowed to sell the chip. At press time, this issue was still not resolved, but an arbitrator had ruled that AMD could use "386" as part of its product name.

AMD had not decided on pricing or availability by press time. Company officials said AMD is not going to challenge Intel aggressively on price. "There is no reason to beat Intel on price; we have a better product," said Mike Webb, director of marketing for AMD's Personal Computer Products division. Intel's 386 prices currently range from $180 to $200.

AMD is proceeding with sampling and says it's ready to go into full production. The surface-mount chip will be available sometime this year, the company said.

At least 20 computer makers have been testing the 386 clone. While none was ready to commit to AMD's chip, most PC manufacturers interviewed by BYTE said that they're interested. Price, performance, and compatibility were the issues they all mentioned. "Tandy has always used multiple vendors of the 286, so I assume we'd use multiple vendors of the 386," said Tandy vice president John Patterson.

— Owen Linderholm

NANOBYTES

Eastman Kodak (Rochester, NY) has come up with a series of development tools and utilities intended to guarantee that color images on a computer screen look exactly as they'll appear when put on hard copy. Kodak is hoping that vendors of computer software and hardware adopt its new technology, called PhotoYCC—essentially **a new method for representing color** in digital form—and that it becomes the industry standard for representing color in digital form across software applications, computer platforms, and peripheral devices. The new Color Management System software products define the way individual components in a color desktop graphics system—including scanner, monitor, CPU, and printer—read colors in a computer application, effectively calibrating the equipment to accommodate for the way people see color. Because the system resides individually in both the application and the hardware in use, a Kodak official explained, it is independent of device and operating system. Being able to predictably control the color space "has been lacking in the industry for 20 years," said John Warnock, chief of Adobe Systems.

Turbo Windows: Borland International (Scotts Valley, CA) is at work on a version of **Turbo Pascal** that will run under Microsoft **Windows** and produce true Windows applications. "Turbo Pascal for Windows is a hosted graphical interface for Windows," said Gene Wang, manager of Borland's languages unit; in other words, Windows provides the user interface. It uses the Multiple Document Interface for handling multiple files, he said. While a demonstration program was running in one window, Wang compiled and ran a Pascal adaptation of Charles Petzold's Hex Calculator application. The company will deliver Turbo Pascal for Windows sometime in the first half of this year, according to Wang.

NANOBYTES

IBM has become the thirteenth company to join the coalition promoting the **DOS Protected Mode Interface.** The DPMI specification, first released last May, defines a standard for extended DOS programs to run in protected-mode, multitasking environments on Intel-based PCs, such as Windows, OS/2, Desqview, VP/ix, and Unisys CTOS. Microsoft and Intel are the two major forces behind DPMI; other supporting companies include Borland, Quarterdeck, Locus, Lotus, Phar Lap, Ergo, IGC, Phoenix Technologies, and Rational Systems. The group has sent out about 2000 copies of the specification, an Intel spokesperson said. DPMI-compatible products should be reaching users soon.

The **first laser printer to support PostScript Level 2** is slated to arrive in March. **Dataproducts** (Woodland Hills, CA) says its LZR 660 ($2995) can output images faster because of changes made to PostScript, not to the print engine itself. (The machine uses a Weitek RISC processor and is rated at 6 pages per minute.) PostScript Level 2 supports compression and decompression, so files can be sent faster to the printer. There is one problem: Very few software programs are capable of driving PostScript Level 2. Dataproducts has a program to help developers get printers early so that they can work on drivers.

The **Open Software Foundation** (Cambridge, MA) has released its version of Unix to customer companies, but users won't see it until sometime later this year. In addition to the Mach kernel, **OSF/1** incorporates "significant portions" of IBM's version of Unix (AIX v. 3.1), commands from both Unix System V and Berkeley BSD 4.3, symmetric multiprocessing features from Encore Computer, and security features from SecureWare. Many companies, including IBM, say they'll offer complete versions of OSF/1 or features from OSF/1 in their own versions of Unix but won't say when this will be. **DEC** could be one of the first, with an OSF/1-compatible version of its Ultrix variation of Unix by the middle of this year, DEC says.

Breakthrough in Holographic Memory Could Transform Data Access

Researchers at Bellcore (Livingston, NJ) have developed a new laser-based system that represents a breakthrough in using holograms as computer memory and holds promise for dramatically faster information access. The researchers have built a laser semiconductor array for retrieving holographic images, stored on a glass crystal, at speeds up to 1 gigahertz.

Bellcore's research, aimed at changing the way holograms—recordings of light patterns that represent an image—are retrieved, has yielded a chip the size of a thumbnail that contains an array of over 1000 semiconductor lasers. The laser array replaces the single scanning laser beam currently used for retrieving holographic images. Single scanning laser beams require large and expensive optical equipment such as lenses, beam deflectors, and optical tables. According to Bellcore researcher Ann Von Lehmen, the new laser array will replace the 8- by 12-foot optical table and associated reflectors and lenses in her laboratory.

Bellcore has tested its laser array by retrieving holographic images from a photorefractive crystal made from lithium niobate and gallium arsenide. A single crystal, measuring 1 centimeter on a side, can store 10 million "pages of information," each page containing 100,000 bits (a capacity of 1 trillion bits). Each "microlaser" in thc array is associated with a single page of information and can retrieve it in less than a nanosecond. The information is recorded by dividing the light emitted from the laser into two beams of light and recording the phase and amplitude at their intersection in the photorefractive crystal. Only one beam from the laser, called the "reference beam," is needed to retrieve the information from the crystal. Each laser measures 40-millionths of an inch across, allowing arrays to contain thousands of lasers.

The next step is to develop "optical/electronic interfaces" that convert the parallel data of the holographic image to a serial bit stream suitable for digital computers. However, Von Lehmen says, the development of microchip-size laser-retrieval systems also presents the opportunity to develop parallel data-access systems that would be much faster than serial interfaces in use today.

Although the researchers have demonstrated the retrieval of several images with high fidelity, they have not been able to retrieve more than a few. They hope to retrieve 500 to 1000 images from a single crystal while maintaining high fidelity.

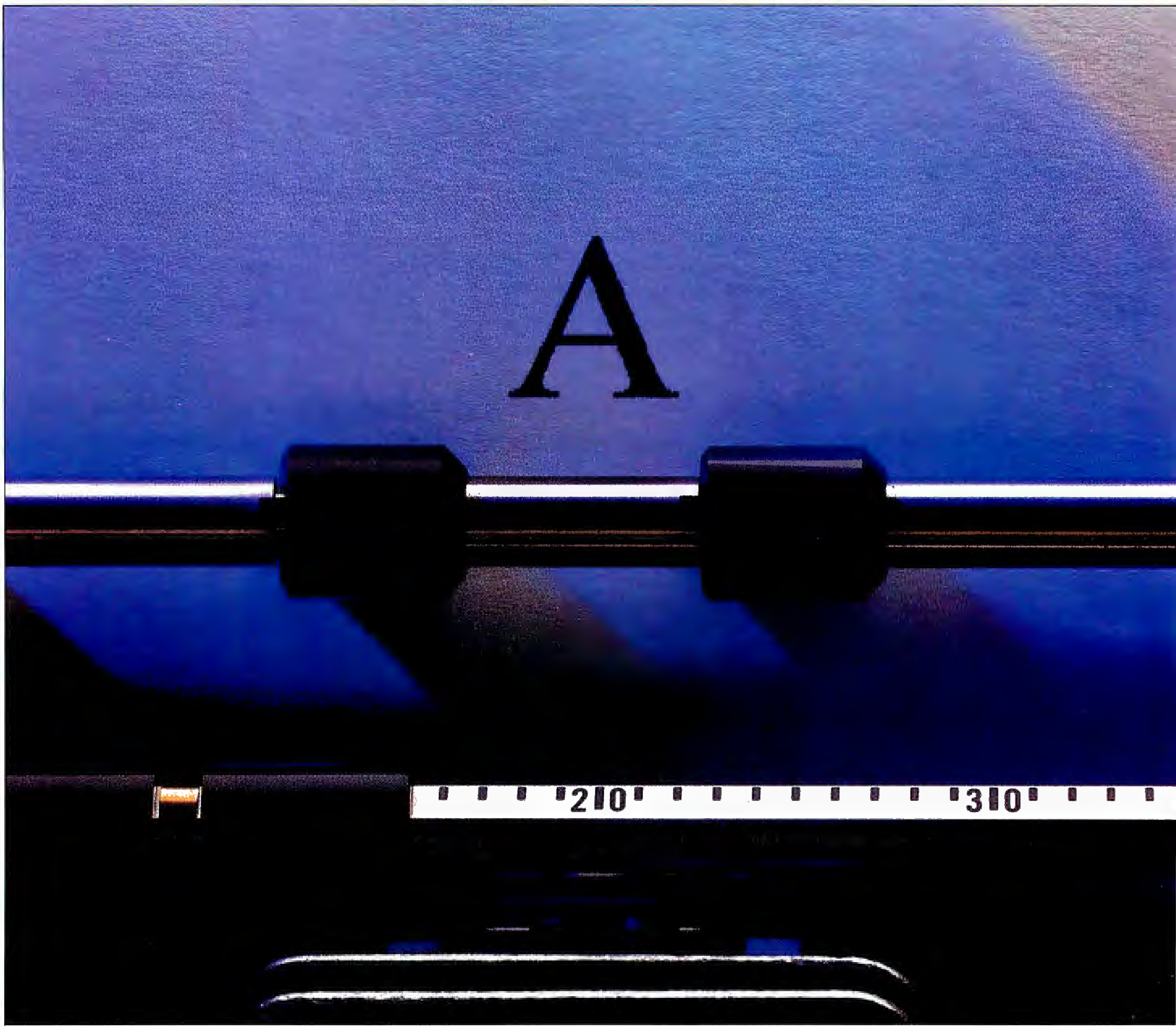
Bellcore has not developed a way to store these images, but Microelectronics and Computer Technology (Austin, TX) is doing complementary research in that area (see the September 1990 Microbytes and the November 1990 BYTE). MCC is using crystallite arrays rather than single crystals for storing holographic data. These crystallites eliminate crosstalk and signal weakening problems associated with large photorefractive crystals. According to MCC's Jerry Willenbring, MCC is enthusiastic about the breakthrough at Bellcore. "We're working on a commercial optical system," says Willenbring, "and the use of a micro laser array is certainly a more advanced approach." It is possible that Bellcore's laser array will show up in a commercial product from MCC within the next few years.

— Nick Baran

SPARC Is Turning into a Blaze

It's not the rabbit-like proliferation of DOS machines that IBM spawned with its PC, but this year will bring a substantial increase in the number of Unix systems based on Sun's SPARC architecture. At least 10 companies exhibited SPARC machines at the recent Comdex, and at least 10 more companies have SPARC machines in the works. These RISC computers will be compatible with Sun's Sparcstation 1 or 1+, but they will vary in price and performance.

Many of these systems will be based around the Sparkit chip set and processor from LSI Logic. CompuAdd, Hyundai, Tatung, and RDI/TriGem expect to ship new desktop and laptop models soon. These systems will all be compatible with Sun's Sparcstation 1 and will be able to run DOS applications using Insignia Solutions' Soft-PC emulator. Some of the other companies planning to build computers around LSI Logic's chips include Northgate, Chicony Electronics, DCM Data Products, DTK Computer, Intelecsis, Sampo, and Twinhead. Opus, whose earlier RISC system was based on Motorola's 88000 chip, has moved to LSI Logic's SPARC CPU for its newest Unix workstation, as well as for an add-



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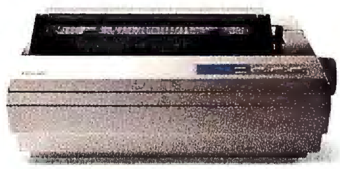

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NANOBYTES

Neatest trick of the month? **Transcomputer** (Sunnyvale, CA) has shown a **50-MHz 486** running on a 25-MHz 386 board. (The company's main product is a module that lets an Intel 486 run in a 386 system.) To get the 50-MHz speed, Transcomputer is using a 25-MHz 486 speeded up to 50 MHz with the help of a Velox Ice Cap refrigeration module. The current 486-PX module, which runs at the same speed as the motherboard, is a $486 PC board about 2 inches square with pins to plug into a 386 socket on the bottom and a 144-pin socket to take a 486 on the top. The logic and other chips needed to do the conversion are buried in a layer of epoxy. According to George Zweifler, vice president of sales and marketing at Transcomputer, the setup has run reliably in their tests. Zweifler admits the 50-MHz 486 is mostly an attention-getting device.

JYACC (New York City), maker of the JAM application development environment, plans to ship a **Motif-based development tool** sometime this quarter. The not-yet-named software will let you construct Motif interfaces and access underlying X widgets, but you will also be able to compile applications down to character mode. JYACC says the software will permit "seamless integration" to multiple databases; the current JAM product accesses Sybase, Oracle, Ingres, and Rdb. Later this year, JYACC plans to release versions of the tool for Open Look and Microsoft Windows.

Edsun Labs (Waltham, MA) is going to incorporate the Speedo font-scaling technology of type house **Bitstream** (Cambridge, MA) into its Continuous Edge Graphics chip (see the October 1990 Microbytes). The CEG chip is designed to plug into a VGA board and sharpen the images on the screen. With Bitstream's Speedo, the chip will be able to scale outline fonts for display and printing. The CEG chip will process Speedo-produced bit maps. The two companies are also working on an OEM version of FaceLift, Bitstream's commercial package for generating scalable type within Windows applications.

in board that turns an AT into a SPARC machine.

One of the most unusual SPARC machines slated to arrive this year is a portable designed by Research, Development & Innovations (San Diego, CA), and manufactured by Korean giant TriGem. In addition to being a Unix system, the 12-pound BriteLite also runs Macintosh software.

"We emulate 68030 Macintosh software calls in a SPARC environment purely in software," making no use of Macintosh ROMs, RDI president Rick Schrameck said. "Any I/O port call is done as if it's SPARC because we want to keep the speed up in there. . . . We make no calls the way the Mac does internally; we can't, because our I/O is totally different." The company also emulates the Mac ROMs in software, he said. RDI has not run into any incompatibilities yet, but some may exist with more hardware-dependent things like 32-bit software, Schrameck conceded. No one has yet managed to legally emulate the Mac except by using original Mac ROMs.

Schrameck said the system takes "a performance hit from 15.8 to 2.5 MIPS to do the emulation," which he said is better than with a plain Mac. The BriteLite can also run DOS software using Insignia Solutions' SoftPC.

Solbourne, the company that built the first SPARC clone and designed its own processor, recently brought out a new model. Toshiba has designed a SPARC laptop around its own chips. One of the most unusual (and expensive) systems is coming from Meiko World, which is developing multiprocessing computers that can use any combination of SPARC, Intel i860, and Inmos T800 transputer chips. Several other companies have announced SPARC compatibles, including Mars, Solarix, and ICL—raising the number of SPARC cloners to at least three times what it was six months ago.

One major test of a SPARC system is whether it can pass SPARC International's SPARC Compliance Definition. SCD 1.0 is based on complete compatibility with the Sun Sparcstation 1. Some of the systems that have passed so far include the Solbourne S4000, the Mars Mariner 4i, and Tatung's color workstation, which was unwrapped at Comdex. Many of the other systems haven't passed yet because they're still in an early stage of development, said SPARC International president Bob Duncan. He expects that most SPARC clones will eventually be SCD-compliant. "It will not be long before an end user won't buy a system that doesn't have the compliance label on it," he added.

This wave of new SPARC adoptees could help establish SPARC as a standard architecture for Unix workstations. It's not just the numbers; the list of SPARC cloners includes companies from all over the globe. "What we see now in the SPARC market is a movement in reality from a proprietary architecture . . . to an open architecture," Duncan said.

— Owen Linderholm and Larry Loeb

Chips' Chip Breaks High Cost of Video Windows

At least one component of multimedia computing will soon drop in price. Chips & Technologies (San Jose, CA) has developed an IC that will drastically cut the cost of hardware for displaying windows of live, motion video on a computer screen. Companies adopting this new $40 chip will be able to build video windowing boards for about $150 instead of $500, C&T officials say. That means users will be paying in the neighborhood of $500 to $800 to get capabilities that now cost more than $2000. A C&T engineer said that the chip replaces about $300 worth of gate arrays and other devices.

C&T's new PC Video chip incorporates all the logic for taking a digitized image, putting it in a window, and controlling its size, shape, and location."We have integrated the logic of a two-board device down to a single chip on a half-size card," said Steve Chen, vice president of C&T's Media Group. This one piece of silicon does the scan rate conversion, input cropping and scaling, memory timing, windows management, frame buffering, color keying, and other operations that require additional circuitry on current products. A board using the chip would also need a digitizing chip set, memory, and assorted logic.

One thing missing is a compression chip, which Chen said C&T is "working on." He wouldn't commit to a delivery date, but he suggested that it would be sometime in the first half of this year.

The prototype board that C&T demonstrated was able to take incoming live video (from a video camera), digitize it on the fly at 16-bit resolution, and then

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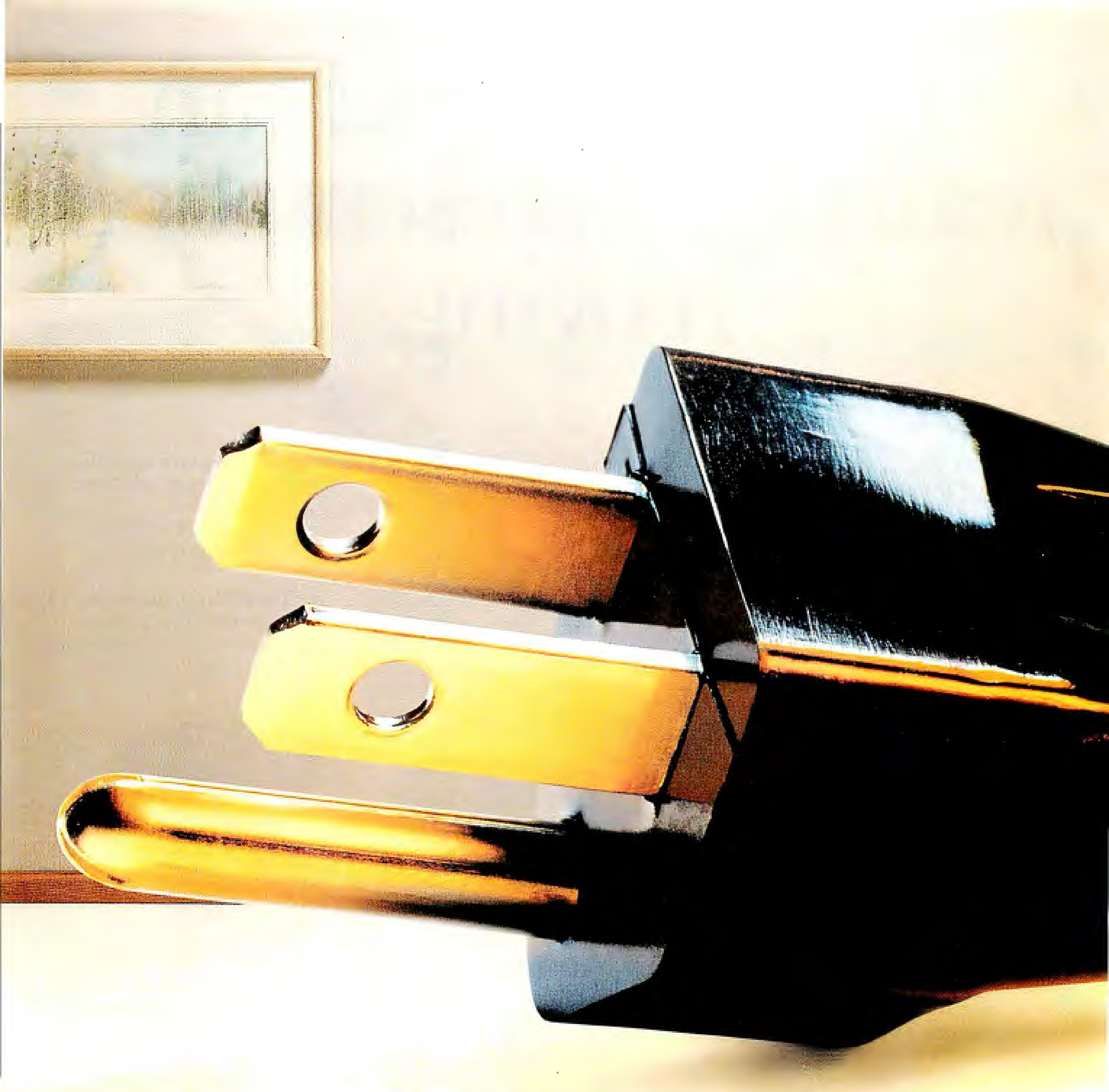

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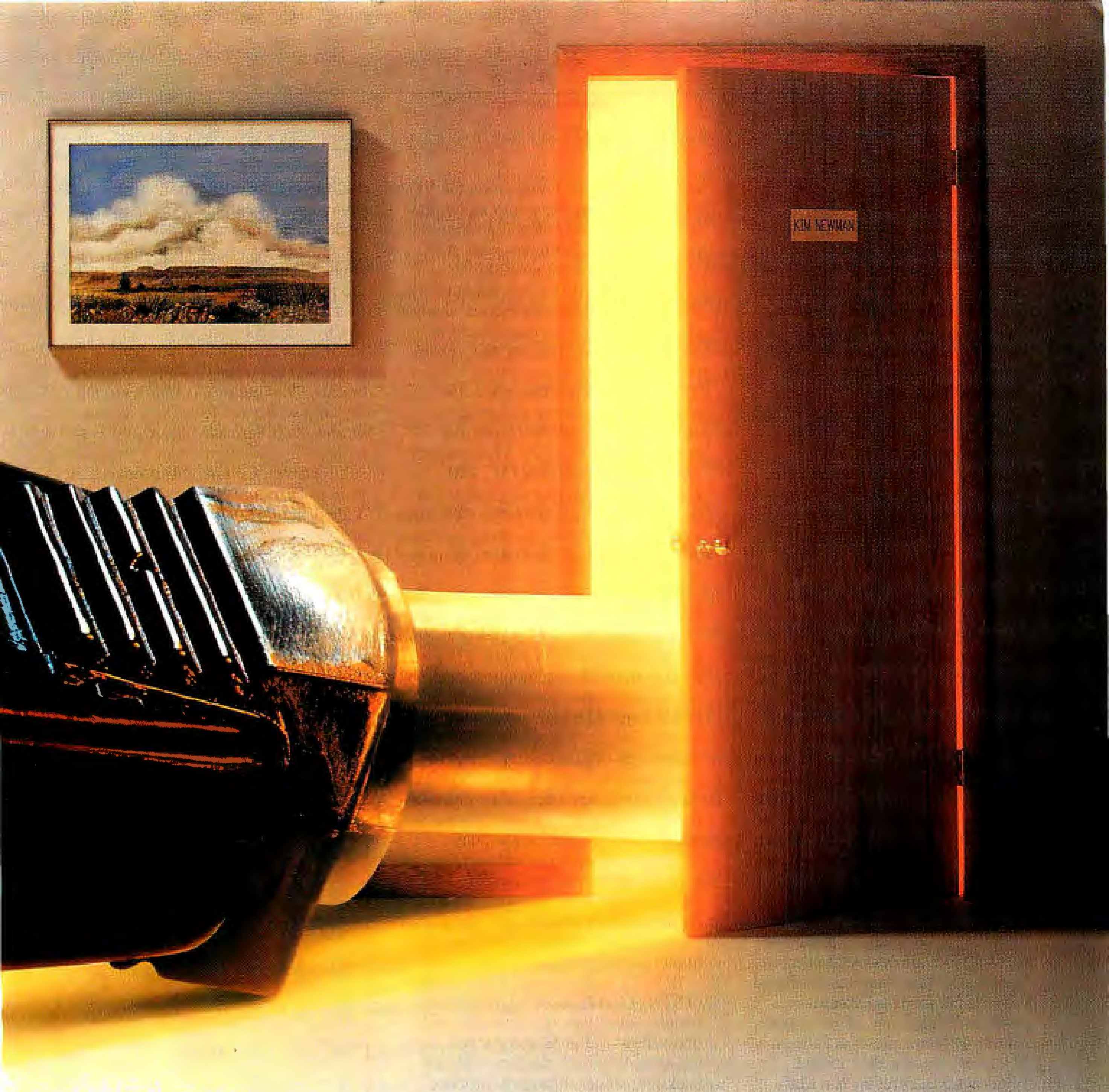

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NANOBYTES

Lotus hopes to buy its way into the world of Windows word processing by acquiring **Samna** (Atlanta), developer of the Amí programs. Lotus has no Windows applications yet; Samna has what's considered one of the best. Samna founder Said Mohammadioun was championing Windows back when it was the Rodney Dangerfield of windowing environments, shipping Amí in 1988. Under the terms of the proposed "definitive merger agreement," Lotus will pay approximately $65 million (or $18.84 per share of Samna common stock) to acquire Samna.

Apple Computer (Cupertino, CA) has switched on a toll-free telephone line to help "solve customer problems." The new phone service, available weekdays from 6 a.m. to 5 p.m. Pacific time, "is not designed to be a technical support hotline, but instead, is an extension to the comprehensive Apple customer relations effort," the company said. The new Customer Assistance Center "solves the problem of people being unable to get satisfaction from their dealer," Apple spokesperson John Cook said. The number is (800) 776-2333.

Multimedia pioneer **MacroMind** (San Francisco) plans to bring out software that allows **OS/2** users to "play back" presentations produced with the company's Director program. Right now, Director users can run Director presentations on a Macintosh or on a PC running Windows 3.0. Director is a Mac-based software package for integrating video, audio, still images, and other media. Plans call for player software for Unix platforms and for the Commodore Amiga.

Nice toys, eh? **DEC** founder Ken Olsen once **scorned personal computers** as "toys," but now DEC is coming out with a multiprocessing server system based on Intel 486 CPUs. The oddly named application DEC 433MP is designed to run SCO Unix with multiprocessing extensions, but there's no reason it couldn't use versions of NetWare or OS/2 LAN Manager in uniprocessor mode or when they support multiprocessing in the future.

smoothly scale and move it on the VGA screen. The card was pumping out the full-color moving video at 30 frames per second, C&T officials said. A PC Video board can put up multiple windows of various sizes, but only one window can be running motion video; if you want to have moving images in several windows, you can daisy chain the boards.

The chip can position a window anywhere on a screen, tied to an *x,y* coordinate or keyed to a particular color. A board using PC Video supports input formats such as NTSC, PAL, RGB, and SVHS, meaning that it can take images from common devices such as TVs, VCRs, video cameras, and laser disk players; input resolutions of up to 1024 by 512 pixels; and interlaced and noninterlaced outputs. PC Video can scale images in one-sixty-fourth increments, so you can have a picture as small as a postage stamp or as large as the full screen, rather than being limited to quarter-, half-, or full-screen video.

Chen said the company is "getting a lot of calls" from manufacturers interested in putting PC Video on their boards. The first product built around the chip will come from New Media Graphics (Billerica, MA), whose Super VideoWindows digital video board will sell for $695. Comparable products, such as IBM's M-Motion Video and VideoLogic's DVA-4000 boards, cost at least three times that.

— *D. Barker*

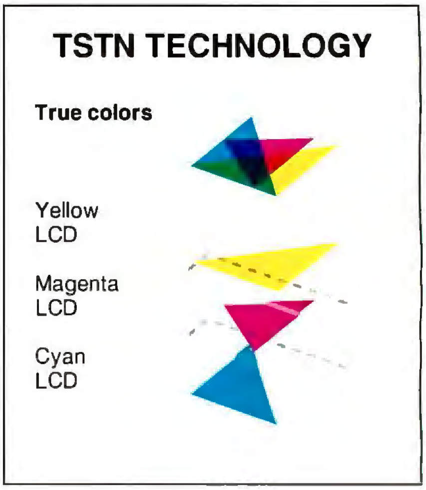
In Focus Puts New Twist on Color LCDs

In Focus Systems (Tualatin, OR) will soon start offering monitors incorporating its patented passive-matrix LCD technology. Although active-matrix displays are considered the color display technology of future computers, particularly laptops, In Focus says its "subtractive" approach to the older passive-matrix technology delivers better-looking color LCDs today. Companies pioneering active-matrix color displays, such as Sharp and the IBM/Toshiba joint venture, are still perfecting their designs and manufacturing processes, and their costs are much higher.

In Focus's triple-supertwist-nematic (TSTN) LCD is based on three LCD panels—one cyan, one magenta, and one yellow—aligned and stacked together. When all pixels are off, the backlight shines through to produce white on the screen. As the .33-mm square pixels are turned on (darkened), they subtract different portions of cyan, magenta, or yellow from the white light to get other colors. In Focus says this produces sharper images and deeper colors. The new display demonstrated by In Focus appeared bright, viewable from all angles, and rich in color. The designers say that the color quality is partially due to each TSTN pixel being a single, fully saturated color.

The company's new monitors, compatible with IBM PC and Macintosh systems, are capable of displaying up to 4913 colors at a resolution of 640 by 480 pixels. There are two models, both with 10½-inch diagonal screens: One displays up to 4913 colors; the other, 64 colors. The display technology used is based on that in In Focus's color overhead projector panels.

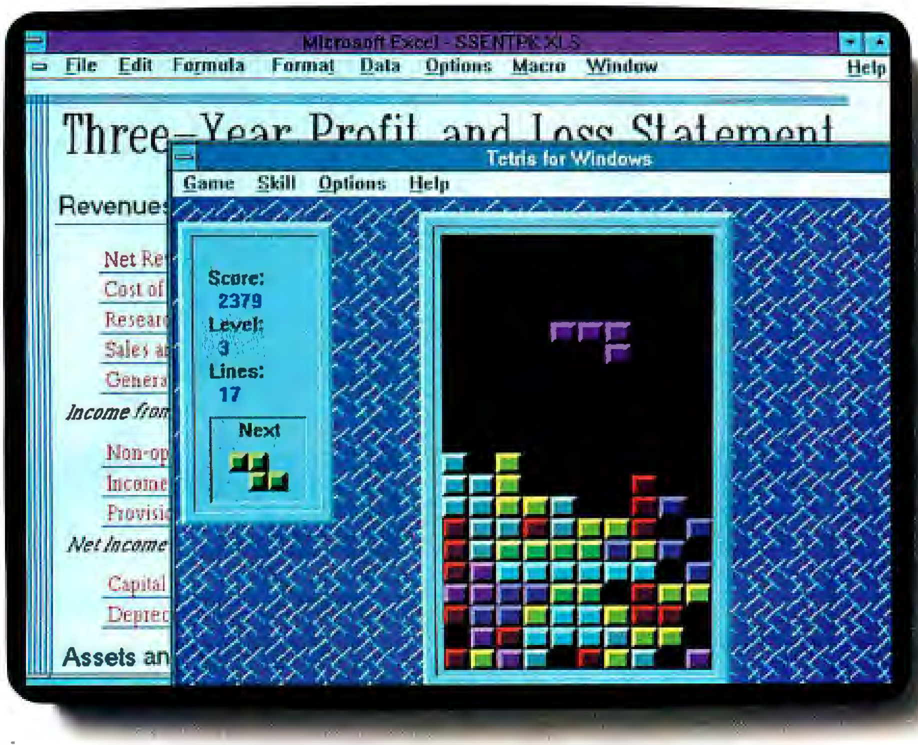
One advantage to this technique is that the displays are easy to manufacture, in quantity, using off-the-shelf



parts. They also don't bring the low-yield problems associated with active-matrix LCDs, says In Focus founder Steve Hix. Part of the problem, Hix says, is that each active-matrix panel incorporates a million interconnects; if one fails, you get a dead pixel on the screen. Another benefit of these monitors over regular CRTs is that they emit no extremely low frequency electromagnetic radiation, Hix said.

One disadvantage of TSTN is its slow response to moving video images. The response time of the display is between 200 and 250 ms. In Focus hopes to have reduced that to about 80 ms by the end of next year, a speed good enough to handle moving screen images. Also, the

Now you can use the incredible power of Windows 3.0 to goof off.



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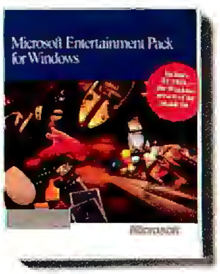

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Now get to work. Call us at (800) 541-1261, Dept. P11, and ask us all about the Entertainment Pack. We'll do our best to give you a completely frivolous answer.

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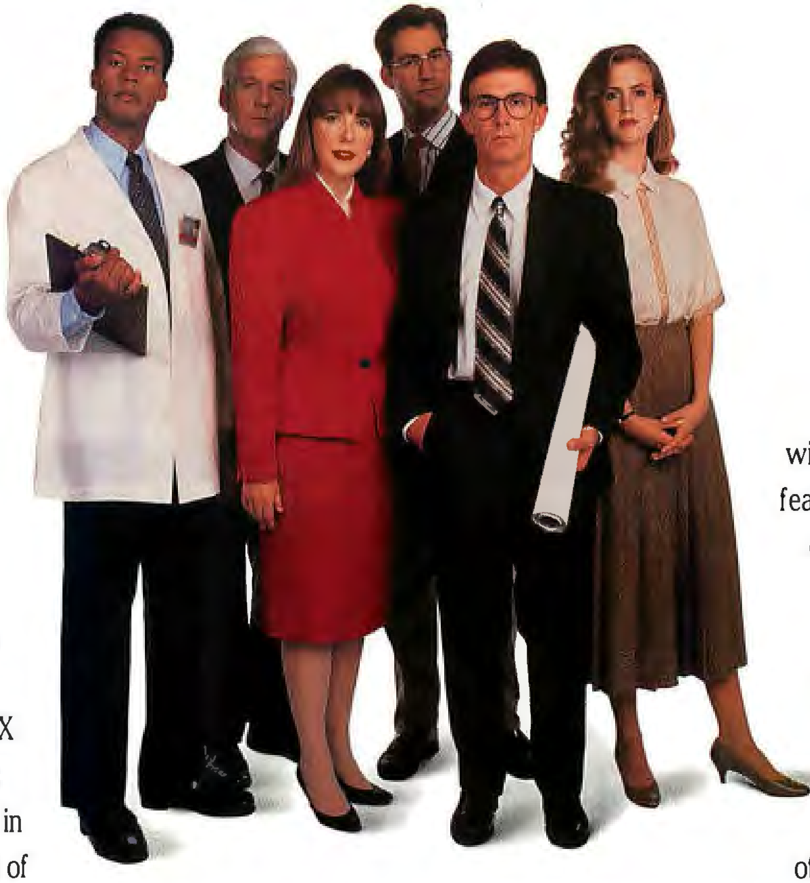
What does Compaq give 386 users who ex ect the moon?



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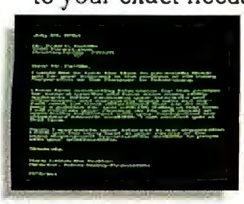

Come look at the COMPAQ DESKPRO 386N Personal Computer, for example. It's a full-function PC with breakthrough features for networked environments. As a stand-alone PC, its 16-MHz 386SX microprocessor handles all of the general business applications our other 386SX-based PCs run. With so many integrated features, you can take care of your expansion needs using only two slots.

And it comes with a host of unique network features like multilevel security, making it the best full-function PC for connected environments. All of this fits neatly into a space-saving design.

The COMPAQ DESKPRO 386S Personal Computer is also designed to handle general business applications. Its 16-MHz 386SX microprocessor gives you exceptional 386 performance. And its 32-bit architecture lets you run today's popular business software. It also offers the flexibility to run tomorrow's advanced business software.

NANOBYTES

RIP Z-1000: **Zenith Data Systems** (Mount Prospect, IL) has abandoned its plans to sell a multiprocessing Unix system. The company announced the Z-1000 well over a year ago but has now decided to leave the multiprocessing business to its parent company, Groupe Bull.

Hercules takes RISC: Hercules Computer Technology (Berkeley, CA), known primarily for its PC monochrome cards, has teamed up with **AQuest** (Santa Clara, CA) to develop graphics cards using Intel's i860 64-bit RISC processor.

The **U.S. government** has virtually eliminated controls on the export of certain high-speed computers to the Soviet Union. Under the latest recommendations being considered by COCOM (the Coordinating Committee for Multilateral Export Controls), most personal computers based on the Intel 486, as well as many graphics workstations, could be exported to the Eastern Bloc.

AT&T's **Unix System Laboratories** is opening a center in Summit, NJ, where software vendors can certify System V release 4 applications on various hardware platforms, including Intel, MIPS, Motorola, and SPARC.

Looking for **scientific information from Japan**? The National Science Foundation (Washington, DC) is now offering free searches of Japan's National Science Center for Science Information System (NACSIS). The database contains information on research activities funded by the Ministry of Education, Science, and Culture, as well as development at universities. American knowledge seekers can request a search by phoning the NACSIS operator, between 1 and 4 p.m. (EDT), at (202) 357-7278.

Virtual book: Harcourt Brace Jovanovich (New York) plans to publish a book next year on **virtual reality** cowritten by one of its foremost explorers, **Jaron Lanier**. Lanier, founder of VPL Research, was paid a six-figure advance for the manuscript on "alternative sensory realities," the publisher said.

monitors require a 50-watt direct backlight rather than the diffuse backlight used in most portables today; the new cold cathode backlights aren't direct enough to work with the In Focus displays, which means that the displays currently use a lot of power.

In Focus has licensed its TSTN technology to an unnamed U.S. laptop manufacturer for products that are expected to appear in late 1991. Hix said the company will have a high-resolution color display later this year.

— Owen Linderholm

Telecommuting Gets Boost from Industry, Feds

Representatives of industry and government have united to promote the concept of telecommuting—people doing their work at remote sites such as home, for example, with the assistance of computers and telecommunications. The new organization, Telecommuting Solutions for America (Washington, DC), hopes to help implement ideas and technical standards for telecommuting.

TSA founder Rich Thoma says telecommuting improves the quality of life, is better for the environment, and increases productivity. "We're not talking about a futuristic dream," he said. "The technology exists for companies and government agencies to establish significant telecommuting programs today." The Environmental Protection Agency estimates that if 5 percent of Los Angeles commuters telecommuted one day per week, it would eliminate 47,000 tons of pollutants and 205 million miles of travel annually.

Link Resources, a research firm, says that over three million Americans spend 35 or more hours a week working from home, and some 22 million work partly from home or from satellite locations. According to Jeff Garbers, director of development at Crosstalk Communications, a telecommunications software maker, this is now possible because all the factors have "started coming together on a widespread basis: cost-effective personal computers, easy-to-use communications products, and reliable and inexpensive services."

The federal government is represented in the group by the EPA, the Department of Transportation, the Office of Personnel Management, and the General Services Administration. Each agency has pledged to encourage telecommuting both for its own employees and as public policy. Companies that support the new organization include MCI, Tigon (a subsidiary of Ameritech Corp.), U.S. Sprint, Novell, Hewlett-Packard, and Northern Telecom.

— Allan Davidson and Jan Ziff

Superfloppy Drive Will Work with Regular Disks

The first very high-density floppy disk drive to work with regular floppy disks is scheduled to arrive this month. Insite Peripherals (San Jose, CA) plans to start shipping limited quantities of its Floptical disk subsystem, which can store 20.8 MB on 3½-inch floppy disks. But the drive can also read and write 720K-byte and 1.44-MB floppy disks, the company said.

Insite's Floptical disk drive uses embedded optical tracks and a closed-loop servo motor to dramatically increase the storage capacity of a magnetic floppy disk. Because it can both read from and write to 720K-byte and 1.44-MB media, it could become a standard A drive without making the installed base of drives and disks obsolete.

The drive offers an average seek time of 65 ms and a data transfer rate from the Floptical disk drive of 1.6 MBps, Insite says. When operating on older media, the transfer rate drops to 600 Kbps or 1.2 MBps.

Volume production is planned for April 1991, the company said. The OEM price is $325.

— Andy Reinhardt

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People the World Over

Everywhere you look these days you'll find Gateway 2000 computers. That's because people

everywhere know a good value when they see one. In all 50 states and in over 70 foreign countries, thousands of people are comparing price, quality and service – and choosing Gateway 2000.

In Gothenburg, Sweden

Anders Bjernefors, a computer dealer and programmer, bought a Gateway 2000 25 MHz 486 system last April. "After many faxes and a lot of study, I selected Gateway 2000," said Anders. "I'm pleased with the machine. I received a very powerful, well-built computer for an astonishingly low price."

Anders Bjernefors, Computer Link AB, and his Gateway 2000 25 MHz 486™ system.

Anders was so impressed by his system and by the people at Gateway that he contacted the company about becoming a Gateway 2000 reseller. "I telephoned my salesman," Anders remembered, "and he told me I'd have to visit the factory to make the arrangements. I was on the next plane out of Goteborg on my way to North Sioux City, South Dakota."

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In Worland, Wyoming

Bob Borst, owner and operator of Cloud Peak Pest Control in Worland, spent two and a half months researching his computer purchase. He chose a Gateway 2000 386SX.

Bob Borst, owner and operator of Cloud Peak Pest Control, and his Gateway 2000 386SX.

"My final decision was based on people, not hardware," said Bob. "The Gateway people make you feel like you're the most important person in the world. I didn't buy a computer – I bought Gateway."

Bob was equally impressed by Gateway's service people. "One time I got into a file and couldn't get out of it," Bob related. "Even though it was a software problem, I called Gateway and they talked me through it."

In Socorro, New Mexico

Gordon Kane, Laboratory Associate at New Mexico Tech, runs a computer lab with 15 Gateway 2000 286 systems. "At first we bought Gateway's because of the good prices," said Gordon. "But now I buy them because of the technical support, which is very superior, and because the company is committed to improving its product line."

Gordon Kane, New Mexico Tech, with his Gateway 2000 286 lab computers.

NMT also uses Gateway computers in its research programs. "A Gateway 386 cache system will be used

Choose Gateway 2000!

at Kennedy Space Center next summer," said Gordon, "as part of a large program of thunderstorm studies being conducted there by NASA and the Air Force."

PC Magazine's survey about service and reliability confirms what these customers are saying:

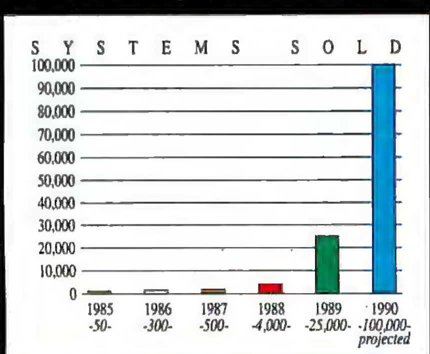
"Gateway shared top billing with such heavy-weights as Compaq, IBM, and HP for those who would buy their products again...Overall, Gateway's high marks bode well for the company's future, as does its commitment to customer service."

PC MAGAZINE

PC Magazine
September 25, 1990

From the Heartland

The combination of price, quality and service makes Gateway 2000 the best value in the industry. But value alone doesn't explain how a little company in the Midwest, just celebrating its fifth anniversary, managed to outdistance hundreds of other companies, selling more systems through the direct market channel than any other PC manufacturer in the country.



Gateway 2000 sells more computers through the direct market channel than any other PC manufacturer in the country.

"It was the cows," laughed Ted Waitt, Gateway 2000 President and CEO. "Of course." Computer magazine readers will remember the company's early ads featured a picture of the Waitt cattle farm with the headline, "Computers from Iowa?"

5TH ANNIVERSARY GATEWAY 2000

"In the computer industry, longevity should be measured in dog years."

"We can't run that ad anymore," continued Ted, grinning, "because we built a new plant 14 miles down the road in South Dakota. But the cows really worked for us. They made the phones ring. From then on, though, we built our business on value – good prices on quality systems with old-fashioned, personal service."

Ted mentioned another reason for Gateway's success. "We take a long-term approach to customer service," he said. "When you buy a computer from Gateway 2000, you become part of our family and we're going to be there for you as long as you own that machine."

As Ted talked about the company's fifth anniversary, he laughed again. "In the computer industry, longevity should be measured in dog years," he chuckled, "because every-thing's moving so fast. That makes Gateway 35 years old! But seriously, we've come a long way in five years. And I owe it all to the great people at Gateway and to our customers."

Gateway 2000 will be there for you 'til the cows come home.

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LETTERS

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Object Orientations

I just read Brad J. Cox's stimulating article "There *Is* a Silver Bullet" (October 1990). His analysis hits the software crisis dead center.

It is interesting to note the resistance of typical programmers to creating modular systems, as well as to investing the effort in making modules and programs user-friendly. Commercial software is certainly making strides toward being user-friendly (but not toward modularity). Programmers still appear to think that it is unprofessional to make their work accessible to users, much less to other professionals. This appears to be true even of those programmers who create modules for their own use.

The modular approach is certain to be attacked by programmers as demeaning by changing a highly skilled occupation into one that merely produces useful objects. However, the definition of useful objects, of collections of useful objects, and of hierarchies of useful objects is a higher-level and more difficult skill than programming.

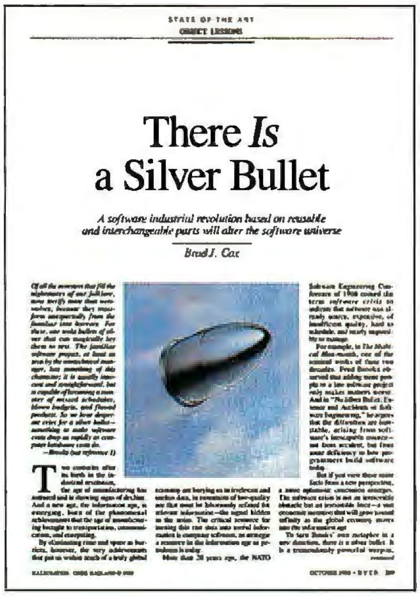
Chris E. Kuyatt
Sandy Spring, MD

I fear that Christopher M. Stone and David Hentchel reflect their lack of experience in the banking industry when they argue that the object-oriented approach is not the right thing for bank accounts ("Database Wars Revisited," October 1990). After spending many years leading software development efforts for large banking systems, I can assure you that there is almost no area in computing that can benefit as much as banking applications.

Why? Because the central profitability issue for a bank is being quick to market with new products (e.g., a new type of bank account). New accounts are clones of old ones with minor modifications. Take 10 COBOL programmers and six months using traditional technology to implement a new product, and you can find yourself clobbered by competitors who have grabbed your market share.

Yet, in a few weeks, using inheritance as an example, a new account type can be up and running and fully tested. No competitor can beat this using conventional technology.

In addition, version testing is extremely useful to a bank. New products must be tested against a clone of a real database to look at profit-margin effects. Using conventional technology requires setting up a completely independent test database, which involves a lot of time and expense. By the time you are done, you always get somewhat ambiguous results, because a real production database is far too large and time-sensitive to accurately duplicate.


STATE OF THE ART
OBJECT LESSONS

There *Is* a Silver Bullet

A software industrial revolution based on reusable and interchangeable parts will alter the software universe

Brad J. Cox

With version testing, the marketing department can run as-if scenarios against the real database and throw away the test versions after the results have been analyzed, all without affecting production.

The authors are correct in assuming that someone should not be able to check out an account using optimistic locking, allowing someone else to update it while it is in use. However, using object-server technology, at the bank where I work, we implemented pessimistic locking with transaction processing performance an order of magnitude faster than relational systems and three times faster than benchmark results from a number of the best hierarchical database management systems.

The auditors were ecstatic with object-server technology that could store methods in the database. Using methods as triggers, they could submit encrypted rules to the bank that caused certain accounts or certain transactions to be monitored. The database would automatically generate encrypted reports to be returned to the auditors or, alternatively, send a mail message to the auditor that something suspicious was going on.

The trigger approach is the most advanced auditing scheme currently available, because transactions can be monitored without the knowledge of the banking staff and completely independently of any COBOL application programmer's code. Only the database designers know how the public/private key-encryption algorithms are generated, and even they can't crack the auditors' encrypted audit requests or the encrypted reports generated by the system.

Jeffrey V. Sutherland
President, Object Databases
Cambridge, MA

The Object Lessons section (State of the Art, October 1990) was excellent, and it contained enough technical information for me to sink my teeth into.

I would like to comment, however, on a recurring theme in this sort of subject area. I like to call it the Evangelical Theme. Simply put, it refers to supporters of some new concept (in this case, object-oriented programming) believing that their method is going to revolutionize computing and that no one will use the old way ever again. I detected quite a bit of evangelism in some of the articles in this section.

I am what one of your authors would call a synthesist. That basically means that I recognize the inescapable fact that no one system, technology, or methodology is appropriate to all programs. For the most part, people do not write data acquisition software in Scheme, and they don't write database software in

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. Letters two pages in length or under have a better chance of being published in their entirety. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send letters via BIXmail c/o "editors."*

Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.

FORTRAN. Why? Because neither of those languages is appropriate to the task at hand.

A similar argument applies to the present "objective" craze. Object-oriented languages and techniques are useful for modeling object-oriented problems, like the manipulation of desktops or message-passing simulations. Does this mean that you can't use C++ to do numerical analysis? Of course not. But it does mean that C++ or Smalltalk or Xlisp may not be the appropriate tool for the job.

I liked the way your articles gave Objective-C equal time alongside C++. Many programmers think that Objective-C is in some way better that C++, and the debate is still not over.

Garrett A. Wollman
South Burlington, VT

I read BYTE because it goes into advanced topics sufficiently to stretch my mind; the comprehensive object-oriented programming (OOP) material in your October issue puffed my mind up like a balloon.

In spite of my reverence for Edward Yourdon's knowledge and ability compared to mine, I disagree with some of his comments in "Auld Lang Syne." I approach analysis and programming by looking for the tool that will do the best job for what I want to do. I won't use a pipe wrench to drive a nail (well, I will in an emergency), and I won't use a hammer to put in a screw. If OOP in one area does the job better, I'll use it; if it does not, I won't. Saying that structured procedural programming is always right is as foolish as saying that OOP is always the answer.

However, I do believe that OOA (object-oriented analysis) is a very beneficial shift of paradigm. It forces us to be sure that we really understand the system. I can't design it if I don't understand what it does or how it does it.

Your articles on OOP and OOA/OOD (object-oriented design) really helped me understand the subject better.

Thomas J. McCarthy
Indianapolis, IN

More from the Summit

The quote from Bill Gates ("BYTE Summit," September 1990) saying that chaos "doesn't impact computers" absolutely flabbergasted me. That is the equivalent of saying that disease is irrelevant to the development and use of the microscope.

If not for the invention of computers, chaos would be nothing more than the constant annoyance that, despite our "great" knowledge, seems to constantly foil the best computed predictions of mice-using people. Chaos is seeing the forest for the trees.

We in medicine have been constantly confounded by the perceived imprecision of nature. Why do some people with virtually identical environments develop cancer? Why do some survive while others perish?

Computers made the science of chaos possible. Computers are the microscope of the future. A science discovered on computers and that defines the universe certainly deserves more than a few gratuitous lines in BYTE's prediction of the future. Chaos theory is important to computing because it will yield ways to make computers do (not simulate) things of which we now just barely dream.

Thank you, BYTE; you've been my companion for 15 years. I hope you'll be here for many more years to come. Congratulations on your birthday.

Dr. Kenneth D. Hackmeyer
Cleveland, OH

The BYTE Summit is about the future, and, according to the "experts," the future is bright. Computers will be more powerful, cheaper, faster, smaller, and so much a part of our lives that we won't even notice them anymore.

Come on, BYTE, tell us something we don't already know. You chose to talk with people involved with the industry for many years. Why didn't you ask those "experts" to take a look back and reflect on the impact of the work they have done? Better yet, why didn't you ask users about that impact or about what they would like to see in the future? That kind of feedback could be useful and healthy.

Although it makes a cursory nod to social issues, the BYTE Summit is mainly an ode to technological progress, by a bunch of insiders cheering themselves on to a bigger and better future. I can't believe I read the whole thing.

Sarah Brehm
Madison, WI

Recycling Rebuttal

"To Refill or Not to Refill" (July 1990, p. 142) contained inaccurate statements and did not tell the whole story.

As a result of the introduction of Canon laser printers and copiers that use a replaceable cartridge containing the drum and toner supply, an entire industry has sprung up since 1985 to recycle used Canon toner cartridges. There were problems in those early days, with most cartridge refillers using the "drill and fill" method. This simply meant drilling a hole in the cartridge, dumping out the old toner, and filling the cartridge with new toner. The results were not always satisfactory, and the industry obtained a bad reputation.

"Drill and fill" was soon replaced by a remanufacturing process that was a vast improvement; however, the problem of parts wearing out (particularly the optical photo coupler [OPC] drum) was still an obstacle in consistently providing a quality product to the end user.

About a year ago, new technology caused some dramatic changes. You stated that the life of the OPC is limited. This is true, especially as it relates to the original OEM drum. However, cartridge recyclers now have available to them a new "super drum" that allows a cartridge to be recycled as many as 10 to 20 times with no noticeable drum wear. There are also replacement corona wires, wiper blades, and related products to ensure quality. Most cartridge recyclers indicate on the cartridge the date and/or the number of times a recycle is completed in order to monitor the life of the cartridge.

Because most cartridge recyclers guarantee their product (many even guarantee a minimum number of refills), it is not necessary to require that the recycler return the exact cartridge you sent him, although most recyclers will work with you should you require that the original be returned.

Regardless of what a manufacturer's service representative tells you, using a recycled cartridge will not void your warranty. Manufacturers' official policy [often] states that if a refilled cartridge causes any damage, the warranty won't cover repairs caused by that cartridge. There is no record of damage caused by properly recycled cartridges during the industry's five-year history. Properly recycled cartridges can cause no more damage than a brand-new cartridge. Most cartridge recyclers will provide a guarantee in the event that this should happen.

Cheryle White
President, American Cartridge Recycling Association
Miami, FL

Alternative Operating Systems

Thank you for your reviews of alternative operating systems to OS/2, Unix, and DOS extenders. However, I was very disappointed in Ben Smith's review of OS-9000 ("From a Tiny Kernel...," September 1990). There were no comparisons of the size of the kernel, or of the

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speed of doing common operations versus QNX, Xenix, or Unix. No mention was made of the ability to install, remove, or modify drivers without regenerating the kernel.

Also, Smith stated, "You probably won't be using OS-9000 for your common PC applications." Why not? The article was supposed to be about alternative operating systems, right?

Ramer W. Streed
North Mankato, MN

My article was not a review, so my intent was to give a brief description of an operating system, not to compare operating systems.

To do what you are asking, we would need to develop an independent set of operating-system benchmarks that tested the common advanced features of each operating system. That's a task that I would suggest as a doctoral project for a Ph.D. in computer science.

—Ben Smith

ASK BYTE

Hyperion Huzzahs

Once upon a time, there was a marvelous little machine called the Hyperion and a marvelous word processing program with it, called In:scribe. The program did all the basic things that most people want. It did not do a bunch of things that pretty sophisticated people want, but the trade-off was that the program was virtually idiot-proof and took only a few minutes to master. The secret was the use of softkeys that were displayed on-screen in a cascading sequence. It was a delight to use.

Do you know of any program now available that uses this system? If so, I'd like to know where I can get it. The nearest I have come is Microsoft Word. Also, is In:scribe for the more advanced versions of MS-DOS still commercially available anywhere?

P. M. Pitfield
Westmount, Quebec, Canada

Ahh...another fan of the Hyperion. In tracking down the current whereabouts of In:scribe, I keep running into more and more die-hard fans of the Hyperion portable. Dynalogic Info-Tech (the developer of the Hyperion) disappeared some time ago, changing its name and merging several times. The technology behind In:-Scribe is currently part of the NTM Menu Manager interface from Diligence Technologies. Now known as Notemaker, the program has been turned into an ASCII system editor, and while it still uses function keys, it no longer has the cascading key sequences that were the Hyperion's trademark. Too bad, too, as that idea was a popular one used in a number of commercial products. Hewlett-Packard used it in its 64000 series development system, and when I worked for Coleco, we used it on the Smart software family for the Adam. Maybe we'll see it again someday.

In the meantime, Comterm (93 Hymus Blvd., Pointe Claire, Quebec H9R 1E2, (514) 694-4332) is still handling service on the Hyperion. The service division is undergoing a name change even as we speak, but if you contact the people there at the above address, they'll put you in touch with the right people.—H. E.

A Luggable Beast

As I read through "15 Years of Bits, Bytes, and Other Great Moments" (September 1990), I was surprised to see a reference to the IBM 5100 that was announced in 1975. I have one of these "luggable" machines collecting dust in my garage because my wife refuses to let me bring it inside. When I told her it originally sold for around $9000, she was still not interested.

As I contemplate selling the beast, I am curious to know what you thought I could sell it for today. Is it a collector's item, or should I consider using it as a boat anchor?

Douglas G. Jones
Valparaiso, FL

I know exactly what you're talking about. I have a dozen or more machines, some dating back to before the 5100. They're neat to have, and it certainly seems like they should be worth something. Get a stout chain ready—I'll get to the 5100 in a second.

There's a fairly booming business in used equipment nowadays. If you're looking to buy or sell equipment, you can contact the Boston Computer Exchange (P.O. Box 1177, Boston, MA 02103 (800) 262-6399). The people there have set standard prices for common equipment, and for a $25 fee, they will appraise any unusual stuff. The BCE didn't have a listing for the 5100.

Another place to check is in one of the used computer listing books. The National Association of Computer Dealers publishes the Computer Bluebook *of wholesale and retail prices. You can order the book directly ((800) 223-5264) for $15.95. A more detailed book is available from Orion Research (1315 Main Ave., Durango, CO 81301, (303) 247-8855) for $124.95.*

Back to the 5100. None of the listing books shows the 5100. A specialty machine like the 5100 has no real value as an everyday machine, unless you happen to need one specifically. That makes it hard to find a buyer. A curiosity seeker might give you $25 for it, while someone who has built an entire testing facility around one might offer you $1000 or more. You might take out an ad in the paper and see who bites. Basically, we're talking Boat Anchor City here.

Since the machine was built back in the 1970s, it's one hefty beast. It's probably worth a fair amount for scrap value. You might contact some scrap dealers and sell it for enough to buy you and your wife a nice dinner out. If you want to see it used by someone, the folks at Orion Research recommend that you contact the National Christina Foundation for the Blind and Disabled ((914) 738-7494). It's a charitable organization that helps get donations (i.e., used computers) directly to people who can use them. The group doesn't resell the equipment, but it finds a good home for it.

Someday, I expect we'll be getting letters from people who need to find out what their old 486s are worth. It's sad, isn't it?—H. E.

On Pascal's Trail

I am trying to learn Pascal. Can you recommend a few textbooks on the subject?

J. D. St. John
Oak Creek, WI

If you've made up your mind to learn Pascal, the first thing you should do is buy a good Pascal compiler. It will include your most important resource: the language reference. Many compilers also come with tutorial books or floppy disks.

A few popular compilers are from Borland International (1800 Green Hills Rd., P.O. Box 660001, Scotts Valley, CA 95066, (408) 438-8400); IBM (Old Orchard Rd., Armonk, NY 10504, (800) 426-2468); Jensen & Partners International (1101 San Antonio Rd., Suite 301, Mountain View, CA 94043, (800) 543-5202); MetaWare (2161 Delaware Ave., Santa Cruz, CA 95060, (408) 429-6382); Microsoft Corp. (1 Microsoft Way, Redmond, WA 98052, (800) 426-9400); and MicroWay (P.O. Box 79, Kingston, MA 02364, (508) 746-7341).

When you order, you should also ask about any companion books for the specific compiler you choose.

Pascal is no longer the hot language it

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once was. Some publishers—such as the Waite Group, which put out very good Pascal books in the past—are no longer carrying titles on the subject.

Holt, Rinehart & Winston (301 Commerce St., Suite 3700, Ft. Worth, TX 76102, (800) 776-2606) has discontinued a fine book on Pascal by James Peters. The company still has some Pascal books in its catalog, so you can give the people there a call.

Osborne/McGraw-Hill (2600 10th St., Berkeley, CA 94710, (800) 227-0900) has some titles geared toward Borland's Turbo Pascal. Sybex (2021 Challenger Dr., Suite 100, Alameda, CA 94501, (800) 227-2346) has an introductory book on Pascal as well as titles covering Microsoft's Quick Pascal. For other books on Quick Pascal, call Microsoft Press (P.O. Box 97200, 10700 Northup Way, Bellevue, WA 98009, (800) 888-3303). You can call any or all of these publishers and request a catalog.

—S. D.

OOP Help

At British Steel, we are looking into object-oriented programming, and I need a comprehensive text for reference.

I have long been a convert to BYTE and would like to know if you could either recommend a sensible book or quote me a price for a collection of BYTE articles packaged up that I could refer to in my work on a pilot project.

Gary R. Pead
South Yorks, U.K.

I love to answer reader requests that are so easy.

The October 1990 State of the Art section is devoted to object-oriented programming.

There are quite a few OOP books out. I suggest you browse through a bookstore's technical section. Here are some titles to look for:

- Designing Object-Oriented Software *by Rebecca Wirfs-Brock, Brian Wilkerson, and Lauren Wiener (Englewood Cliffs, NJ: Prentice-Hall, 1990).*
- Object Oriented Program Design with Examples in C++ *by Mark Mullin (Reading, MA: Addison-Wesley, 1990).*
- Object-Oriented Turbo Pascal *by Alex Lane (Redwood City, CA: M&T Publishing, 1990).*

—S. W.

CAI Search

I am looking for authoring software for developing CAI courseware on the PC. Would you please let me know the names and addresses of reputable manufacturers and the names of their products. I would also appreciate it if you could send me the address and telephone of Kinko Academic Software.

Dr. Ivan Tomek
Nova Scotia, Canada

Authoring software continues to evolve on the PC. The coming year should bring some exciting products. For now, there is Authorware Professional for Windows (Authorware, 8500 Normandale Lake Blvd., Minneapolis, MN 55437, (612) 921-8555); Guide (Owl International, Inc., 2800 156th Ave. SE, Bellevue, WA 98007, (206) 747-3203; ask for Sharlene or Julie); IconAuthor (Aimtech Corp., 77 Northeastern Blvd., Nashua, NH 03062, (800) 289-2884); and Quest (Allen Communications, 5225 Wiley Post Way, Suite 140, Salt Lake City, UT 84116, (801) 537-7800).

I cannot find a listing for Kinko Academic Software. Perhaps one of our readers has the information. Any takers?

—S. D.

Faster, Please

Help! I have an upgrade question that probably is answered in Computer Science 101, but for which I can't find an answer locally.

I own a Leading Edge Model D that works fine for me. I added an Amdek 600 color monitor, a 30-MB hard disk drive, and an Epson 24-pin printer. However, my wife has gotten the genealogy bug, and some of the sort routines on her program are taking too long to run. Ergo, I want to speed up the machine.

I considered using a 286 board, but I was told that I could double the operating speed by using a V20 CPU. I would probably have to upgrade the RAM chips and would need a new ROM, but I can't find out which one.

I wrote to Leading Edge in Westborough, Massachusetts, back in July but never received an answer. So, if someone at BYTE could run the solution by me, I surely would appreciate it.

Sure, a 486 or even a 386 would be nice, but I have neither the money nor the need for a new machine, so my D and the Heath H-89 will keep on doing fine.

Jose C. Cabanillas
Orange Park, FL

You've been misinformed. The V20 CPU is a direct replacement for the 8088. You don't need faster RAM chips or a new ROM BIOS. At most, the new CPU would give you a 5 percent increase in computing power. Plugging a 286 speedup board into your computer may work, depending on how old your Model D is. Early models had bugs in the BIOS ROMs, and they may not work with speedup boards. You could try the speedup with the proviso that you could return the upgrade if it didn't work.

Leading Edge was bought out by Hyundai Electronics, and support for the Leading Edge is practically nonexistent. Good luck.—S. W.

It Kept Going, and Now It's Gone

I have an Epson PX-8 laptop computer that I have used to good effect on business trips here and overseas since 1983. It is just the right size to fit in my briefcase and carry along without constantly reminding me of its presence.

My problem is that the rechargeable battery has finally given up the ghost. Where can I find replacement batteries for the PX-8 and for the separate 3½-inch floppy disk drive?

David M. Dacus
Chantilly, VA

Epson still carries replacement batteries and parts in its catalog. You can bring your machine to any sales and service center and have the battery replaced. If you'd rather do it yourself, a number of service centers will sell you the parts directly. You can reach Epson's Accessories division at (800) 873-7766. The people there will give you the name of a service center in your area.

One place you might try is Transaction Equipment in Yorba Linda, California, at (714) 970-7881. The people there seem to know anything you'd ever want to know about the PX-8. Unfortunately, the PX-8 accessories are no longer available, but that machine was fairly popular, and service should be available for a long time to come. Just remember that as parts become less and less common, they become more and more expensive. That battery you need won't be cheap.—H. E.

FIXES

- The price of a single-user PC license for the Pick operating system ("Pick: OS or DBMS?" November 1990) was incorrect. The correct price is $495.
- As careful readers of the time line ("15 Years of Bits, Bytes, and Other Great Moments," September 1990) well know, the importance of the original IBM PC cannot be *overstated.* ■

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Put all that together, and you get the kind of power you can actually use.

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Just look at SPARCstation 2GX. It gives you ultra-high speed at no extra cost. And brings a whole new level of performance to X-window applications. So it's ideal for electronic publishing. Financial analysis. And for anyone who has to work with 2-D and 3-D wireframe applications.

And that's just the most basic color model. We've also built SPARCstation 2GS. It lets

486 EISA in a Tower

CCS Custom Computer Systems has introduced its CCS 486-25c EISA computer. The 25-MHz system has six EISA slots for bus-master devices, as well as one 16-bit and one 8-bit slot.

The CCS 486-25c uses a Mylex MAE486-25 motherboard with a Phoenix BIOS. The board provides 128K bytes of static RAM write-back cache in addition to its 8K-byte internal cache. The 4-MB 80-ns single in-line memory modules on the board are expandable to 32 MB. A Weitek WTL4167 math coprocessor socket is also provided.

The CCS 486-25c has two floppy disk drives (one 5¼-inch, one 3½-inch), a Conner Peripherals CP3200F 212-MB SCSI drive, and a real-time clock/calendar with battery backup. Housed in a 30- by 10- by 29-inch tower case with 12 half-height drive bays, the CCS 486-25c has a 375-W power supply. Options are available.
Price: $9999.
Contact: CCS Custom Computer Systems, Inc., 191 Woodport Rd., Sparta, NJ 07871, (201) 729-6762.
Inquiry 1271.

The CCS 486-25c EISA features a Mylex MAE486-25 motherboard with a Phoenix BIOS. Its 128K bytes of write-back cache provides zero-wait-state operation.

Two SPARCs

The 25-MHz Solarix/4 Personal Workstation Plus (Solarix/4 PW+) operates at 18 MIPS; by replacing its credit-card-size processor module, called the A-Module, you can upgrade to 40-MIPS performance.

The Solarix/4 PW+ uses both the SPARC 32-bit SBus and the SPARC 64-bit MBus and provides 8 to 32 MB of RAM using standard single in-line memory modules. You have the option of adding from 64 to 128 MB with Solarix SIMMs.

Available as a mini-tower with an internal bay supporting up to six half-height peripherals, the Solarix/4 PW+ works as a stand-alone unit or as part of a network. It comes with 8 MB of RAM and a 17-inch monochrome monitor. A second configuration offers a 104-MB SCSI internal hard disk drive, a 17-inch monochrome monitor, 8 MB of RAM, and a 1.44-MB floppy disk drive.
Price: Standard configuration, $6995; configuration with SCSI internal hard disk drive, $7995.
Contact: Solarix Systems, 46791 Fremont Blvd., Fremont, CA 94538, (415) 659-1544.
Inquiry 1272.

The Mariner 4i is a workstation that combines the power of SPARC technology with DOS accessibility, all in one box. The heart of the Mariner 4i is a Sun-compatible SPARC workstation, but because it's based on a standard ISA bus, you can add an optional DOS module for full DOS compatibility.

According to Mars, the 25-MHz Cypress SPARC CPU provides 16.8-MIPS performance. Add the plug-in DOS module, and you get a 386 processor with cache, VGA display capability that runs in a window of the SPARC screen, and up to 8 MB of RAM. The module includes four PC bus connectors that let you use AT peripherals.
Price: Diskless unit with 16-inch monochrome monitor, $5995; unit with DOS module, 19-inch color monitor, and 207-MB hard disk drive, $10,995.
Contact: Mars Microsystems, P.O. Box 1080, Mars, PA 16046, (412) 934-1040.
Inquiry 1273.

SPREAD THE WORD

Your new product is important to us. Please address information to New Products Editors, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Better yet, use your modem and mail new product information to the microbytes.hw or microbytes.sw conferences on BIX. Please send the product description, price, ship date, and an address and telephone number where readers can get more information.

A Smaller EISA 386 for Small Businesses

In addition to 33-MBps burst DMA transfers, the 25-MHz Micro Express ME 386-EISA system offers 14 independently programmable channels. It comes with 1 MB of RAM, a 1.2-MB floppy disk drive, and one serial and one parallel port. It is housed in a mini-tower case.

A Phoenix EISA BIOS is included on the motherboard, with an expanded memory manager and disk caching as standard features. The system and video BIOS are transferred to shadow RAM to increase performance. The standard 8 MB of RAM is expandable to 16 MB with an 8-MB add-in board.

The ME 386-EISA accommodates six 32-bit EISA expansion cards and two 8-bit ISA cards. It has a socket for an Intel 80387 or Weitek WTL3167 math coprocessor.
Price: $1799.
Contact: Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705, (800) 642-7621 or (714) 852-1400.
Inquiry 1274.

Marstek's 800-dpi hand scanner works with PCs and Macs to let you scan stamp-size images and create special effects.

A Hand Scanner for PCs and Macs

The M800 Plus, an 800-dpi hand scanner, lets you scan an image as small as a postage stamp and retain the full details of the image. For use with PCs and Macs, it produces 64 levels of gray and 12 halftone patterns.

With the M800 Plus's inverse image function, you can create special effects. The PC version includes PC Paintbrush Plus and CAT Reader OCR; a special PC version, M800W Plus, is compatible with Windows 3.0; the Macintosh version includes Digital Darkroom and Scanlink.
Price: PC version, $459; Macintosh version, $549.
Contact: Marstek, Inc., 17795-F Sky Park Cir., Irvine, CA 92714, (714) 833-7740.
Inquiry 1275.

Eight Keys to Easy Typing

Vatell is offering an alternative to the QWERTY keyboard: the Accukey. The 2-pound, eight-key unit is ergonomically designed and about half the size of a conventional keyboard. According to Vatell, an average user can learn to touch-type on it in 3 to 4 hours following the tutorial included with the unit.

Each key has three states: forward, backward, and neutral. You produce characters by using one finger of each hand to form two-finger chords. Your fingers always rest on the same keys, and your palms rest on the base of the unit.

The Accukey performs all the functions of other keyboards and is compatible with all types of computers and CRT terminals, according to Vatell.
Price: $500, including a multiuser tutorial.
Contact: Vatell Corp., P.O. Box 66, Christiansburg, VA 24073, (703) 961-3576.
Inquiry 1276.

Ergonomically designed, the Accukey is Vatell's alternative to the QWERTY keyboard.

An Upgrade Kit Long on Compatibility

A hard disk drive kit for your PC that offers a total upgrade solution and easy installation is available, according to its manufacturer, Micropolis. Called the PC PAK (Performance Advantage Kit), each kit contains a high-speed ESDI controller or a SCSI host adapter, software, hardware, and an installation guide.

Compatible with PC-DOS, Novell, Xenix, and Unix systems, the PC PAK comes in half-height (180-MB or 380-MB) and full-height (760-MB or 1.2-gigabyte) capacities. The hard disk drives feature read-ahead caching and command queuing. They carry a mean-time-between-failures rating of 150,000 hours, according to the manufacturer.
Price: $1895 to $5895, depending on configuration.
Contact: Micropolis Corp., 21211 Nordhoff St., Chatsworth, CA 91311, (818) 709-3300.
Inquiry 1277.

Remote Audio Control for Your Mac

Based on VLSI technology, Mirror Technologies' CDR-10 CD-ROM/audio player offers full audio support and an embedded SCSI interface. The company packages the unit with its custom remote-control software, which controls the audio portion of the CD-ROM.

The CDR-10's 350-ms access rate lets you use it with any Macintosh. You can also attach it to an audio system via RCA jacks. The audio player has variable volume control and reads any disk written in HFS High Sierra ISO 9660 standard format. Each unit comes with a 30-day guarantee, a one-year warranty, and lifetime technical support.

Price: $697.
Contact: Mirror Technologies, 2644 Patton Rd., Roseville, MN 55113, (800) 654-5294 or (612) 633-4450.
Inquiry 1278.

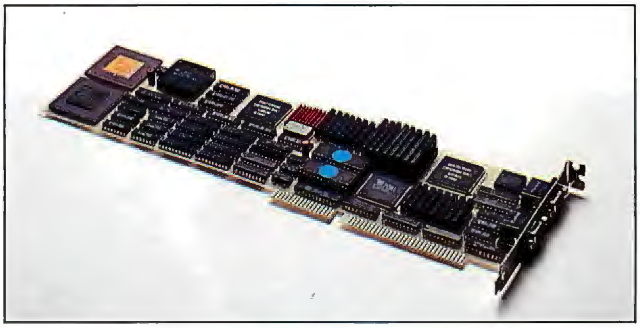
Fly Through Your Graphics with These Cards

According to National Design, the Volante Series intelligent graphics controller cards, based on the Texas Instruments TMS34020 graphics processor, have a processing speed 50 percent faster than cards based on the TMS34010 processor. The cards are also equipped with application-specific ICs.

Volante cards are available for ATs and compatibles and for the VMEbus. They include an AutoCAD software driver and are designed to handle all major graphics environments. Able to support 256 active colors from a palette of 16.7 million, they have a maximum resolution of 1280 by 1024 pixels.

The cards' standard 512K bytes of DRAM is expandable to as much as 4 MB; their 1 MB of video RAM is expandable to 8 MB. The optional TMS34082 floating-point processor is capable of performing functions such as 3-D convolution.

Price: $995 to $3495.
Contact: National Design, Inc., Houston Building, Suite 230, 9171 Capital of Texas Hwy., Austin, TX 78759, (512) 343-5055.
Inquiry 1279.



The Volante AT1000 video graphics card has an AutoCAD driver and supports 256 active colors.

Colorful Windows from Matrox

The M-WIN 1280 is the first of Matrox's new M-WIN series of graphics boards for 286 and 386 systems. It is also compatible with 486 EISA computers.

A high-resolution, single-slot controller, the M-WIN 1280 displays up to 256 screen colors from a palette of 16.7 million. The board, based on Western Digital's 8514/A chip set, runs programs such as Lotus 1-2-3 and WordPerfect at a resolution of 1024 by 768 pixels. It has 1280 by 1024 drivers for running Windows 3.0, Presentation Manager, and X Window System 11.4.

Price: US$2495.
Contact: Matrox Electronic Systems, Ltd., 1055 St. Regis Blvd., Dorval, Quebec, Canada H9P 2T4, (514) 685-2630.
Inquiry 1280.

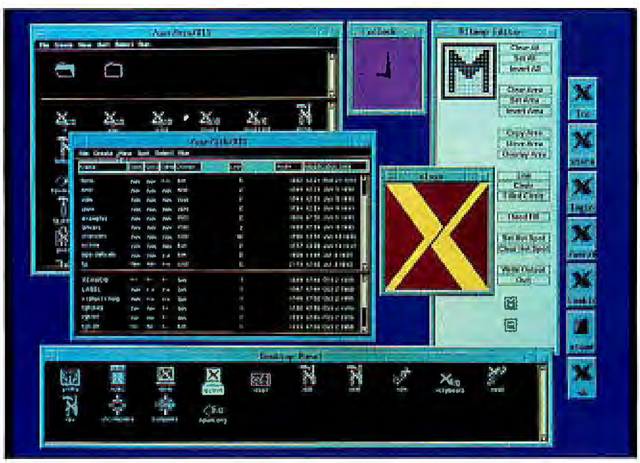
The MAC-56 DSP System Lets You Be Original

A digital signal processing system based on Motorola's DSP56001 microprocessor is available for the Macintosh. The system, a joint venture of Momentum Data Systems and Ariel, comprises a MAC-56 board and software that lets you develop your own programs for the DSP56001 chip.

The MAC-56 has 144K bytes of zero-wait-state memory, expandable to the chip's limit of 576K bytes. You can use DSPnet, the board's high-speed parallel interface, to interconnect multiple MAC-56 boards.

Bundled software includes a Motorola-compatible macro assembler and SCSI and DSPnet drivers. The MAC-56 incorporates a private SCSI bus for real-time signal I/O. For audio I/O, it includes a Next-compatible DSP port.

Price: $2995.
Contact: Ariel Corp., 433 River Rd., Highland Park, NJ 08904, (201) 249-2900.
Inquiry 1281.



Matrox's M-WIN 1280 graphics card is compatible with Windows 3.0, Presentation Manager, and X Window System 11.4.

Cache Your Data Securely

The ESDI-Security Cache Controller from GSI accommodates up to four ESDI drives with up to 3 MB of cache per drive. The controller is designed for use with disk-intensive applications such as CAD and database and network server applications.

Features include a 20-MHz transfer rate, a 5-MBps bus transfer rate, vertical and horizontal skew, and an on-board BIOS with built-in utilities that supports drives with up to 2046 cylinders.

Price: $495.
Contact: GSI, 17951 H Sky Park Cir., Irvine, CA 92714, (714) 261-7949.
Inquiry 1282.

Fax/Modem Card for Toshiba Laptops

The MaxFax 9624LT-T is Macronix's new integrated fax/modem for Toshiba laptop and notebook computers. The 9600-bps fax and Hayes-compatible 2400-bps modem card fits into the dedicated internal modem slot on most Toshiba laptops.

Able to operate in the background, the MaxFax has an auto-direct function that determines whether an incoming call is for the fax or the modem. The MaxFax supports dot-matrix and laser printers and allows direct faxing from scanner input.

Price: $599.
Contact: Macronix, Inc., 1348 Ridder Park Dr., San Jose, CA 95131, (408) 453-8088.
Inquiry 1283.

DBMS Case Study:

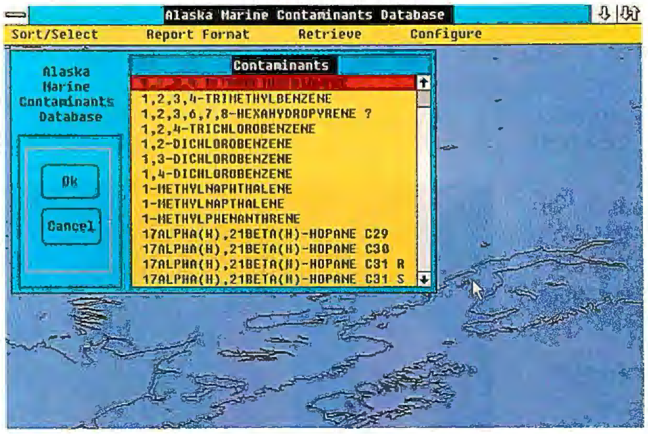
The Exxon Valdez Disaster

March 24, 1989. Exxon VALDEZ tanker runs aground, creating the worst oil spill in U.S. history. 11,000,000 gallons contaminate the pristine waters of Alaska's Prince William Sound.

The Problem Major disasters, like the Exxon Valdez spill, require quick response based on careful data analysis. Fortunately, an easy-to-use database was already being created which would help.

The Application The Alaskan Marine Contaminants Database lets oceanographic chemists easily access 60 megabytes of data covering the past decade. The database is provided free of charge on CD-ROM, and the Windows interface means they can get right to work, assessing damage to the ecosystems of Prince William Sound and other Alaskan waters.

The Solution db_VISTA III is the only DBMS with the features this project required: C language support, Windows compatibility, royalty-free runtime distribution, quick performance in large databases, quality documentation and support. With the Alaskan Marine Contaminants Database, the difficult job of calculating the long-term effects of the Exxon spill is a little easier.*



A Microsoft Windows front end lets chemists select regions from a map to retrieve data. And, db_VISTA III's SQL-based query and report writer lets users perform complex SQL data searches.

Your DBMS problems may not make the headlines, but they are no less important and often no less challenging. If you develop applications for MS-DOS, MS Windows, UNIX, VMS, QNX, OS/2, Macintosh, and other environments, db_VISTA III is your solution.

Call 1-800-db-RAIMA (1-800-327-2462)

In Washington State call: (206)747-5570. Ask for extension 101.

* Reprints of the story, as published in PC Week and Data Based Advisor, are available from Raima.

db_VISTA III™

Database Management System

Specifications: ***Complete C source code available. No Royalties***
C Lanaguage Portability & High performance

Network Data Model. Relational B-tree indexing. Relational SQL query and report writer. Single & Multi-user. Automatic recovery. Built-in referential integrity. Complete revision capability. **Supports:** MS-DOS, MS Windows, UNIX, QNX, SunOS, XENIX, VMS, Macintosh.. OS/2 compatible. **Most C Compilers supported. LANs:** 3COM, Novell, Banyan, Appleshare. Call for other environments.

Power Tools For C Programmers

RAIMA™ CORPORATION

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Circle 273 on Reader Service Card

db_VISTA III DBMS rated number #1

For Performance and Flexibility of DBMS Programming Tools- **PCWEEK** Poll of Corporate Satisfaction, August 28, 1989.

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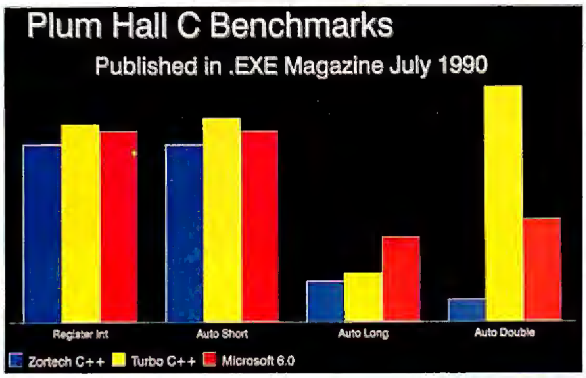
Multi - Platform

MS-DOS • WINDOWS • OS/2 • DOS 386 • UNIX 386

MS-DOS

Zortech's industrial strength compiler provides all the benefits of C++, but with the speed and code size you would expect from the best C compilers.

The quality of the original Zortech C++ implementation together with the continuous improvement achieved since its launch in June 1988 produces fabulous benchmarks. Just look how far it's ahead of the nearest competitor.



Zortech C++ provides state of the art, USEFUL features, most of which are added in direct response to customer requests.

You can effortlessly cruise through the DOS 640K barrier using Zortech's Virtual Code Manager (VCM™). This allows you to develop applications up to 4MB in size whilst in real mode, without changing your C/C++ source code. Zortech's much acclaimed 'handle pointers' provide an elegant solution to processing EMS memory.

Zortech C++ also uses the Rational Systems™ DOS Extenders allowing you to easily compile and debug really large programs, even large MS-Windows 3.0 applications. If you want to purchase a Rational Systems license for your own applications, your Zortech code is Plug & Go.

Zortech's new C++ Workbench provides a cross platform development environment for C++. It has really useful features including powerful source and grep browsers, to look at your handiwork.

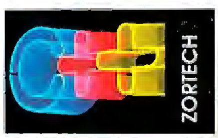
In response to hundreds of requests, MS-Windows 2.1 support was added into the base DOS C++ Compiler in version 2.0. Now with Zortech C++ V2.1 development of C++ applications for Windows 3.0 is a reality not a promise.

Along with the C++ compiler comes a top quality ANSI C compiler. In fact, after reviewing 14 C/C++ compilers in its May 1990 issue, Computer Language editor J. D. Hilderbrant said:

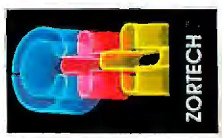
"The pressure to name an overall winner in the compiler sweepstakes is nearly overwhelming...it's an easy choice. We pick Zortech!"

Thousands of our customers had existing C code they wanted to recompile, so we made it simple. In the words of BYTE Magazine:

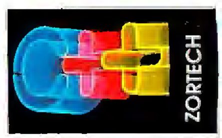
"I fed a Microsoft C specific version of the Micro-EMACS editor source to Zortech's compiler, and less than one hour later, I had a new (and smaller) program."



V2.1
DEVELOPER'S EDITION



V2.1
OS/2 EDITION



V2.1
DOS 386 EDITION

Our C++ Debugger, which understands C and Assembler too, is CodeView™ compatible, but that's where the similarities end. This feature packed tool can examine your program from 19 viewpoints and uses overlapping windows with full mouse support, icons and dialog boxes.

Debugging large programs is no problem with our DOS Extender, Virtual and Remote debugger versions. Quite simply, there's no better C++ debugger to use and no better C++ to debug.

Our C++ Tools package is the most comprehensive set available. All 25 class libraries are extensively documented and come with the full source code.

The Zortech C++ Developer's Edition V2.1 includes C and C++ Compilers, C++ Debugger, C++ Tools and the FULL Library Source Code (excluding Flash Graphics). That's right, you don't have to pay hundreds of dollars extra for source code - it's in the box!

MS-WINDOWS

Improved support for MS-Windows (including new Windows 3.0 support) is provided in the base C++ DOS compiler, at no extra cost. With Zortech, you can now even compile from within Windows!

Support for new extended keywords _loadds and _export as well as the ability to create DLL's make programming in Windows with C++ practical. We provide extensive documentation and 50K of sample code to illustrate development of

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Zortech C++

MS-DOS • WINDOWS • OS/2 • DOS 386 • UNIX 386

applications in this exciting new environment. Do you need MS-Windows class libraries? Call for details of third party Zortech Validated Products.

OS/2 NEW

The OS/2 Developer's Edition now provides a C++ Compiler and source level Debugger designed for C++. In the words of OS/2 Magazine:

"Zortech C++ serves as a direct replacement for the Microsoft C Compiler in developing applications, allowing programmers to use object-oriented techniques in OS/2 development."

The OS/2 Developer's Edition also includes C++ Tools, Flash Graphics and C++ Workbench for OS/2 together with the standard DOS Developer's Edition.

Upgrades for existing OS/2 Compiler Option owners now available. Please call for details.

UNIX 386 NEW

Not a day passes at Zortech HQ without numerous requests for a UNIX version of Zortech C++. Now, DOS and OS/2 developer's can reach new markets by easily moving their code to SCO UNIX 386 and binary compatibles.

The Zortech C++ V2.1 UNIX 386 Compiler generates the same tight, fast code that Zortech's DOS and OS/2 users have come to expect. UNIX specific versions of Flash Graphics and the C++ Workbench are also provided.

In line with the traditional Zortech Policy, owners of the Zortech C++ V2.1 UNIX 386 Compiler will be able to inexpensively upgrade to the forthcoming Zortech C++ V2.1 UNIX 386 Developer's Edition.

DOS 386 NEW

Now, with the 386 you can address up to 4 Gigabytes of memory. Why spend so much money on 386 hardware and not use software which will take advantage of it?

On the other hand, you need to retain the facilities of standard MS-DOS too.

MS-DOS developers can now build true 32 bit C and C++ applications for 386 processors using Zortech's powerful 386 development system. The Zortech C++ V2.1 Developer's Edition for DOS 386, contains 32 bit versions of the C and C++ Compiler, Flash Graphics library, C++ Debugger and full standard library source code together with all the familiar features provided with the standard DOS Developer's Edition.

Using Phar Lapp's much acclaimed 386/DOS Extender Technology, you can build applications which access 4 Gigabytes of linearly addressable memory. Your applications will also be Plug & Go for use with Phar Lapp's 386 DOS Extender which may be purchased seperately.

C++ VIDEO COURSE

Zortech's C++ Video Course is all the training material you need to move a team of good C programmers into the world of C++. Many corporations have already done just this.

Cut the hotel bills, travel expenses and fees of outside training courses and seminars - not to mention the inconvenience and disruption to your normal routine.

Use a proven training tool, that in one hour a day, over a period of six weeks, can train your whole team in C++ for the price of one airline ticket.

The course consists of 32 tutorials on six one hour VHS tapes together with one 256 page workbook containing course notes and exercises. Unlimited additional course workbooks are available at modest cost. Compiler & hardware independent. NTSC or PAL format available.

C++ for Macintosh
Call for details

Circle 373 on Reader Service Card

3-D Viewing in Two Styles

StereoGraphics is shipping its new CrystalEyes/PC eyewear. Designed for stereo 3-D viewing by PC and Macintosh users, the lightweight eyewear is geared for users of such specialized graphics applications as CAD/CAM, CAE, architectural, sensing/mapping, and medical image processing. The viewer is activated by infrared signals from an emitter on top of the display monitor.

CrystalEyes/Pro, another 3-D viewer, is an enhanced version of the company's CrystalEyes. Also activated by infrared signals, CrystalEyes/Pro has a Stereo/Pseudo switching option that gives users an enhanced visualization capability for applications with complex depth information, such as mapping. A multiple-range emitter permits viewing by single users or a group. The Brite Mode option allows users to make rapid transitions from stereo viewing to brighter, nonstereo viewing.
Price: CrystalEyes/PC, $995; CrystalEyes Pro, $1995.
Contact: StereoGraphics Corp., 2171-H, East Francisco Blvd., San Rafael, CA 94901, (800) 247-8373 or (415) 459-4500.
Inquiry 1287.

When a Mouse May Not Be a Mouse

Alternatives to the traditional mouse are available from several companies.

The Icontroller is Suncom's mouse emulator for the PC. It sports speed selectability, three mouse function buttons, and a fingertip cursor-control knob with a selectable function button. Compatible with Microsoft and Mouse Systems software, the space-saving Icontroller attaches to either side of the keyboard.
Price: $79.95.
Contact: Suncom Technologies, 6400 West Gross Point Rd., Niles, IL 60648, (708) 647-4040.
Inquiry 1284.

The Icontroller mouse

The cordless Zen Mouse

The MousePenPortable

Zeny's cordless Zen Mouse uses urethane wheels in its two-wheel direct drive system to eliminate maintenance problems and allow smooth tracking on most surfaces. With an operating range of 4 feet, the Zen Mouse draws its power from three rechargeable nickel-cadmium batteries. A power-saving feature is activated when motion is not detected. Operating at from 10 to 1000 dpi, the Zen Mouse is compatible with Microsoft, Logitech, and Mouse Systems mice.
Price: $129; corded version for IBM PCs and PS/2s, $89.
Contact: Zeny Computer Systems, Inc., 4033 Clipper Court, Fremont, CA 94538, (415) 659-0386.
Inquiry 1285.

The MousePenPortable, for use with IBM and compatible laptops, is Appoint's latest addition to its series of pointing devices. You can operate the 3.2-ounce MousePenPortable at any angle and on a variety of surfaces. The device requires a serial port or a PS/2 mouse port, DOS 2.0, and 256K bytes of RAM. The MousePenPortable uses a built-in dynamic gain resolution of 50 to 1000 counts per inch and includes TelePaint, a color paint program.
Price: $149.
Contact: Appoint, Inc., 1332 Vendels Cir., Suite 101, Paso Robles, CA 93446, (800) 448-1184 or (805) 239-8976.
Inquiry 1286.

For All Your Soldering Needs

The Ungar Model 2110 is a soldering station with an electrically controlled heating element. The iron operates in a temperature range of 550°F to 850°F.

Features of the soldering station include a cool-grip handle, a burn-resistant cord, and a replaceable ceramic heater. The iron comes with a thermal-thrust soldering tip. The station also includes a static-dissipative power unit, an on/off switch, a power-on LED indicator, a sponge, and an iron holder. An optional tip retainer is also available.
Price: $132.50.
Contact: Hub Material Co., 33 Springdale Ave., Canton, MA 02021, (617) 821-1870.
Inquiry 1288.

From PC to Geiger Counter

Aware Electronics is marketing version 2.0 of its RM-60 Micro Roentgen Radiation Monitor. When plugged into a PC's serial or parallel port, the RM-60 monitors and plots background radiation, the presence of radon gas, atmospheric radioactivity, and alpha, beta, gamma, and x-rays.

Features of the RM-60 include a high-speed scrolling bar chart that lets you scan stored data for surges or trends, and an alarm system that you can set to activate between 1 and 30,000 microroentgens per hour. The company provides a five-year warranty on parts and labor.
Price: $149.50.
Contact: Aware Electronics Corp., P.O. Box 4299, Wilmington, DE 19807, (302) 655-3800.
Inquiry 1289.

You Always Knew There Was Something Special About Your Thumb.

PC MAGAZINE
EDITORS' CHOICE
August 1990
TrackMan Stationary Mouse

You have a lot of power in your thumb. So we designed TrackMan™—the world's most popular stationary mouse—to put that power to work. TrackMan's brilliant ergonomic design includes a lightweight, thumb-driven ball, three buttons at your fingertips and room to rest your hand. It is far more comfortable than any other stationary mouse. Because the thumb is far more agile and powerful than any finger. With TrackMan's adjustable resolution, you command the cursor with exhilarating speed and precision, even in the most confining workspace. And you get all this for only $139, including Logitech's™ life-time hardware warranty. TrackMan works with any application on an IBM® PC (or compatible). For more information call Logitech's Customer Sales Center: (800) 231-7717 ext. 347. In California: (800) 552-8885; in Canada: (800) 283-7717; in Europe: ++41-21-869-9656.

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Selecting a new computer system can be a real challenge. That's where we come in. We have the knowledge, experience and the best value packed computer systems available. So, pick up the phone and check us out. Ask us about our quality. Our service. And especially our prices. You'll like what you hear.

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Then ask us about our new 386/25 and 386/33 systems. The list of standard features includes the latest that high technology has to offer. Like a 64 KB memory cache for the 386/25, and 128 KB for the 386/33, both expandable to 256 KB. Then there's the integrated VGA controller supporting 1024 x 768 resolution, with 256 vibrant colors and a 50% performance increase all made possible by 1 MB of 32-bit video memory. Plus support for interlaced and non-interlaced monitors. When it comes to features, we set the standard.

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- ☐ Super Hi-Res 14″ VGA color monitor with tilt/swivel base
- ☐ 105MB IDE hard drive with Cache buffer
- ☐ 1.2MB 5.25″ and 1.44MB 3.5″ floppy drives
- ☐ 1 parallel and 2 serial ports
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ Microsoft Windows 3.0
- ☐ Hi-Resolution mouse
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386▼33 with 128K Cache Memory	386▼25 with 64K Cache Memory
$2995	$2695

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No one can beat our flexibility either. An integrated floppy controller and hard disk interface that support up to three floppy drives and two hard drives. Up to 16 MB of RAM on board using the new industry standard 32-bit memory modules leave all six expansion slots available.

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All of these fully-loaded systems include:

- ☐ 2MB of 32-bit high speed memory (Expandable to 8MB on-board)
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- ☐ Super Hi-Res 14″ VGA color monitor with tilt/swivel base
- ☐ 40MB IDE Hard Disk Drive
- ☐ 1.2MB 5.25″ & 1.44MB 3.5″ floppy drives
- ☐ 1 parallel and 2 serial ports
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ 386/SX includes Windows 3.0 and mouse
- ☐ Free one year on-site service

386▼SX only $1895.00　　286▼16 only $1595.00

Shown with optional tape drive. 386 is a trademark of Intel Corporation.

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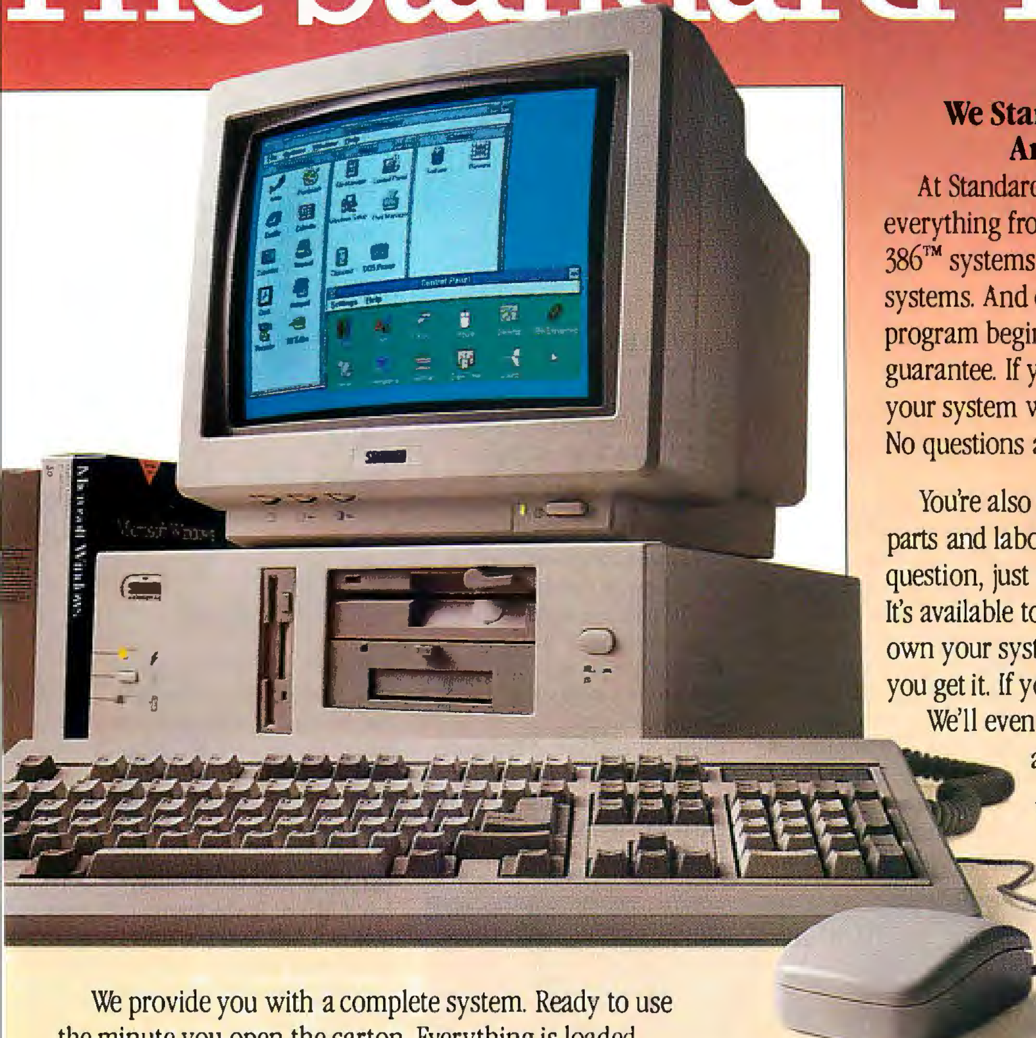

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CONNECTIVITY

Neat, Simple, Instant Communication

If you're looking for a neater image at work, you might want to try GEC-Marconi's Verran AC DataLink. With this device, you can link your PC to a printer, plotter, modem, or other peripheral without using the cables normally required. You configure the device using DIP switches.

DataLinks work in pairs, one at the sending unit and the other at the receiving unit. They hook up via standard electrical outlets, allowing data to be transmitted over your building's AC circuit. AC DataLinks connect serial or parallel communications, with the capability of converting back and forth between the two. They have a 2K-byte data buffer and communicate at a rate of 840 cps.

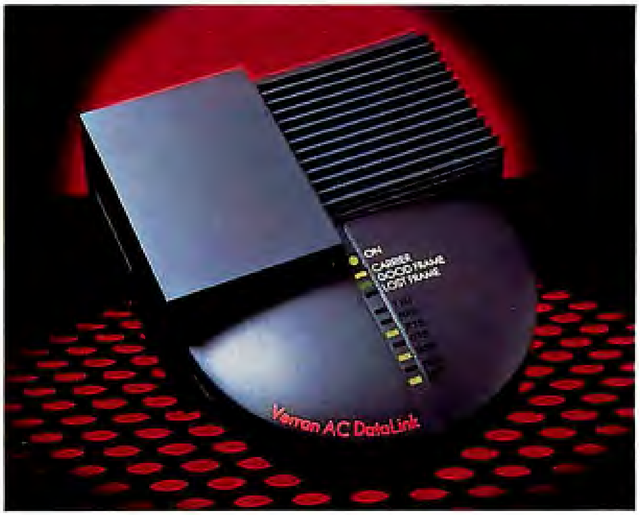
Software for the DataLinks is built in, eliminating the need for additional software. For secure transmissions, you can encrypt your data prior to transmitting it and decipher it at the receiving end.

An accessory device, the AC DataLink DPS (dedicated printer sharer), is also available. When connected to a printer, it acts as a print spooler and can handle multiple print orders from as many as seven computers.

Price: AC DataLink, $345; AC DataLink DPS, $395.

Contact: GEC-Marconi Software Systems, 12110 Sunset Hills Rd., Suite 450, Reston, VA 22090, (703) 648-1551.

Inquiry 1290.



GEC-Marconi's Verran AC DataLink, which works in pairs, uses standard AC circuits to transmit data.

OS/2-PM Communications Package Available

KXCom, a communications package for OS/2, includes a full-fledged Presentation Manager interface. It also features an integrated dialing directory that supports the Hayes Smartmodem (and compatibles), single and multiple file transfer using the Kermit or XMODEM protocol, and file transfer rates of up to 19,200 bps.

KXCom simultaneously supports COM1 and COM2, supports both color and monochrome video, and has a windowed command shell to the operating system. Additionally, the package automatically renames files in case of a name clash and offers on-line help. It also features a windowed command shell to the operating system.

The package includes complete source code in Stony Brook Professional Modula-2 and a user's manual.

Price: US$30.

Contact: KXCom, 5105 Lorraine Ave., Burnaby, British Columbia, Canada V5G 2S3, (604) 437-0893.

Inquiry 1291.

Able to double as a file server or a LAN station, the Super-386T works with OS/2 and Unix systems.

Remote-Control Network Program

Invisible Software has introduced Invisible NET Control, a remote-control program that works with any NetBIOS-compatible network. Capabilities include group broadcasts, two-way talk, and remote control of other workstations.

Invisible NET Control supports remote diagnostics and CGA, EGA, and VGA modes. It also lets you monitor other users' screens. The DOS overhead is 30K bytes.

Price: $279 per network site.

Contact: Invisible Software, Inc., 1142 Chess Dr., Foster City, CA 94404, (415) 570-5967.

Inquiry 1292.

A Versatile 386 File Server

The Super-386T 33-MHz desktop from Hyundai can be used as a network file server and as a LAN station. It is compatible with Novell NetWare and with OS/2 and Unix systems.

The small-footprint computer (16.1 by 16.3 inches) has 4 MB of RAM (expandable to 8 MB on the motherboard with single in-line memory modules), a 64K-byte memory cache (expandable to 256K bytes), and 64K bytes of ROM. The Super-386T includes a 16-bit VGA card that supports Super VGA and has a built-in mouse port. Hyundai ships a mouse with the unit. The computer's configuration includes two serial ports and one parallel port.

Price: $4995 to $8495, depending on configuration.

Contact: Hyundai Electronics America, 166 Baypointe Pkwy., San Jose, CA 95134, (408) 473-9200.

Inquiry 1293.

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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:

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Circle 285 on Reader Service Card

you'll need powerful specs.

CPU
Intel 386™ microprocessor
33 MHz processing speed (zero wait states)
8 MHz compatibility mode (1 wait state)
Optional Weitek WTL 3167 or Intel 387 math coprocessor
Calendar/clock (with battery backup)

MEMORY
4 MB or 8 MB (80 ns) memory standard
Dedicated 32-bit high-speed Concurrent Memory Bus architecture (33 MHz)
Total high-speed memory expandable to 32 MB
64 KB (20 ns) SRAM cache

INTERFACES
Parallel printer port
Two RS-232C serial ports
PS/2®-style mouse port
PS/2-style keyboard port

EXPANSION SLOTS
One 32-bit full-size memory slot
Five 8/16/32-bit ISA/EISA full-size slots
One 8/16-bit full-size ISA slot
One 8/16-bit half-size ISA slot

STORAGE SLOTS
Five 5¼" half-height
Support for alternate two full-height 5¼" and one half-height configuration

KEYBOARD
101-key mechanical keyboard
Separate numeric and cursor control pads

SYSTEM SECURITY
Power-on password
Keyboard password
Network password
System cover lock (optional)

SOFTWARE/NATIVE MODE SUPPORT
MS-DOS®
Windows™ 3.0
NEC-enhanced OS/2™ (optional)
SCO™ UNIX® System V (optional)
NEC-enhanced EISA configuration utility

DATA STORAGE
Floppy disk drives
—1.2 MB 5¼"
—1.44 MB 3½" (5¼" form factor)
Hard disk drives
—100 MB 3½" ESDI (<23ms, 5¼" form factor)
—118 MB 3½" SCSI (<20ms, 5¼" form factor)
—140 MB 5¼" ESDI (<18ms)
—300 MB 5¼" SCSI (<18ms)
—300 MB 5¼" ESDI (<18ms)
—600 MB 5¼" SCSI (<16ms)
Tape drives
—40 MB 5¼"
—150 MB high-speed 5¼"

DISK SUBSYSTEMS
EISA SCSI host adaptor (optional)
—EISA bus master capability
—support for 7 SCSI devices
—32-bit EISA bus interface
—33 MB/second burst rate
—scatter-gather transfer
—SCSI command queuing
—auto configuration
ESDI controller (optional)

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—MultiSync 3D
—MultiSync 4D
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NEC GRAPHICS OPTIONS*
MultiSync® Graphics Engine™
—intelligent 50 MHz TMS34010 processor
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—Super VGA (800x600, 16 colors)
—1024x768 (interlaced)
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Width: 21.2" (538 mm)
Depth: 17.7" (450 mm)
Height: 6.3" (160 mm)
Weight: 51 lbs (23 kg)

OPERATING ENVIRONMENT
Temperature—50° to 95°F
Relative humidity
—20% to 80% (non-condensing)
Power supply
—universal 115V/230V
—auto sensing
—325 watt maximum rated output

Multi-media. Presentation graphics. In short, for virtually any com-

plex application requiring the ultimate in 386 computing, it's a

perfect fit. For more details, call 1-800-NEC-INFO.

NEC

Circle 214 on Reader Service Card

CONNECTIVITY

ChainLink Doesn't Fence You In

ConnectWorks' ChainLink uses standard telephone wire, a central switching unit, and software to link as many as 16 PCs and laptops or up to 48 printers. With a transfer rate of 115,000 bps and average throughput of 77,240 bps, the network requires DOS 3.1, a hard disk drive, and a serial port on each PC. It is mouse compatible.

Through its switching unit, ChainLink provides file transfer, peripheral sharing, E-mail, print spooling, and directory management capabilities for each linked PC. Since ChainLink remains resident in RAM, you can use a hot key to access it while you're working in another application.

Price: Four users, $395; eight users, $595; 16 users, $795.
Contact: ConnectWorks Co., 110 Causeway Dr., P.O. Box 497, Wrightsville Beach, NC 28480, (800) 992-5465 or (919) 256-2366.
Inquiry 1294.

ChainLink users can do such things as exchange files, send and receive E-mail, and share peripherals.

Two for the Network from US Sage

Two networking products are new from US Sage. MainLan 386 equips 386-compatible PCs as network file servers; MainLan for PS/1 is a 10-Mbps Ethernet adapter card for networking PS/1 computers.

The MainLan 386 kit includes NetBIOS-compatible system software, 10-Mbps Ethernet cards, and cabling. Designed for systems of up to 255 users of cross-network transactions, the system requires a 386 or 386SX computer as a dedicated file server. MainLan 386 runs with Microsoft Windows 3.0 and is Novell NetWare compatible.

MainLan for PS/1 links a computer as a workstation or a file server. The card is available as part of a kit or by itself. The kit includes two 10-Mbps Ethernet cards, MainLan NetBIOS-compatible software, and cabling. Cards are compatible with MainLan's operating system as well as with Novell NetWare. MainLan for PS/1 also runs with Windows 3.0.

Price: MainLan 386 kit: two to four users, $999; two to eight users, $1399. MainLan software only: two to four users, $599; two to eight users, $999; unlimited use, $1499; 8-bit Ethernet card with Novell drivers, $249. MainLan for PS/1 kit, $499; 8-bit PS/1 Ethernet card with Novell drivers, $199; MainLan 3.12 peer-to-peer operating system software, $199.
Contact: US Sage, Inc., 2005 Tree Fork Lane, Suite 113, Longwood, FL 32750, (407) 331-4400.
Inquiry 1295.

Color Graphics in a Fax Board

The Communiqué Fax9600, a half-slot, 9600-bps fax board, combines the convenience of a stand-alone fax machine with the power of a personal computer, according to its manufacturer. Requiring a PC with 640K bytes of RAM, a hard disk drive, DOS 3.0 or higher, a graphics display card, and a mouse, the board's key feature is its user interface. You operate the system using mouse-activated icons, buttons, and scroll bars. It is compatible with VGA, EGA, CGA, and Hercules graphics modes.

To send a fax, you type in the text or load it from any ASCII text file; Communiqué automatically inserts a custom letterhead and personal signature. The system uses typefaces with proportional spacing. Other features include a Phonebook, which allows you to store and group names; mail-merge commands that automatically merge Phonebook information into your text; and a clipping function, which lets you save portions of a received fax to use as graphics in other documents. A hot key to pop up Communiqué from any DOS program and a TSR program requiring less than 9K bytes of RAM round out the system.

Price: $279.
Contact: Grey Matter Response, Inc., P.O. Box 3147, Santa Cruz, CA 95063, (408) 427-3678.
Inquiry 1296.

High-Speed Modem for PCs and Macintoshes

A 9600-bps V.32 modem for IBM PCs and Macintoshes is available from Intel. Providing error-free throughput of up to 38,400 bps, the 9600EX conforms to international modem standards. A plug-and-play modem, it installs without jumpers or switches. The modem operates in synchronous or asynchronous mode over dial-up or two-wire leased lines and carries a five-year warranty.

The 9600EX supports the V.42 Link Access Procedure for Modems and MNP through level 5. Automatic speed selection allows you to use the 9600EX with 4800-, 2400-, 1200-, and 300-bps modems.

The 9600EX for the PC comes with Communications by Crosstalk; the Macintosh version includes Quick Link II by Smith Micro Software.

Price: IBM version, $799; Macintosh version, $819.
Contact: Intel Personal Computer Enhancement Operation, CO3-7, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124, (800) 538-3373 or (503) 629-7354.
Inquiry 1297.

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Microsoft C Professional Development System version 6.0

is simply the fastest, most productive professional C development environment for MS-DOS, Microsoft Windows, or Microsoft OS/2 Presentation Manager applications. 6.0 features include: The Programmer's Workbench, a new approach to development–integrating all tools into one environment; Source Browsing–interactively see any part of the project with the revolutionary project database, which can tell you where any-thing is located; CodeView 3.0–third generation of the industry-leading debugger which allows developers to use as little as 15K from DOS's 640K space.

Microsoft

List: $495 Ours: $349

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Get to the market quicker with graphics that don't compromise performance. The **GSS® Graphics Development Toolkit** (GDT) for DOS gives you access to more than 100 high-level graphics functions and supports over 300 graphics devices. Choose from C, FORTRAN, Pascal, BASIC Compiler or Macro Assembler. IBM has licensed the GDT for three PC operating systems: DOS, OS/2, and AIX. SPC's Harvard Graphics and Ashton-Tate's Draw APPLAUSE use GDT technology. So do hundreds of other PC packages for science, business and engineering.

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FAXcetera # **1088-0001**

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NEW! **Greenleaf's CommLib 3.1** now supports Intelligent Multiport boards and 16550 UARTS! Plus hundreds of C functions for communications: XMODEM, YMODEM, Kermit, XON/XOFF, and Hayes modem control. Free source. On-line help. 196 example programs. All major compilers supported.

GREENLEAF Software

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FAXcetera # **1035-0007**

Unleash 386 power

on your Microsoft C code with **WATCOM C8.0/386**, a 100% ANSI C optimizing compiler and run-time library generating applications for 32-bit 386 protected mode. With C8.0/386, you can go beyond the 640K DOS limit. Library and source compatibility with Microsoft C simplifies porting 16-bit applications to the 386. Significant features include: full-screen source-level debugger; protected mode version of the compiler; execution profiler; linker; graphics library. Run-time compatible with WATCOM F77/386.

WATCOM

Standard
List: $895 Ours: $639

Professional
List: $1295 Ours: $939

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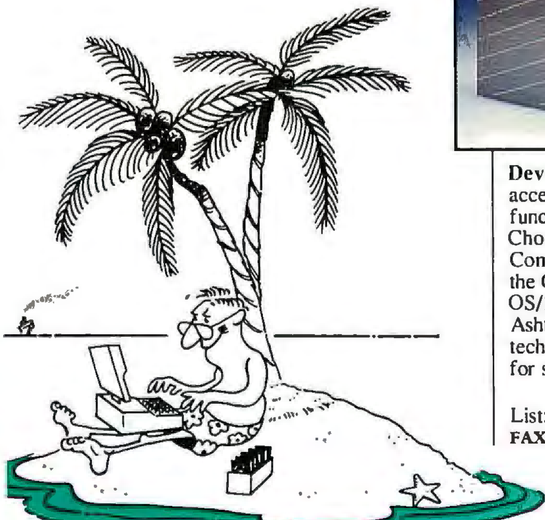
Supercharge your applications with windows, menus, forms, and a spectacular user interface. **Vitamin** C's powerful library of C functions includes overlapping virtual windows, data entry forms, dialog boxes, menus, context sensitive help, a pop-up text editor, mouse support, and more! Library source is included, and applications are royalty free. Available for DOS, OS/2, UNIX, XENIX and VAX.

CREATIVE PROGRAMMING

List: $225 Ours: $165

FAXcetera # **1437-0001**



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386 CONTROL PROGRAMS

	LIST	OURS
DESQview 386 w/QEMM	220	169
Microsoft Windows 3.0	150	99
VM/386	245	209
VM/386 MultiUser	895	839
VM/386 MultiUser Starter	395	339

386 DEVELOPMENT TOOLS

	LIST	OURS
386 ASM/LinkLoc	1295	1159
386/DOS Extender	495	439
C Windows Toolkit/386	200	179
C-Terp 386	239	189
Lahey F77L-EM/32 (w/OS/386)	1290	1035
MetaWare High C 386	895	849
Novell C Network Compiler/386	995	799
PC-lint 386	239	179
WATCOM C 8.0/386 Prof.	1295	1099
w/386/DOS Extender	1790	1399
WATCOM C 8.0/386 Standard	895	719
WATCOM FORTRAN 77/386	1095	CALL
Zortech C++ 386	995	849

ADA

	LIST	OURS
Academic IntegrAda	249	225
Ada Scope Debugger	495	445
Ada Training Environment	895	805
Adagraphics	695	629
IntegrAda	795	719
Meridian Ada Developer's Kit	1195	1095

ASSEMBLY LANGUAGE

	LIST	OURS
Advantage Disassembler	295	279
ASMFlow	99	89
MS Macro Assembler	150	105
OPTASM	150	129
Re:Source	150	129
Sourcer w/Pre-Processor	170	149
SpontaneousAssembly	395	189
Turbo Debugger & Tools	150	105
Visible Computer: 80286	100	89

BASIC COMPILERS

	LIST	OURS
MS BASIC Prof. Devel. System	495	349
Power Basic	129	89
QuickBASIC	99	69

BASIC LIBS/UTILITIES

	LIST	OURS
GraphPak Professional	149	129
P.D.Q.	129	115
ProBas	159	149
ProBas Toolkit	99	94
QBase	149	125
QuickComm	149	119
QuickPak Professional	169	149
QuickWindows Advanced	149	119

C COMPILERS

	LIST	OURS
Lattice C 6.0	250	155
Microsoft C 6.0	495	339
w/Objective-C	699	539
MS QuickC 2.5	99	69
MS QuickC w/QuickAssembler	199	139
Turbo C 2.0	99	69
WATCOM C 8.0 Professional	495	419
WATCOM C 8.0 Standard	395	335

C++

	LIST	OURS
C++/Views	495	419
Data++Windows	189	169
Intek C++	495	CALL
NDP C++	495	479
Rogue Wave Math.h++	200	179
Rogue Wave Tools.h++	200	179
Turbo C++	200	139
Turbo C++ Professional	300	205
Competitive Upgrade	150	139
Zinc Library	200	179
Zortech C++	200	165
Zortech C++ Database	300	255
Zortech C++ Debugger	150	129
Zortech C++ Developer's Edition	450	399
Zortech C++ Tools	150	129
Zortech C++ Video Course	500	449

C-COMMUNICATIONS

	LIST	OURS
Breakout II	249	189
C Asynch Manager 3.0	189	139
C Communications Toolkit	150	129
Essential Communications	329	259
Greenleaf CommLib	359	287
Greenleaf ViewComm	399	319
SilverComm "C" Async Library	249	209
View-232	189	149

C-FILE MANAGEMENT

	LIST	OURS
AccSys for dBASE or Paradox	395	349
Btrieve Devel. System	595	449
Codebase IV	295	219
c-tree Plus	595	475
dBC III Plus	500	439
db_FILE Bundle	295	249
Essential B-Tree w/source	198	149
Paradox Engine	495	349
The Toolbox - Prof. Edition	1295	1035
The Toolbox - Special	795	635

C-GENERAL LIBRARIES

	LIST	OURS
C Function Library	99	79
C TOOLS PLUS/6.0	149	109
C Utility Library	249	199
Greenleaf Functions	229	179
Greenleaf SuperFunctions	299	239
Turbo C TOOLS/2.0	149	109

C SCREENS

	LIST	OURS
C-Worthy	399	CALL
Greenleaf DataWindows	395	315
Vermont Views	495	395
Vitamin C	225	165
VC Screen	149	125

C-UTILITIES/OTHER

	LIST	OURS
Bar Code Library	389	319
Clear for C	200	169
C Shroud	198	149
Heap Expander	80	70
MKS LEX & YACC	249	197
Objective-C	249	225
PC-lint	139	105
PCYACC Professional	495	459
TimeSlicer	295	279

CASE TOOLS

	LIST	OURS
EasyCASE Plus	295	265
Professional Pack	395	355
Personal CASE	199	179

COBOL LANGUAGE

	LIST	OURS
Micro Focus:		
COBOL/2 w/Toolset	1800	1499
Personal COBOL	149	129
MS COBOL	900	629
Realia COBOL	995	849

DATABASE DEVELOPMENT

	LIST	OURS
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Clipper 5.0	795	519
Data Junction Advanced	299	269
dBASE IV	795	495
dBFast/PLUS	345	295
dGE	295	249
Dr. Switch-ASE	180	149
Facelt	99	90
FlashTools!	89	79
Flipper	195	169
Force 2.1	695	589
FoxPro	795	489
FUNCKy Library	195	179
R&R Code Generator	150	129
R&R Report Writer	150	129
Say What?!	50	39
SilverComm "C" Interface	99	89
SilverComm Library 2.0	249	209
The Documentor	295	245
Tom Rettig's Library	100	80
UI2 Version 2	595	479

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	LIST	OURS
MultiScope	179	139
Periscope Debuggers	CALL	CALL
Trapper	200	179
w/optional cable	240	219
Turbo Debugger & Tools	150	105

DOCUMENTING/ FLOWCHARTING

	LIST	OURS
allCLEAR	300	229
Clear for C or dBASE	200	169
C-Clearly	130	115
Flow Charting 3	250	199
Interactive Easyflow	150	125
Source Print	99	74
Tree Diagrammer	99	74

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	LIST	OURS
BRIEF 3.0	249	CALL
EDT+	295	269
EMACS	395	315
Epsilon	195	159
KEDIT 4.0	150	125
MKS Vi	149	129
PI Editor	195	175
Sage Professional Editor	295	249
SLICK Editor	195	154
Speed Edit	295	275
SPF/PC	245	199
SYNDIE	495	399
VEDIT PLUS	185	CALL

EMBEDDED SYSTEMS

	LIST	OURS
C6toPROM	149	119
Link & Locate ++	395	349
Link & Locate ++ Extended	479	395

FORTRAN LANGUAGE

	LIST	OURS
Grafmatic	135	119
Lahey F77L	595	535
Lahey Personal FORTRAN 77	99	89
MS FORTRAN	450	299
Plotmatic	135	119
RM/FORTRAN	595	499

GRAPHICS LIBRARIES

	LIST	OURS
Baby Driver	250	199
Essential Graphics	399	319
Font-Tools	150	119
Graf/Drive Plus Developer's	299	269
GraphiC 5.0	395	319
GSS Graphics Devel. Toolkit	795	685
GX Graphics	149	135
HALO	395	279
HALO Professional	595	419
HALO Window Toolkit	595	419
Icon-Tools/Plus	150	119
Menuet	325	279
MetaWindow	250	209
MetaWindow Plus	325	289
PCX Effects	99	89
PCX Programmer's Toolkit	195	175
PCX Text	149	135
SilverPaint	129	109
Slate w/graphics	448	399
Turbo Geometry Library	200	179

LINKERS/LIBRARIANS

	LIST	OURS
Overlay Toolkit	395	369
Plink86+	395	335
Plink/LTO	495	419
PolyLibrarian	249	209
.RTLink	295	265
.RTLink/Plus	495	359

OBJECT-ORIENTED TOOLS

	LIST	OURS
Objective-C	249	225
Smalltalk/V	100	85
Smalltalk/V 286	200	169

OS/2 TOOLS

	LIST	OURS
Brief	249	CALL
CASE:PM for C or C++	1995	1799
Epsilon	195	159
MKS LEX & YACC	349	279
MS OS/2 Pres. Manager Toolkit	500	349
MultiScope for OS/2	449	345
PCYACC	695	625
PI Editor	249	225
Smalltalk/V PM	495	369
Vitamin C (OS/2)	345	279
Zortech C++ OS/2 Devel. Ed.	600	509

PASCAL LANGUAGE

	LIST	OURS
Asynch PLUS	149	115
B-tree Filer	125	109
MS QuickPASCAL	99	69
Object Professional	150	109
ObjectVision	400	CALL
Power Tools PLUS/5.0	149	109
Topaz	99	89
Topaz Multi-user	149	135
Turbo Analyst	99	89
TurboMAGIC	199	179
Turbo Pascal 6.0	150	105
Turbo Pascal 6.0 Professional	300	205
Turbo-Plus 5.5	199	159
Turbo Professional 5.0	125	109

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	LIST	OURS
Codan	395	345
CodeCheck	495	469
MKS Make	149	119
MKS RCS	189	149
MKS Software Mgmt. Team	299	239
PolyMake	179	149
PVCS Professional	495	419
SMS	495	399
TLIB	139	109
5 Station LAN	419	339

WINDOWS (MS) TOOLS

	LIST	OURS
Actor 3.0	895	719
Asymetrix Toolbook	395	CALL
Bridge Toolkit	695	659
Case:W	995	CALL
C-Talk/Views	450	375
dBFast/Windows	395	335
DialogCoder	499	435
Drover's Toolbox for Windows	295	269
w/source	885	799
More Power to You	395	339
MS Windows Development Kit	500	349
MultiScope for Windows	379	289
ObjectGraphics	445	365
PC-Connect	495	449
ProtoView	695	625
Resource Workshop	300	269
Spinnaker Plus	495	349
WindowsMAKER	795	635
WinTrieve	395	339
WNDX GUI Toolbox	499	449
XVision	449	399

NEW RELEASES

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A Softelligence library that extends the Microsoft Windows SDK 3.0 to allow direct hardware access to video modes, memory and registers. Provides direct access to the DPMI (DOS Protected Mode Interface) services, bypassing the Windows 3.0 GDI for instantaneous control of video, memory, keyboard, mouse, joystick, etc. Includes examples of animation, arcade-style games, and MIDI. Source available. *Requires Windows SDK 3.0, MS C 6.0.*
List: $395 **Ours: $339**

Zortech C++ Database Library
A collection of C++ classes using OOP's techniques, to provide all that's needed to construct a single/multi-user b-tree database system. Comes with FULL SOURCE CODE and extensive documentation.
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Caseworks CASE:PM for C++ Common View prototypes CUA compliant Presentation Manager interfaces, then generates the required Glockenspiel C++ and Common View Object Classes for the graphical user interface of Presentation Manager applications.
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BLAST	495	395
Epsilon	195	169
Esix System V (2 user)	595	535
Unlimited	825	745
Informix Products	CALL	CALL
Interactive Products	CALL	CALL
LPI-COBOL	1495	1199
LPI-FORTRAN	995	799
MetaWare High C	895	849
Microport Products	CALL	CALL
MKS RCS	395	335
MKS Trilogy	119	105
Norton Utilities	295	235
PI Editor	349	319
RM/COBOL 85	2250	1895
SCO Products	CALL	CALL
SVS C	725	689
SVS FORTRAN	825	795
SVS Pascal	725	689
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SpontaneousAssembly

An assembly language library that lets you produce the fastest, tightest

possible programs with the same ease you'd expect from a high-level language. It includes an impressive collection of over 700 functions and macros for high-speed text windowing, heap management, array searching and sorting, critical error management, 32/64 bit integer math, and much more! Comprehensive 750+ page manual. Full source code. No royalties. Easy integration with C.

"If you program in assembly language, you gotta have SpontaneousAssembly."
- Michael Abrash

basetwo DEVELOPMENT *List: $395* *Ours: $189* **FAXcetera #2614-0001**

DialogCoder

DialogCoder is a powerful "C" source code generator for MS Windows 3.0 application development. It provides a complete development environment for the creation, modification and maintenance of source code to support dialog boxes. With DialogCoder's simple point & click graphical interface, in just minutes source code is generated to support simple flat WYSIWYG dialogs to highly complex dialogs. Dialogs that used to take hours or days to program can now be programmed in minutes, eliminating endless hours of costly debugging and coding time. Supports custom code, automatic regeneration of source code, owner-drawn controls, optional generation of DLLs, edit field validation, and much more.

DialogCoder Set-up Window

List: $499 *Ours: $479* **FAXcetera #2939-0001**

.RTLink®/Plus 4.10 with VML™

(Virtual Memory Linking)

Automatically execute large MS-DOS programs in as little as 100K, or execute in all available memory. No source code changes.

Supports Microsoft C, QuickC, MASM, FORTRAN, Pascal, CodeView, Clipper S'87, and Clipper 5.0.

List: $495 *Ours: $359*

Pocket Soft, Inc. **FAXcetera #1987-0002**

Hyper-Word™

Hyper-Word is a multi-window hypertext word processor and development system. Instantly create interactive tutorials and reference systems. Hyper-Word provides you with the necessary navigation tools to create and explore vast amounts of information. Includes context sensitive help, multi-level undo, pull-down menus. For the programmer: create program mock-ups, automatically display subroutine from any reference, interrelate all program source files. Full WYSIWYG word processing features; 120,000 word main dictionary plus user dictionary, recent reference list, multiple printers and font control. Uses standard text files. Works with or without mouse. Network compatible. Not copy protected.

List: $149 *Ours: $109* **FAXcetera #2868-0001**

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Circle 265 on Reader Service Card

Develop DSP Applications on the Mac

DSP Designer 1.1, for developing digital signal processing applications, now includes Z, a C-like interpretive language for modeling. Zola says you can use Z to create a model of your DSP algorithm to make sure it's correct before you use it in a program. Z also provides floating-point filter simulation.

DSP Designer includes analysis and simulation capabilities for digital filters. You can use it to create, manipulate, and display real and complex-value test signals, as well as for generating filter code for the Motorola DSP56001 24-bit processor.

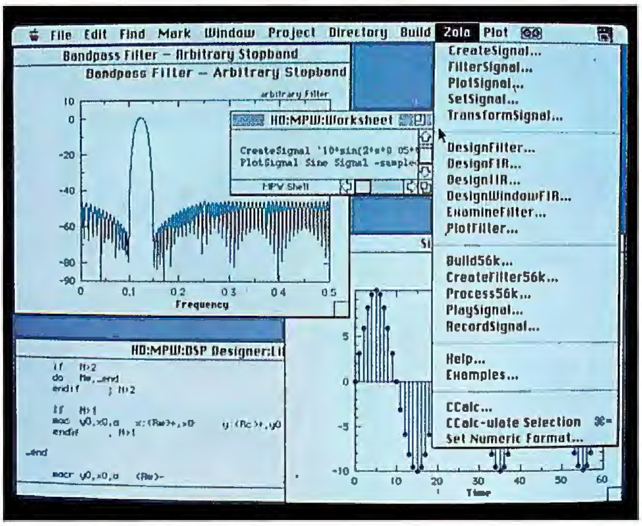
A DSP I/O Subsystem supports real-time evaluation of DSP56001 programs running on Digidesign's Audiomedia or Sound Accelerator cards.

DSP 1.1 works directly with MPW 3.0, letting you develop and test in a single environment.
Price: $895.
Contact: Zola Technologies, Inc., 6195 Heards Creek Dr. NW, Suite 201, Atlanta, GA 30328, (404) 843-2972.
Inquiry 1298.

C Function Libraries for AutoCAD

A set of C function libraries that provides four components for CAD/CAM applications helps you write stand-alone applications or applications that can link into AutoCAD through release 11's new C-binding interface.

The components include DXF input and output, 2-D and 3-D geometry display and geometry operations, and list management. The CAD/



From within the MPW shell, a menu provides access to all DSP Designer commands.

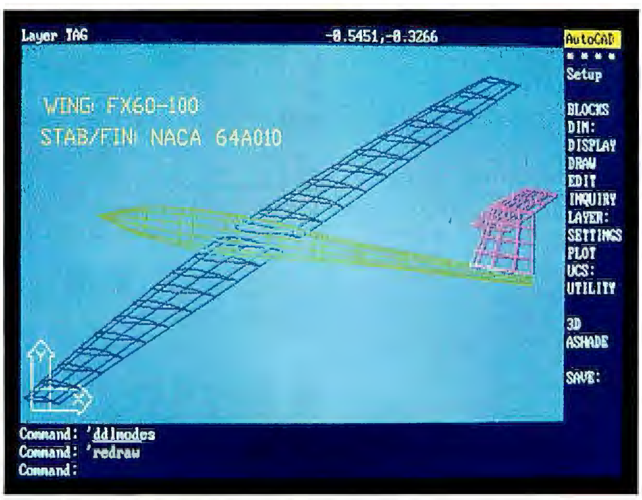
CAM Developer's Kit supports a variety of C compilers.
Price: $1295.
Contact: Building Block Software, P.O. Box 1373, Somerville, MA 02144, (617) 628-5217.
Inquiry 1299.

Screen Manager for C Programmers

Screen Manager Professional (SMP) 2.0, an interface design library that supports a variety of C programming environments, includes functions for windows, menus, context-sensitive help, data entry, and keyboard and mouse support.

SMP 2.0 includes event-driven mouse support, according to Magee Enterprises. The program supports Personics' UltraVision, so that applications can display up to 120 columns by 63 rows.

A minimum configuration requires 13K bytes of RAM, with a maximum configuration using 34K bytes. SMP 2.0 supports Microsoft C 5.1 and 6.0, Turbo C and C++, Zortech C and C++ 2.0, Watcom C 7.0, and Lattice C 6.0.



The CAD/CAM Developer's Kit makes it easy to write parametric applications for AutoCAD, such as this sailplane design program.

Price: $349.95 (royalty free).
Contact: Magee Enterprises, Inc., P.O. Box 1587, Norcross, GA 30091, (404) 446-6611.
Inquiry 1300.

All-in-One Maintenance Tool

When you're involved in software maintenance, trying to unravel the structure and logic of someone else's program can be exasperating. Hindsight, Advanced Software Automation's software maintenance tool for Unix workstations, helps you evaluate code performance and understand code structure.

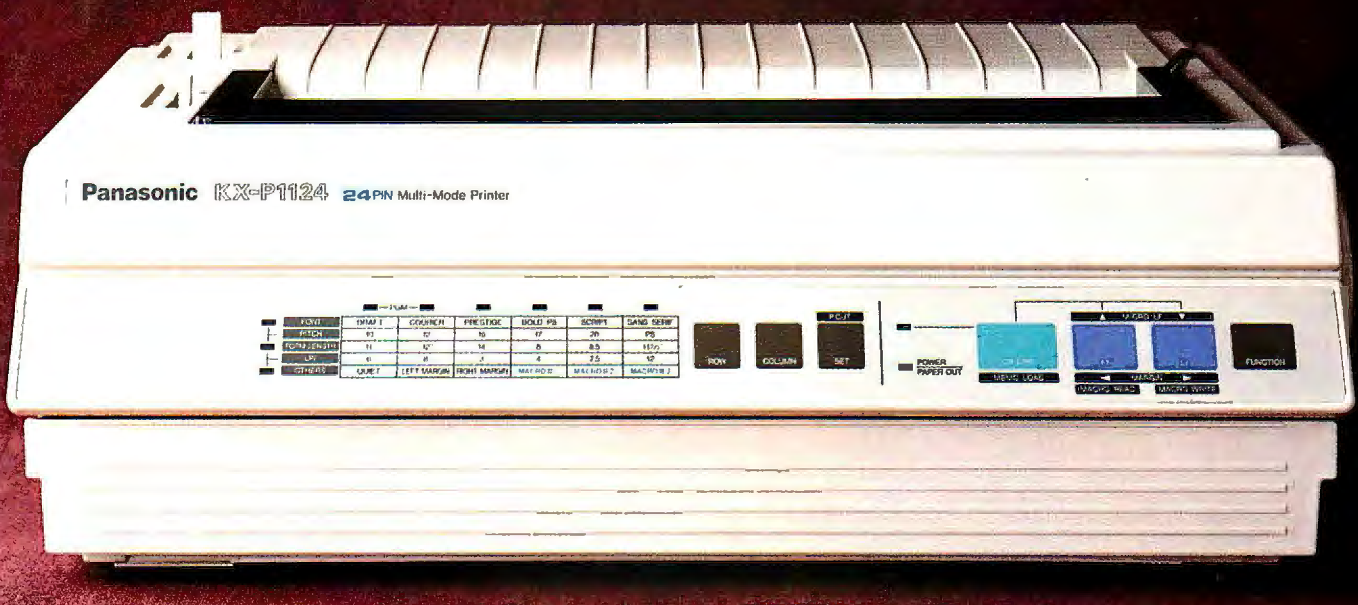
Hindsight generates graphical interactive structure charts and active logic diagrams from your existing C code. Functions and paths are color coded to clarify relationships. The program's assisted code tracing lets you follow function calls and references by pointing to a reference and jumping to the referenced line.

For software testing, Hindsight monitors the effectiveness of your quality-assurance methods as you test program code, providing resolution of test coverage results down to the procedural level, the company says.

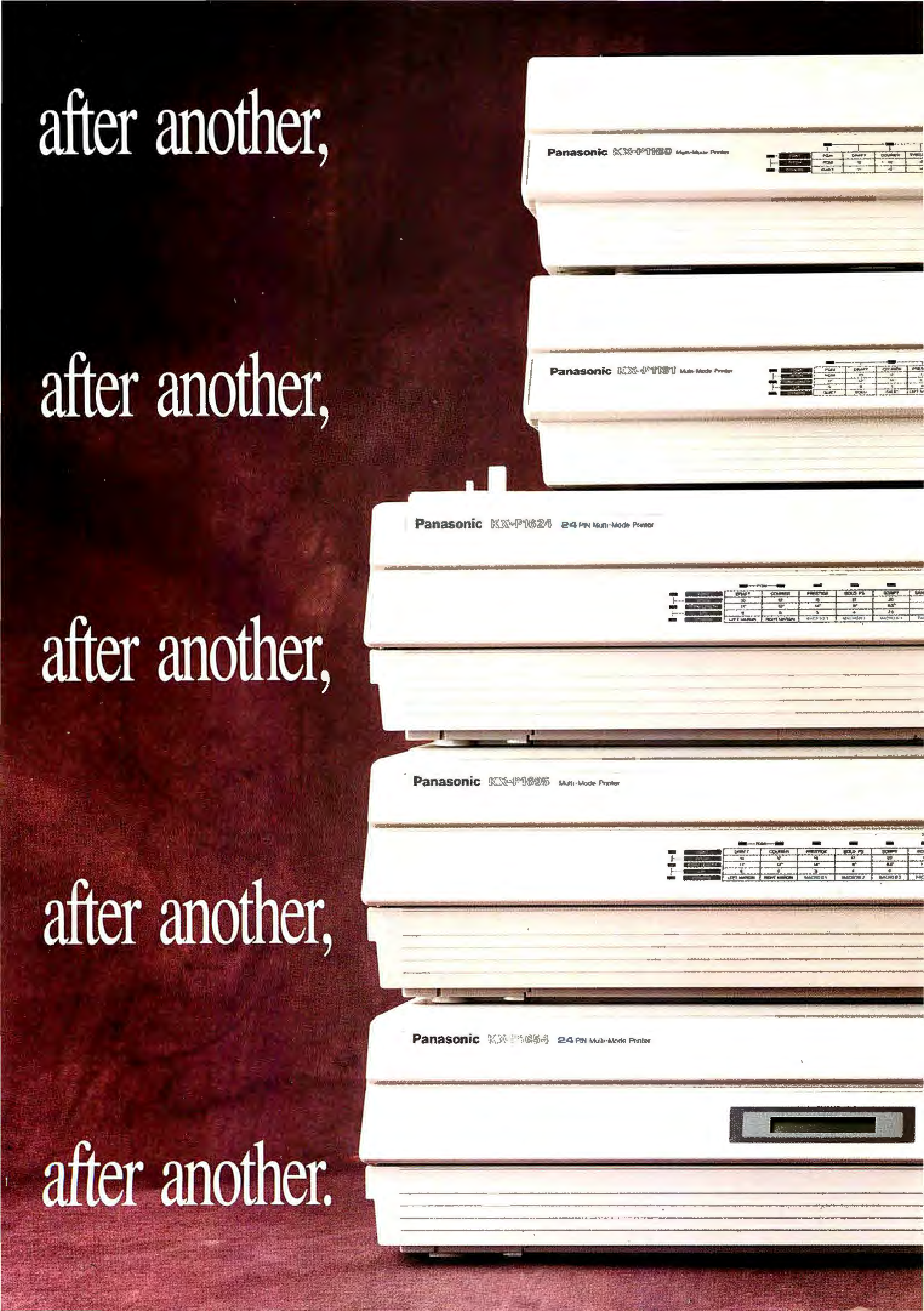
Hindsight tracks changes from one version of a program to the next and automatically updates documentation.

Hindsight runs on Unix workstations (including Apollo, DEC, IBM, and Sun) running Motif, Open Look, or SunView.
Price: $12,000 to $23,000.
Contact: Advanced Software Automation, Inc., 2880 Lakeside Dr., Suite 226, Santa Clara, CA 95054, (408) 492-1668.
Inquiry 1301.

To become the hottest name in dot matrix printers you simply build one terrific printer



The award-winning KX-P1124.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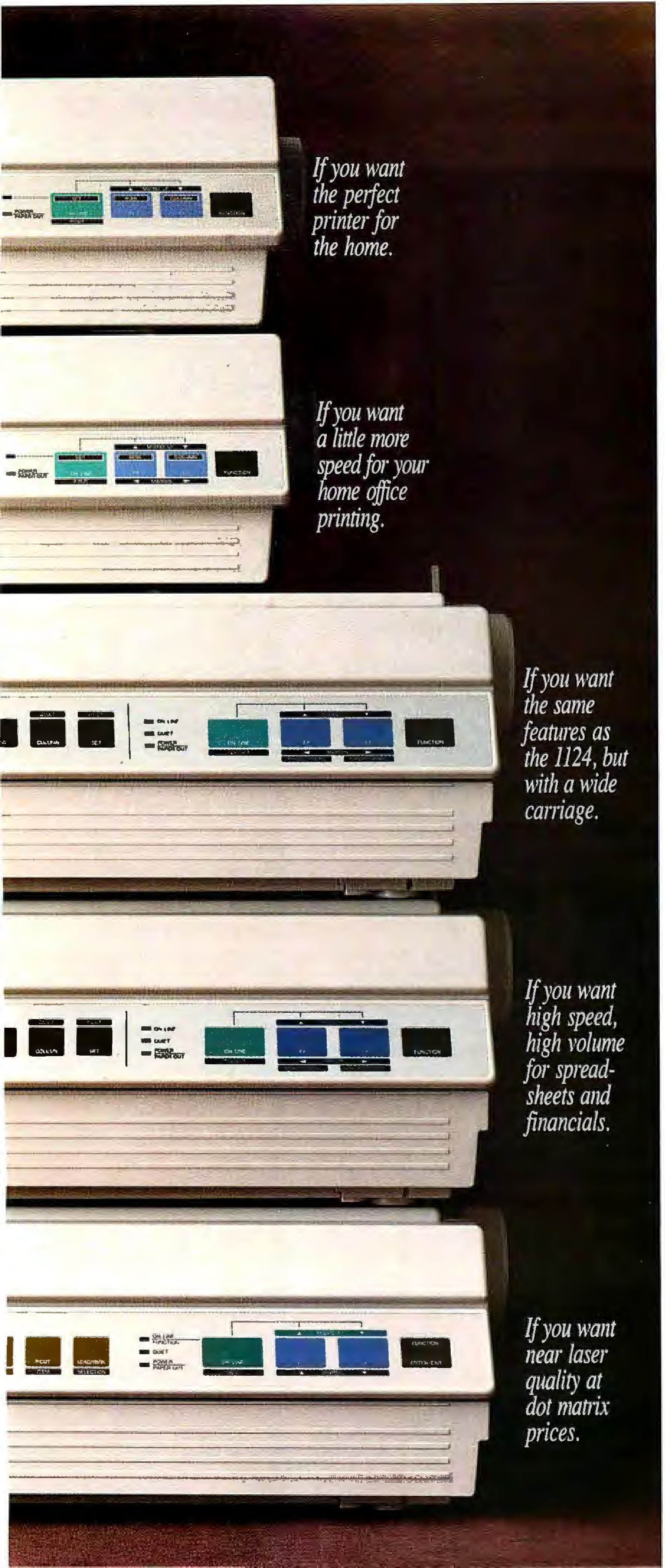

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And we've just introduced what may well be the quintessential office printer for the 90's, the KX-P1654. A wide-carriage 24-pin that rockets along at up to 375 characters per second. With print quality approaching that of lasers.

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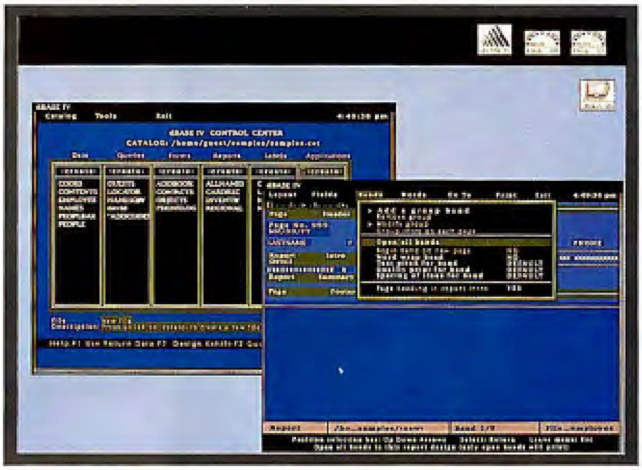
A-T Moves dBASE into the Sun

For businesses that want to run DOS-based dBASE applications on Sun workstations, Ashton-Tate developed dBASE IV for Sun. The program lets you port a DOS dBASE application to the Sun without reprogramming or recompiling, except for occasional hardware differences, the company says. dBASE applications that need to run on ASCII terminals or non-PC-standard keyboards may require slight modification, the company says.

dBASE IV for Sun is an implementation of dBASE IV 1.1, with enhancements to support multiuser and multitasking capabilities, virtual memory, and security. The program includes design tools that let you create screens, reports, menus, and other objects. The Automatic Code Generator can then produce documented code for the objects.

dBASE IV for Sun runs on the Sun-3, Sun-4, Sun386i, Sparcstations, and Sparcservers with at least 4 MB of RAM.
Price: $995 for single-user license; multiuser package that adds up to four users, $2995.
Contact: Ashton-Tate Corp., 20101 Hamilton Ave., Torrance, CA 90509, (213) 329-8000.
Inquiry 1302.



dBASE IV for Sun includes the dBASE IV Control Center, from which you access the program's design tools and code generator.

Mac Mapping Program Has Its Own DBMS

Descartes, a business mapping program for the Mac, includes its own relational database, allowing you to combine your data with demographics and display it in maps and charts from one package.

The program comes with a core set of data that includes state and county demographics and boundaries, ZIP code and major city locations, and interstate highways. An importing tool lets you integrate data from other applications into the Descartes database.

The company also provides Snap-In Data geographic and statistics options such as Arbitron Areas of Dominant Influence, Nielsen Designated Market Areas, and related demographic data. The program requires a Mac SE or higher.
Price: $795; Snap-In Data options, $100 to $3000.
Contact: Intermap, Inc., 13 Dartmouth College Hwy., Lyme, NH 03768, (603) 795-4751.
Inquiry 1303.

Softsync's Accounting Entry Point for the Mac

Accountant, Inc. Professional uses a task approach to accounting and finance that shields users from having to learn accounting procedures they don't need to know, according to Softsync.

The program integrates general ledger, accounts payable, accounts receivable, inventory, payroll, a project manager, and financial analysis in one package.
Price: $595.
Contact: Softsync/BLOC, 800 Southwest 37th Ave., Suite 765, Coral Gables, FL 33134, (800) 955-1888 or (305) 445-0903.
Inquiry 1304.

Manage by Objective with Key Results

Key Results combines time and task management, planning, word processing, and information management to help you control your time and accomplish goals, TMI says. By helping you manage your time, Key Results lets you set priorities, communicate, coordinate, and delegate tasks.

The program provides an overview of goals, tasks, and activities, letting you know what's completed, what has to be done, and, perhaps more important, what can wait.

The program integrates all of its sections (Diary, Key Area, and Key Results). As you make appointments, they are allocated time in daily, weekly, and monthly plans.

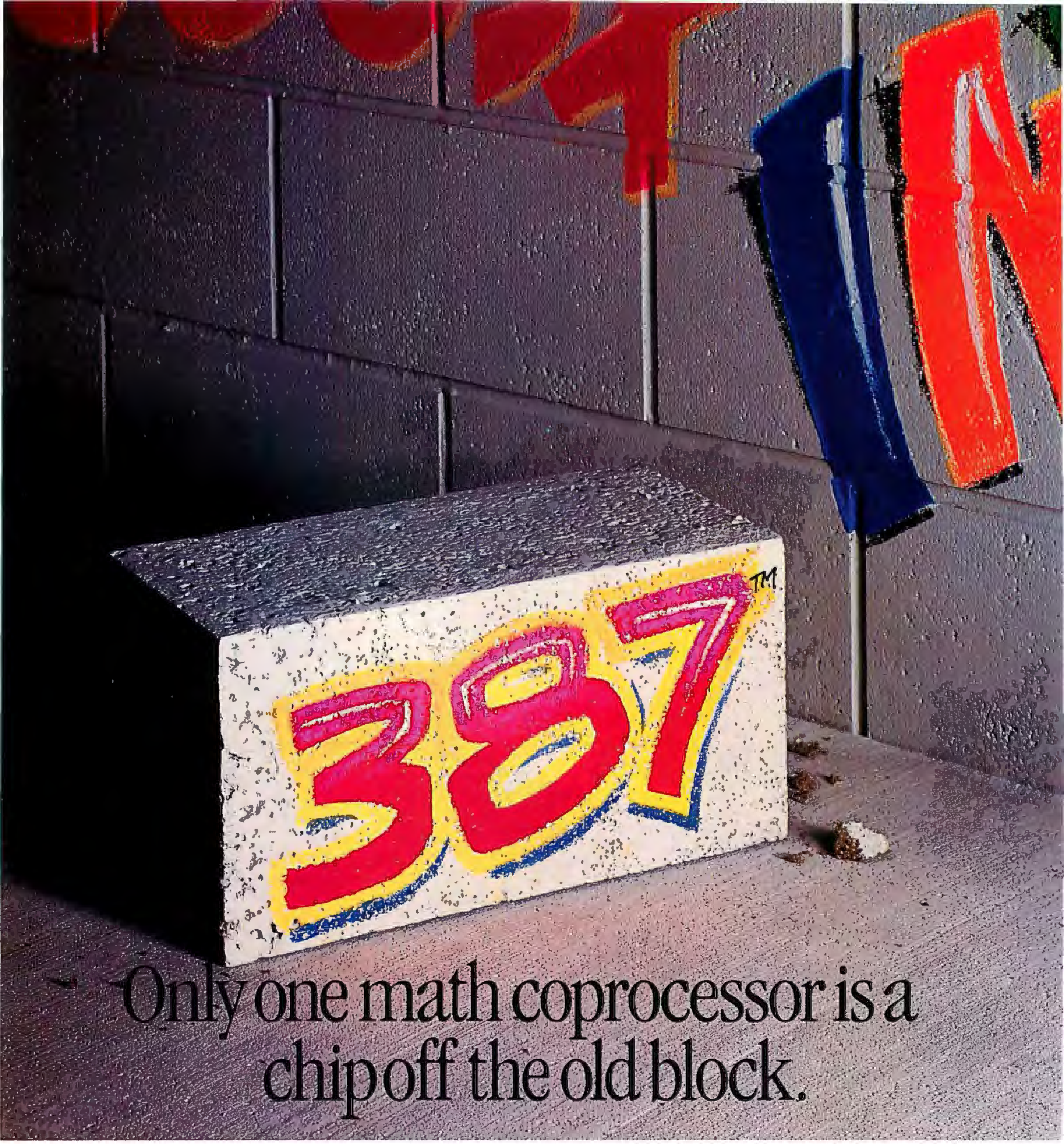
Key Results works on the IBM PC with 512K bytes of RAM.
Price: $595.
Contact: TMI, Inc., 185 Berry St., Suite 6504, San Francisco, CA 94107, (415) 957-1133.
Inquiry 1305.

FirstMark Seeks Out the Important Data

For managers who want to analyze data to make decisions without having to rely on the interpretations of an intermediary statistical analyst, FirstMark has developed KnowledgeSeeker. The program combines statistics and AI to provide a snapshot of important trends and relationships in your business. It presents this information in an interactive graphical decision tree or in the form of decision rules.

KnowledgeSeeker can automatically derive these snapshots from data stored in dBASE III, dBASE IV, Lotus 1-2-3, or ASCII format. By using AI and statistical analysis, the program lets you interact with your database or worksheet directly to cull out critical relationships and patterns that fall along geographic or demographic lines.

KnowledgeSeeker runs on the IBM PC with 640K bytes of RAM and a hard disk drive.
Price: US$495.
Contact: FirstMark Technologies, Ltd., 14 Concourse Gate, Suite 600, Ottawa, Ontario, Canada K2E 7S8, (800) 387-7335 or (613) 723-8020.
Inquiry 1306.



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Because Intel developed the first Math CoProcessor in 1982, and we've shipped millions since then. Each one is manufactured by Intel in the world's most advanced logic

Bring Your Data to Life

EasyPlot 2.0, the interactive plotting and data-analysis package for the IBM PC, has a new windowing system for working with multiple graphs, expanded memory support, new editors, and improved analysis capabilities, its developer says.

As you enter data or equations, EasyPlot instantly generates a plot, complete with tick marks and labels. You can then customize any aspect of the graph, changing axis ranges, including log scales, position of axes, tick mark locations, fill patterns, and other attributes. The program updates graphs immediately after every change.

With EMS support, the program can now handle more than 100,000 points without having to do the disk shuffle. Text-based and graphical editors let you add, delete, or adjust data points.

The program's new curve-fitting algorithm works with any function of up to 20 unknowns. The new version supports dual axes, bar charts, and 3-D scatter plots that can rotate in real time.

EasyPlot requires 400K bytes of RAM.
Price: $349.
Contact: Spiral Software, 6 Perry St., Suite 2, Brookline, MA 02146, (800) 333-1511 or (617) 739-1511.
Inquiry 1307.

EasyPlot's pull-down menus let you access functions while graphs appear on the screen. You can annotate the graph directly and reposition objects by clicking and dragging.

The Program of 10,000 Stars

The new version of EZ-Cosmos includes a database of 10,000 stars and other celestial objects. According to Future Trends Software, the program can display the sky as it would appear from any location on Earth between 4000 B.C. and 10,000 A.D. You select a location by entering longitude or latitude or the name of a major city (more than 560 cities around the world are on file). Version 3.0 also includes over 35 digitized photos of NGC (New General Catalog) objects and the solar system.

You can search for celestial objects by common name, NGC designation, or constellation designation. You can also animate occurrences such as solar eclipses in intervals that you designate.

The program requires 512K bytes of RAM.
Price: $69.95.
Contact: Future Trends Software, P.O. Box 1418, DeSoto, TX 75115, (800) 869-3279 or (512) 443-6564.
Inquiry 1308.

This photo of the Trifid nebula, taken from the Kitt Peak Observatory, is one of many images included with EZCosmos.

CCD Image Processing for the Mac

For scientific imaging applications in medicine, microscopy, and astronomy, the IPLab line of imaging programs has been updated to work with the Photometrics Series 200 charge-coupled-device camera.

With IPLab-SU2, you can control the camera directly from the program. IPLab (for gray-scale) and IPLab/Spectrum (for 24-bit color image processing) can both display and process image data with a dynamic range of more than 8 bits per pixel while retaining data integrity, Signal Analytics says.

The program provides image-processing operations such as fast Fourier transforms, linear and morphological filtering, and statistical operations.

IPLab-SU2 requires a Mac II with at least 4 MB of RAM, an 8-bit video card, and a hard disk drive.
Price: $1099; with color support, $1349.
Contact: Signal Analytics Corp., 374 Maple Ave. E, Suite 200, Vienna, VA 22180, (703) 281-3277.
Inquiry 1309.

Easy Equilibrium Chemistry

For aquatic chemists, biochemists, and geologists who are tired of spending hours on complicated aqueous equilibrium solutions, MicroMath Scientific offers Equil. The program's built-in equilibrium compiler automatically constructs mass balance relationships.

Equil 2.0 features an expanded database and now handles 300 reactions, over 100 chemical reagents, and 400 chemical species. You can now test reactions according to varying temperatures, and the program has several new methods for calculating the activity coefficient affecting equilibrium constant.
Price: $249.
Contact: MicroMath Scientific Software, P.O. Box 21550, Salt Lake City, UT 84121, (800) 942-6284 or (801) 943-0290.
Inquiry 1310.


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Paint Landscapes on Your Monitor

Going beyond the shooting stars and flying animals found in most screen-saver programs, Dawn paints landscapes on your IBM PC monitor. With thousands of variations on a dozen themes, the program puts art on your monitor when it's not in use. The program requires EGA graphics capability or higher.
Price: $39.95.
Contact: Iron Mtn Software, P.O. Box 1676, Mariposa, CA 95338, (209) 742-5000.
Inquiry 1311.

No More Dirty Floppy Disk Drives

Viruses are bad enough, but how do you know if dirt and dust in your floppy disk drive aren't causing you to lose data? A program called Trackmate Generation 3.0 tests your floppy disk drive's read/write heads and loading rail assembly to see if cleaning is needed and recommends the length of the cleaning program.

When you determine that there's too much dirt in your system, you insert a cleaning disk included with the software. The disk has 265,000 absorbent filaments that fit the read/write heads and remove dirt. Additional brushes clean the loading rails.

The program supports 3½- and 5¼-inch floppy disk drives on the Mac and IBM PC.
Price: $34.95; $44.95 for the 5¼-/3½-inch combination pack for PCs.
Contact: Trackmate America Corp., 14577 South Bascom Ave., Los Gatos, CA 95032, (408) 356-0795.
Inquiry 1312.

Even if your office doesn't have a window, Dawn gives you a view of the great outdoors.

Take Stock of Your Office

In a large corporate environment, taking a PC census involves disrupting workers, pulling out boards, taking notes manually, and rekeying data into a database. PC Census makes it easier to tell who's got what and where it is.

PC Census provides a centralized inventory of the software and hardware in your installation, telling you what's on each system.

When you run PC Census on a PC, it scans the machine's internals and recognizes hardware add-ins, applications such as WordPerfect, and other components, eliminating the need to take apart the PC and search through subdirectories. With a remote-access program, you can use PC Census on a LAN.
Price: $745 for a combined hardware-software module for 50 PCs.
Contact: Tally Systems Corp., Buck Rd., P.O. Box 70, Hanover, NH 03755, (800) 262-3877 or (603) 643-1300.
Inquiry 1313.

Central Point Unbundles Its Backup Program

Central Point Backup is a stand-alone version of the backup program found in PC Tools Deluxe 6.0. The program lets you save options and selections for launching subsequent backups from the DOS command line.

A character-based program, Central Point Backup includes a graphical user interface that makes it easy to select files and options to perform regular backups.
Price: $99.
Contact: Central Point Software, Inc., 15220 Northwest Greenbrier Pkwy., Suite 200, Beaverton, OR 97006, (503) 690-8090.
Inquiry 1314.

Electronic Directory of Toll-Free Numbers

The Toll-Free Hotline contains more than 115,000 listings drawn from AT&T's roster of 1-800 customers. Each listing includes the company name, phone number, calling area, and demographic information. The program, which runs on the IBM PC, has a database manager and auto-dial capabilities.
Price: $59.95.
Contact: General Information, Inc., 11715 North Creek Pkwy. S, Suite 106, Bothell, WA 98011, (800) 882-3900 or (206) 483-4555.
Inquiry 1317.

Get Up to Speed with Windows

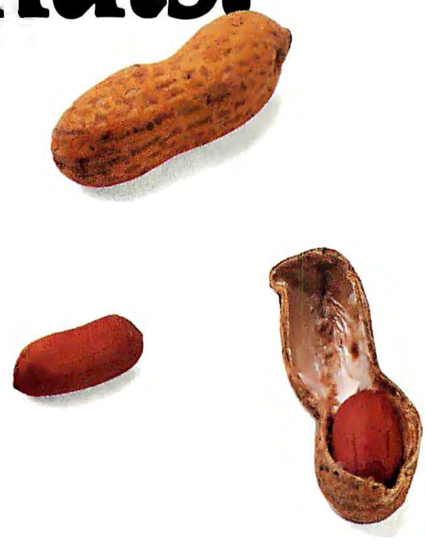
Microsoft developed its Productivity Pack for those who want to learn Windows 3.0 and get the most out of the operating environment. A Windows application, the Productivity Pack offers three tools.

Learning Windows gets you up to speed while providing on-line help. Working Smarter provides hints, tips, and strategies while you're in another Windows application. The Quick Troubleshooter helps you diagnose and answer Windows support questions.
Price: $59.95.
Contact: Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080.
Inquiry 1315.

Virus Protection Around the Clock

This virus protection program works around the clock. Besides scanning for known viruses, HardDrive Overlord! seeks out activities often associated with viral attacks, such as a program's unauthorized attempt to stay resident in RAM. When it detects such activities, the program pops up a warning with options for stopping the function or continuing.
Price: $99.95.
Contact: POP Computer Products, Inc., P.O. Box 1389, Evergreen, CO 80439, (303) 674-0200.
Inquiry 1316.

PostScript for peanuts.



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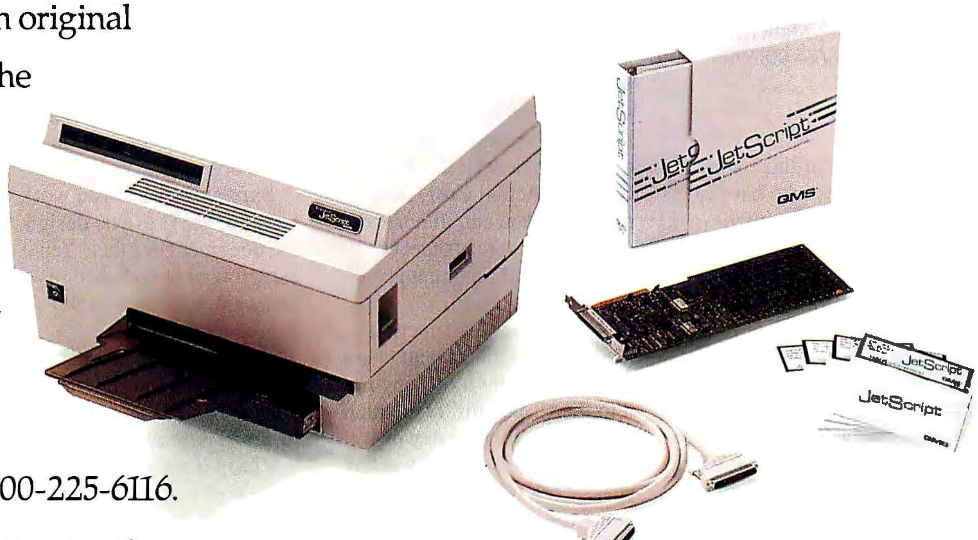
JetScript was developed jointly by Adobe Systems, QMS and Hewlett-Packard to bring the power of PostScript to the HP LaserJet™ Series II. If you already have an HP LaserJet II, or an original LaserJet, you can get the JetScript controller separately for as low as $495. That's a whopping 80% below the list price!



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Circle 625 on Reader Service Card (RESELLERS: 626)

FORMS AND CHARTS

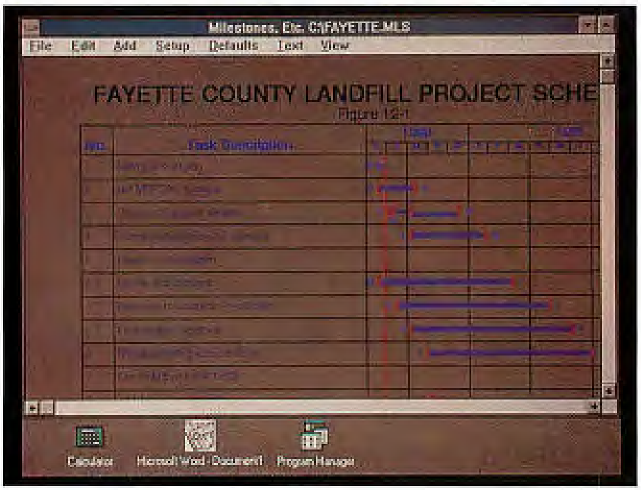
Chart Drawing Under Windows 3.0 and the Mac

Kidasa Software's newest release of Milestones, Etc., for creating Gantt charts, now supports up to 500 task lines and up to 40 milestone symbols per task line. An auto-connect option automatically connects every two symbols on a line with a default connector type. It can import Comma Separated Variable files from Microsoft Project.

Kidasa improved the program's metafile exchange to support Microsoft PowerPoint, Windows Write, Word for Windows, Corel Draw, Amí Professional, Designer, and PageMaker.
Price: $149.
Contact: Kidasa Software, P.O. Box 1167, Manchaca, TX 78652, (800) 666-3886 or (512) 282-1544.
Inquiry 1170.

A program for those unlucky ones who have to update company organizational charts in these times of economic uncertainty, Instant Orgcharting! takes advantage of proportional fonts, multiple document interfaces, and other features of Windows 3.0.

The program lets you choose from nine organization tree structures. As you enter new personnel information, the program automatically redraws the chart. By clicking on an employee box, you can access detailed information about each person.
Price: $149.
Contact: Roykore, Inc., 2215 Filbert St., San Francisco, CA 94123, (415) 563-9175.
Inquiry 1171.



Milestones, Etc. 2.1 supports 300 more task lines and 30 more milestone symbols per task line than the previous version.

The new version of Great Gantt! for the Mac includes a dollar progress tool that lets you click on a bar to see how much money you've spent to date compared to how much you'd planned to spend. To allow for this new feature, Varcon Systems added two new fields, Planned Cost and Actual Cost, to the program. You can import cost data from a spreadsheet or other application or enter it directly on the chart.

A print preview function lets you view your Gantt chart before you print it by copying it to the Clipboard. New calendar options include day of year, day of schedule, week of year, week of schedule, and month of schedule.

Great Gantt! 1.3 also has two new commands that bring a chart to the front or send it to the back of another task bar. The program's MacProject reader lets you easily create charts from Claris's project management program, Varcon reports.
Price: $195.
Contact: Varcon Systems, Inc., 10509 San Diego Mission Rd., Suite K, San Diego, CA 92108, (619) 563-6700.
Inquiry 1172.

Bar Coding Design for Labels on the PC

The Barney Ellis program integrates graphical design, information management, and printing for the production of labels, forms, and signs. The program comes with 101 character fonts and several standard bar code symbologies.

Barney Ellis lets you work in WYSIWYG as you design the document or label. You can grow or shrink designs and rotate elements in 90-degree increments.

You can queue and batch print jobs to achieve unattended printing on up to four printers. A report feature lets you keep track of printed material and who printed it. The program's data dictionary lets you access data in other spreadsheets, word processors, and databases.
Price: $1695.
Contact: Integrated Software Design, Inc., 171 Forbes Blvd., Mansfield, MA 02048, (508) 339-4928.
Inquiry 1169.

When Forms Meet a Database

With the EZ-Forms' Database, you can manage your business's information from one package, entering new information through a form input screen that's linked to a dBASE-compatible database. Once you've entered the information into the form and transferred it to the database, you can perform relational operations (e.g., query, browse, seek, or record finds).

EZ-Forms' Database loads a form that you've created with the included EZ-Forms Executive as an input screen. You can also use one of the program's predesigned forms as an input screen. By giving a common name to the input screen field of the database and a cell within the form, you can transfer information between forms and the database. In this way, information in the database is readily available for insertion into any type of business form, the company says.

The program can convert other file formats, such as fixed length, ASCII, or FileExpress databases, into a dBASE EZ-Forms' Database. Because it generates dBASE files, any third-party product that uses the dBASE format will work with EZ-Forms' Database, the company says.

Version 2.1 of the program is available in single and LAN versions. Both versions come with 10 applications for inventory, time billing, phonebook, cities, and other business functions.
Price: $239; LAN versions start at $795 for five users.
Contact: EZX Corp., P.O. Box 58177, Webster, TX 77598, (713) 280-9900.
Inquiry 1168.

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VGA-Mono	$1,799	$2,024	$2,049	$2,449	$3,249
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VGA-Mono	$3,049	$3,449	$3,449	$4,249	$5,349
Hires	$3,299	$3,699	$3,699	$4,499	$5,599

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DATABASE MANAGEMENT

Object Databases for Sun and DOS

Developers of applications for managing data stored as text, sound, images, and graphics are starting to turn to object databases for their needs.

Based on C++, ObjectStore for the Sun-3 and Sparcstation includes the run-time component, application interface, and C++ development tools. The application interface provides access from other programs to the run-time system using either a data-manipulation language (DML) preprocessor interface, a C library interface, or a C++ library interface.

The DML preprocessor supports parameterized types for defining container classes and developing reusable code. You can store C and C++ data in native format, allowing an application to work unmodified with both transient and persistent data.

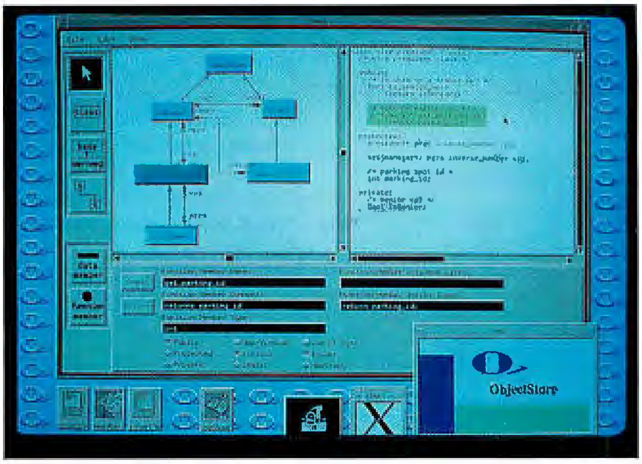
Development tools include a debugger, a browser, and SchemaDesigner, a graphical tool for developing schemata and generating their associated C++ code.

ObjectStore supports collaborative work among teams of design professionals. It supports the TCP/IP networking protocol.

Price: $2000 to $9000 per user.

Contact: Object Design, Inc., One New England Executive Park, Burlington, MA 01803, (617) 270-9797.

Inquiry 1180.



ObjectStore, the object database management system for the Sun-3 and Sparcstation, is based on C++.

Persistent Data Systems says that its IDB Object Database runs on DOS-based PCs, HP/Apollo workstations, and Sparcstations.

Through its Interface Description Language, the program lets you write applications using off-the-shelf C development tools. As you create an application, you use the IDL to describe the data. That information is mapped into C through the IDL translator. The program supports most popular C development tools, and support for other languages is planned.

The IDB Object Database supports dynamic binding, exceptions, and transactions for use in a workgroup environment.

Price: $2500 for one license; $6000 for workstations.

Contact: Persistent Data Systems, Inc., 75 West Chapel Ridge Rd., Pittsburgh, PA 15238, (412) 963-1843.

Inquiry 1181.

Relational Capabilities Added to askSam

Relational capabilities have come to askSam, the free-form information tool that can function as a database, personal information manager, hypertext system, or text manager. However, unlike traditional relational databases, askSam doesn't require you to establish links between files through common fields, askSam Systems says.

Instead, askSam lets you establish links through the common occurrence of letters, words, or groups of words. Version 5.0 of the program is also more flexible than a traditional relational DBMS, letting you repeat fields in the same file, according to the company.

For developers who want to create stand-alone applications that use askSam as a database engine, the company has also introduced a developer's edition.

Improvements to both programs include the ability to sort as much data as your system will allow and support for nested subroutines. This lets you write communications like dialog box requests, allowing you to send messages to end users to guide them in their operation.

Other new features include a controlled field editor, which lets you restrict data entry to specific fields and specify field length to control accuracy, and a time and date generator to stamp entries.

Price: askSam 5.0, $395; developer's edition, $695.

Contact: askSam Systems, Inc., P.O. Box 1428, Perry, FL 32347, (800) 327-5726 or (904) 584-6590.

Inquiry 1178.

R:base Has dBASE Ad Hocs Without Programming

R:base 3.1, the latest upgrade of Microrim's relational DBMS, is now compatible with dBASE III and dBASE III Plus, letting you combine files from both programs in one database. Once you import your dBASE files into R:base, you can use the program's pull-down menus to produce ad hoc queries and reports without programming, the company says.

Microrim slimmed down version 3.1 from its previous version by 70K bytes. It now requires 450K bytes.

Price: $795; five-user LAN pack, $995.

Contact: Microrim, Inc., 3925 159th Ave. NE, P.O. Box 97022, Redmond, WA 98073, (206) 885-2000.

Inquiry 1179.

Run dBASE IV Programs Very Fast

Arago dBXL 2.0 and Arago Quicksilver 2.0 combine dBASE IV compatibility with a Common User Access–compliant interface to speed execution, according to Wordtech Systems.

The Arago Quicksilver 2.0 compiler lets you create applications without run-time or licensing fees. Along with the compiler, screen painter/generator, and debugger, the compiler includes a Program Test Coverage Analyzer for revealing which portions of your application haven't been executed during testing.

Price: Quicksilver, $695; dBXL, $495.

Contact: Wordtech Systems, Inc., 21 Altarinda Rd., Orinda, CA 94563, (415) 254-0900.

Inquiry 1182.

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- Power control of backlight, mass storage, internal modem and process speed.

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- 13.7"W*8.5"D*4.3"H (349mm*316mm*107mm)

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- 14 lbs (6.4 Kg).

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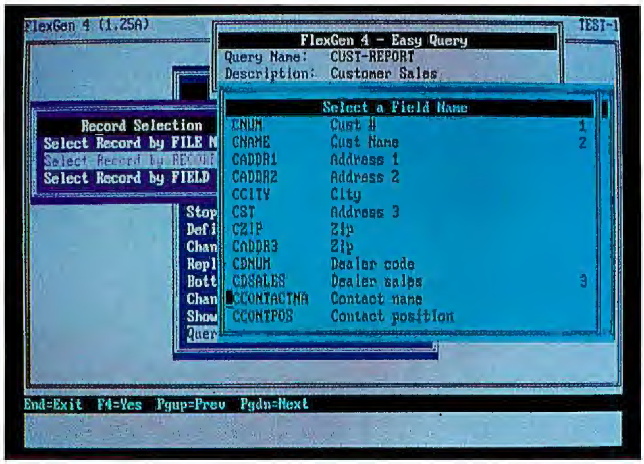
APPLICATION GENERATORS



FlexGen 2.0 lets you put a pretty face on your COBOL program.

Dodging the Windows API

The latest addition to the Caseworks family of application generators lets you develop and prototype the graphical-interface portion of a Windows 3.0 application. Case:W 3.0 has extended code support for dialog-box controls, generating shell dialog message processors to program dialog-box functions, not just calls for the dialog boxes.

You can specify application variables that are logically associated to each dialog control. Then you use the variable as the link to the control instead of writing to the Windows application programming interface. With extended code support, Case:W can prototype the action that occurs when someone edits a field or activates a control.

The program includes a test view for animating the interface and testing its look and feel without compiling, Caseworks says. Case:W creates programs in a modular structure, taking full advantage of the Windows 3.0 memory management facilities.
Price: $795.
Contact: Caseworks, Inc., 1 Dunwoody Park, Suite 130, Atlanta, GA 30338, (800) 635-1577 or (404) 399-6236.
Inquiry 1183.

Two Generators for COBOL

FlexGen 2.0 lets you generate forms and windows for your COBOL program. The program includes Easy *Query*, which guides you in providing 4GL query- and report-writing capabilities in your application. Once you build the query, you can run it interpretively or incorporate it into the program, Sinc says.

FlexGen 2.0 has options for color, field-entry characteristics, auto-lookup windows, auto-browse mode, and others.
Price: $550 to $15,000.
Contact: Sinc, Inc., 1299 LaVelle Dr., Xenia, OH 45385, (800) 543-4035 or (513) 372-4334.
Inquiry 1186.

Flexus International, maker of the COBOL CICS spII and COBOL spII generators, has released versions of both tools for Sun workstations running Open Look. The company says the generators can reduce the time required to add menus, help screens, and I/O screens to mainframe communications and other applications.

With COBOL spII, you can run an application simultaneously on graphics- and character-based terminals, without having to run in character mode on the graphics terminal. The generator offers mouse support. As you debug a program, you can view the source code while monitoring screen interaction from multiple windows.

The CICS version of the program was developed to help create cooperative processing applications on the Sun. In addition to painting Basic Mapping System maps, you can prototype the CICS application using spII's Dialog Definition Facility. Once you paint the user interface and prototype the system, the program lets you generate BMS macros, as well as command-level CICS procedural COBOL.
Price: COBOL spII, $495 to $795; CICS spII, $795 to $995.
Contact: Flexus International Corp., P.O. Box 9199, Morristown, NJ 07963, (201) 895-4724.
Inquiry 1187.

Application Generator for dBASE

A code generator called dB Intuition lets you add form views, menus, and security levels to your dBASE, FoxBase, Quicksilver, or Clipper application.

The program lets you add shadowed menus and multiple page views to your application. A library editor lets you create your own library files, while the linker is LAN-compatible, according to Integrated Database Technology.
Price: $119.
Contact: Integrated Database Technology, 300 Maple Ave., South Plainfield, NJ 07080, (201) 756-8665.
Inquiry 1185.

New Multiplatform Jam Flavors

With Jam 5, you can put features normally associated with a graphical user interface (e.g., virtual forms and viewports) into a character-based application. With the proper run-time libraries, the application can run on DOS, Unix/386, and OS/2.

JYACC has also announced a Motif-based tool that will let you construct Motif interfaces and access widgets. You'll also be able to compile applications down to character mode. JYACC says the program, the price of which was undetermined at press time, will permit seamless integration to multiple databases.

In addition to full mouse support, Jam has sibling windows, shrink-to-fit text windows, screen entry and exit routines, and other widgets, like radio buttons. Through 8-bit internalization, the program lets you easily customize it for international use.

Other JYACC tools include the Jam Graphics Interface, for integrating graphical images into the application; Jam/DBi ReportWriter; and the Jam DBi, for linking applications to relational databases.
Price: Jam for DOS, $595; Jam for OS/2, $1350; Jam for Unix/386, $1950.
Contact: JYACC, Inc., 116 John St., New York, NY 10038, (212) 267-7722.
Inquiry 1184.

Now you can build more in a day.

HyperPAD® 2.0, a powerful software construction set for MS-DOS® systems, dramatically increases your productivity. Applications that might take months to build with tools like Pascal, C, or BASIC now take only minutes.

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Circle 609 on Reader Service Card

WORD PROCESSING/DESKTOP PUBLISHING

ButtonWare Updates PC-Type

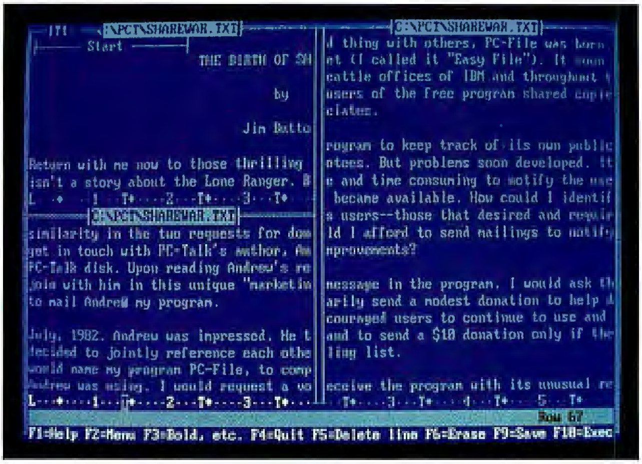
The new version of PC-Type lets you process multiple files as one document. It supports a table of contents and index for large documents, where chapters and sections are automatically numbered.

PC-Type 4.0 adds a print-preview function and a 100,000-word customizable dictionary. The program requires 384K bytes of RAM on an IBM PC.

Price: $99.95.

Contact: ButtonWare, P.O. Box 96058, Bellevue, WA 98009, (800) 528-8866 or (206) 454-0479.

Inquiry 1188.



PC-Type 4.0's split-screen capability lets you open two files at once or view different parts of the same file.

Publish with Special Effects

Power Up Software says that Express Publisher 2.0 adds a module for creating headlines and logos with advanced typesetting effects. The TextEffects module lets you manipulate text to fill a polygon, bend along a curve, grow or shrink in size from one character to the next, or run along an angled line. In addition to special effects, the program adds text-formatting commands for justification, kerning, and character spacing.

The new version also adds five AGFA Compugraphic Intellifont scalable typefaces, bringing the total number of fonts in the program to eight. Express Publisher generates fonts on the fly in sizes from 6 to 144 points.

Other new features include landscape printing and the ability to import CGM files. It previously supported PCX, GIF, ART, IMG, MacPaint, Microsoft Paint, Print Shop, EPS, and TIFF file formats.

The program runs on the IBM PC with 640K bytes of RAM and a hard disk drive. It supports Hewlett-Packard LaserJet III, LaserJet, DeskJet, PostScript, and other laser and dot-matrix printers.

Price: $159.95.

Contact: Power Up Software Corp., 2929 Campus Dr., San Mateo, CA 94403, (415) 345-5900; for upgrades, call (800) 851-2917.

Inquiry 1190.

Screen Capture for Windows

Pizazz Plus, a program for capturing black-and-white or color Microsoft Windows 3.0 screen images, can export TIFF gray, TIFF color, EPS, PCX, and other popular file formats. Once you've captured the whole screen or just a portion of it, you can adjust color and gray-scale brightness and contrast to obtain the best image in your document.

Pizazz Plus is a TSR program that requires 32K bytes of RAM.

Price: $149.

Contact: Application Techniques, Inc., 10 Lomar Park Dr., Pepperell, MA 01463, (800) 433-5201 or (508) 433-5201.

Inquiry 1192.

A Bridge Between CAD and Publishing

The new preview function in CADleaf, an engine for converting CAD files into several desktop publishing formats, lets you monitor the translation process as it occurs. It lets you view the file as it translates so you can ensure that you selected the correct file, which is helpful when you have to deal with thousands of CAD files, Carberry Technology says.

In addition to the preview function, CADleaf 2.0 lets you convert any CAD or drawing program that exports IGES, Hewlett-Packard Graphics Language, CalComp960, AutoCAD, or CGM format into CGM, EPSI, Sun Raster, Interleaf, or FrameMaker format. By supporting these formats and conforming to the Department of Defense MIL-D-2800 specification, the program is CALS-compliant.

CADleaf 2.0 runs on Sun, 386i, and Apollo workstations, and the AT&T 3B2.

Price: $4995.

Contact: Carberry Technology, Inc., 600 Suffolk St., Lowell, MA 01854, (508) 970-5358.

Inquiry 1191.

Ease the Text-Import Blues

Sooner or later, most people using a word processor have to incorporate data from another application into a document. This often means converting to ASCII, stripping out hard carriage returns, and reformatting the text. A program designed to ease that process is now available from Systems Compatibility.

Outside In instantly recognizes 57 file formats, letting you view, select, and import data stored in a host of applications and import it on the fly into your word processor. Once you install Outside In as a TSR program, you can call it up from within your word processor and browse through spreadsheets, databases, and other word processor files and import the data in its native file format.

In addition to preserving boldface, underlining, tabs, and other attributes of the other application's data, the program lets you search for a word or phrase. You can scroll up and down or right to left through a file and mark that text for importing.

Outside In supports the marking of more than just a screen's worth of data. It also lets you select noncontiguous data that's stored in a spreadsheet or database.

The program runs on the IBM PC and uses 70K bytes of RAM. A version expected to ship later this year will require just 40K bytes. The program runs on any DOS-based network, the company says.

Price: $99; network versions start at $299.

Contact: Systems Compatibility Corp., 401 North Wabash, Suite 600, Chicago, IL 60611, (312) 329-0700.

Inquiry 1189.

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5200SX	386sx-16	2x16 Bit	VGA GAS plasma	3.5/1.44	40MB IDE	YES	8MB	$2799
5200NV	286-16	2x16 Bit	VGA GAS plasma	3.5 1.44	40MB IDE	YES	8MB	$2299

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Here is your chance to pick up on the biggest bargain in Laptops anywhere. The LT-3500 is packed with features. The 80286-12 MHz CPU runs at 0 wait state, ready to blaze hrough those tough applications. There is also a 40 MB fast HDD & an internal 3.5 /1.44MB diskette drive

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- Free carrying case

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- AMI BIOS

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- Baby AT case
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- Fully compatible: EMS, LIM 4.0, DOS, OS/2, UNIX, XENIX and NOVELL

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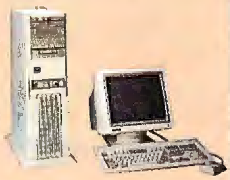

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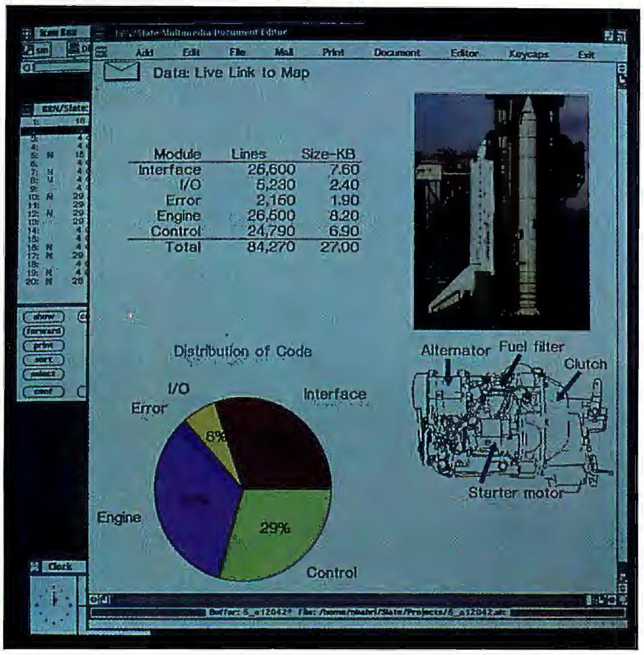
DOCUMENT MANAGEMENT

Slate Now Available on DECstation

Slate, BBN Software Products' multimedia document communications program, lets workgroups create and share documents that contain text, spreadsheets, images, and voice annotations, while providing E-mail and real-time conferencing.

Recently released for the DECstation, the program is also available on the IBM RISC System/6000 and Sun Microsystems workstations running under SunView and X11.
Price: $995 per license.
Contact: BBN Software Products Corp., 10 Fawcett St., Cambridge, MA 02138, (617) 873-5000.
Inquiry 1198.



Slate lets workgroups create and share multimedia information on networked Unix workstations.

DAT's the Ticket for Data Management Program

DataImage's latest electronic data management program works with Sony magnetic digital data storage tape drives to let you convert sheets of microfiche into files that you can index, program, and search.

When you download information from the mainframe, DATwriter lets you designate identifiers that you use to search for certain documents. You can assign up to 16 identifiers per document.

Once indexed, the company says you can find records from a 1.3-gigabyte tape within an average of 25 seconds. After you've downloaded the data, DATwriter installs the index and a run-time version, so that the tape is its own self-contained application.
Price: $5000 (includes Sony drive).
Contact: DataImage, Inc., 628 Hebron Ave., Glastonbury, CT 06033, (203) 659-3980.
Inquiry 1195.

Manage Documents Under Word for Windows

The Viewz document program for Microsoft Windows combines the Saros Mezzanine network application platform with Microsoft's Word for Windows to let you manage all your documents without leaving Word.

Viewz supports network-wide retrieval and management of files, automated tracking of pages printed, file-revision tracking, audit facilities, security, and a template facility for creating standard forms and documents.
Price: $345 per client; $2950 per server.
Contact: Saros Software, 10900 Northeast Eighth St., Suite 7, 1515 Plaza Center Building, Bellevue, WA 98004, (206) 646-1066.
Inquiry 1196.

A Document Administrator for PC Applications

The Document Administrator, a program that provides document administration on PC-based networks, integrates a variety of applications (e.g., Microsoft Word, WordPerfect, DisplayWrite, and Lotus 1-2-3).

Version 2.0 supports automatic document numbering, configurable revision tracking, checkout protection to prevent simultaneous editing, and the ability to maintain forms and boilerplate items.

When searching for documents, the program supports Boolean conductors, proximity searches, word stems, and wild cards. You can use profiles to track graphical- and paper-based information.

The program runs on any DOS 3.1-based network.
Price: $2495 for 10-user installation; $150 for each additional workstation.
Contact: Interpreter, Inc., 11455 West 48th Ave., Wheat Ridge, CO 80033, (303) 431-8991.
Inquiry 1194.

Turn Your PC into an Electronic Filing Cabinet

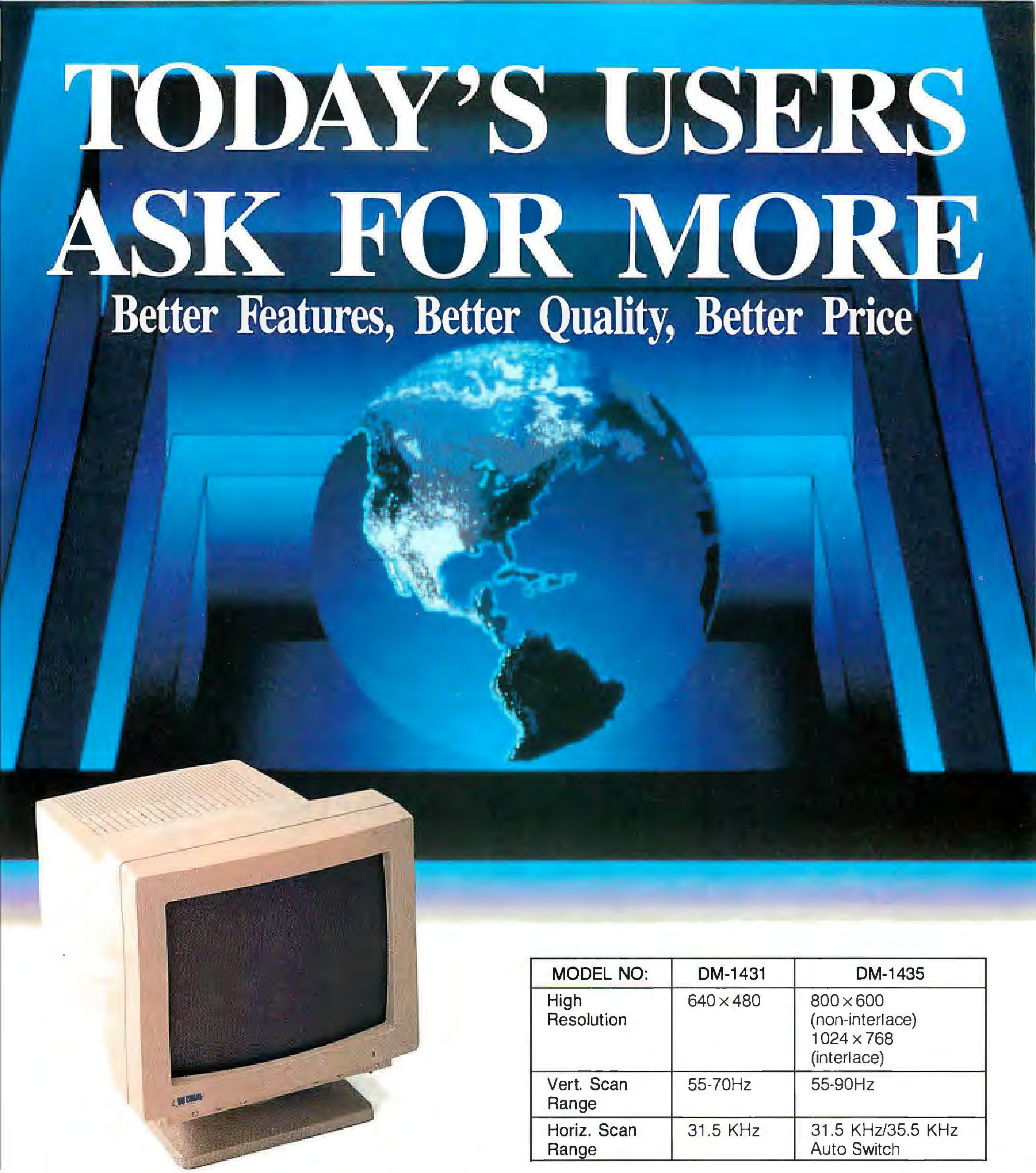
The PaperLess Filer lets you scan single and multiple documents and compress them to reduce storage requirements without having to buy image-compression hardware.

Version 2.1 of the program lets you predefine a series of documents to be scanned into its database in a batch process and lets you fax documents in or out of the program using a PC fax board. Files stored in a batch process can be incrementally numbered as they print. You can also define queues for unattended printing.

The PaperLess Filer lets you search for a particular document by several criteria. Version 2.1 adds multiple filing cabinets for filing different types of documents using user-definable key fields.

The program is LAN-compatible and supports several levels of security. Version 2.1 can import and export files in the TIFF, PCX, or DCX formats.

PaperLess Filer 2.1 runs on a 286 computer with a hard disk drive.
Price: $495; LAN version, $795.
Contact: PaperLess Corp., 1750 North Collins, Suite 200, Richardson, TX 75080, (214) 235-4008.
Inquiry 1193.



MODEL NO:	DM-1431	DM-1435
High Resolution	640 × 480	800 × 600 (non-interlace) 1024 × 768 (interlace)
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Hsin Chuan Factory: No. 49-51 Szu Yuan Rd., Hsin Chuang City, Taipei Hsien, Taiwan, R.O.C.
Tao Yuan Factory: No. 32, Shin Bond Rd., Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

Circle 612 on Reader Service Card

ACCOUNTING AND CONTACT MANAGEMENT

PC Accounting and Customer Database Program

AXS Accounting release 2 includes new modules, reporting capabilities, and enhancements that make the program suitable for large businesses, client write-up, and nonprofit organizations, its developer reports.

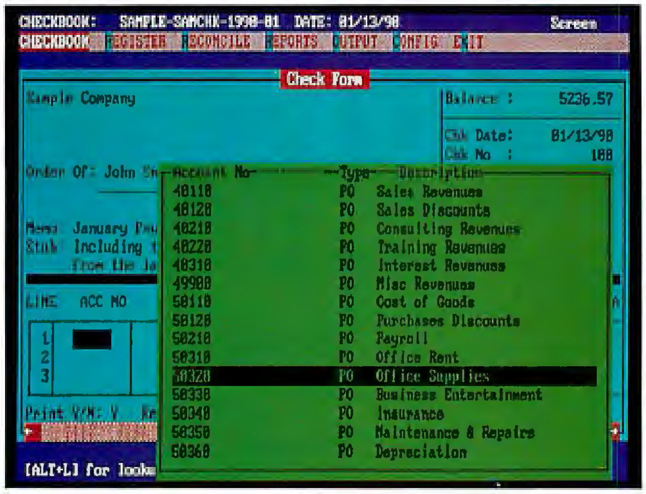
In addition to general ledger, checkwriter, accounts payable, and accounts receivable, the new version has modules for inventory, job costing and time billing, and payroll. Release 2 adds support for ratios, budgets, comparative statements, and cash flow reports.

Throughout the program, you can look up vendors, customers, inventory, and other items by vendor, due date, discount date, amount, reference, or a combination of these. The mail manager lets you maintain a database of customers for generating mailing labels and rotary cards.

Price: $99.

Contact: Computer Trends, Inc., 116 East Washington St., Ann Arbor, MI 48104, (800) 544-2597 or (313) 662-4430.

Inquiry 1173.



Data entry in AXS Accounting release 2 is done in familiar business forms, such as checks and invoices.

Job Tracking for Advertising and Design

Working Computer has released a slimmed-down version of its Clients & Profits agency management program for the Mac. Clients & Profits ez is designed for the advertising agency or design studio with less than $1 million in billings. You can use the program for job tracking, costing, and billing of established accounts.

Clients & Profits ez runs on the Mac Plus.

Price: $1195.

Contact: Working Computer, P.O. Box 87, San Luis Rey, CA 92068, (619) 945-4334.

Inquiry 1175.

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PC MAGAZINE

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See Aug. 1990 P. 109, 120

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- 386SX-16 MHz CPU, 1MB Memory (To 4MB)
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- 1:1 Interleave Cont. Card
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- Mono Graphic Card w/Printer Port
- 12" Amber Monitor (720x348 Res.)

$1,059 On Sale

386-33 200MB SYSTEM (Desk Top)

- 386-33 MHz CPU. w/64KCache Memory
- 1MB Memory on board (To 8MB)
- 200MB, 19ms, IDE Hard Drive
- 128K Cache Memory Optional
- 32MB Memory on Board Optional
- Other features the same as 386SX

$2,239

HDD	286-12	386SX	386/25	386/33	486/25
40MB	799	1059	1349	1629	2449
65MB	869	1129	1409	1689	2509
80MB	1139	1399	1679	1959	2779
100MB	1139	1399	1679	1959	2779
150MB	1396	1659	1939	2219	3039
200MB	1429	1679	1959	2239	3059
345MB	2219	2459	2739	3019	3839

- Upgrade to VGA (640 x 480 Res) + $300
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- Mini Vertical Case + $50
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- Built-in SONY 8.5" Color VGA Monitor
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- 220W P/S 110/220V. 4 Exp. Slots
- 86-Key Detachable Keyboard
- 386-33 MHz CPU, w/64 K Cache Memory
- 1MB Memory on Board (To 8MB)
- 128K Cache Memory Optional
- 32MB Memory on Board Optional
- VGA Graphic Card (512K,1024x768 Res.) External Monitor Adaptor
- 1.2MB or 1.44MB FDD
- 200MB 19ms HDD (To 500MB)
- Serial/Parallel/Game Ports
- Carrying Bag. Weight 27 Lbs.
- Dimensions: 17.5(W) x 14.1(D) x 6.8(H)
- Bigger Case with 7 Exp. Slots Optional

$3,729 (Special)

HDD	286-12	386SX	386/25	386/33	486/25
40MB	2149	2429	2719	3009	3899
100MB	2479	2759	3049	3339	4229
150MB	2839	3119	3409	3699	4589
200MB	2869	3149	3439	3729	4619
345MB	3779	4059	4349	4639	5529

VGA AMBER CRT PORTABLE 100MB AT

- Built-in 9" Amber VGA Monitor
- Speed Digital Display. 3 Drive Bays
- 205W P/S 110/220V. 4 Exp. Slots
- 86 Keyboard, Detachable Keyboard + $30
- AT 12 MHz System, 1MB Memory (To 4MB)
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- 1.2MB or 1.44MB FDD
- 100MB 25ms HDD (To 500MB)
- Serial/Parallel/Game Ports
- Carrying Bag. Weight 26 Lbs
- Dimensions: 17.5 (W) x 14.1 (D) x 6.8 (H)

$1,739

HDD	286-12	386SX	386/25	386/33	486/25
40MB	1409	1689	1979	2269	3159
65MB	1529	1809	2099	2389	3279
100MB	1739	2019	2309	2599	3489
150MB	2099	2379	2669	2959	3849
200MB	2129	2409	2699	2989	3879
345MB	3039	3319	3609	3899	4789

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- 205W P/S 110/220V. 4 Exp. Slots
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- Mono or Color Graphic Card
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- 1,2 MB or 1.44 MB Floppy Drive
- 100MB 25ms Hard Drive
- Serial/Parallel/Game Ports
- Carrying Bag Weight 26 lbs.
- Dimensions 17.5(W) x 14.1(D) x 6.8(H)

$1,479

HDD	286-12	386SX	386/25	386/33	486/25
40MB	1149	1429	1719	2009	2899
65MB	1269	1549	1839	2129	3019
100MB	1479	1759	2049	2339	3229
150MB	1839	2119	2409	2699	3589
200MB	1869	2149	2439	2729	3619
345MB	2779	3059	3349	3639	4629

386-33 200MB VGA PLASMA PORTABLE

- 640x480 VGA Plasma Display
- Detachable 101-key Keyboard
- 200W P/S, 110/220V. 3 Drive Bays
- 386-33 MHz CPU, w/ 64 K Cache Memory
- 1MB Memory on Board (To 8MB)
- 128K Cache Memory Optional
- 32MB Memory on Board Optional
- 1.2MB or 1.44MB FDD
- 200MB 19ms HDD (To 500MB)
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- External Monitor Adaptor
- Carrying Bag. Weight: 26 Lbs.
- Dimensions: 16"(W) x 9.75"(H) x 8.5"(D)

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HDD	286-12	386SX	386/25	386/33	486/25
40MB	1679	1959	2249	2539	3429
65MB	1789	2069	2359	2649	3539
100MB	1979	2259	2549	2839	3729
150MB	2279	2559	2849	3139	4029
200MB	2339	2619	2909	3199	4089
345MB	3159	3439	3729	4019	4909

CGA PLASMA PORTABLE 100MB AT

- 640X400 CGA Plasma Display
- Detachable 86-Key Keyboard
- External RGB Monitor Adaptor

$1,699

HDD	286-12	386SX	386/25	386/33	486/25
40MB	1399	1679	1969	2259	3149
65MB	1509	1789	2079	2369	3259
100MB	1699	1979	2269	2559	3449
150MB	1999	2279	2569	2859	3749
200MB	2059	2339	2629	2919	3809
345MB	2879	3159	3449	3739	4529

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- 640x480 Res. Backlit LCD VGA Display with External Color Monitor Adaptor
- 200W 110/220V P/S. 5 Exp. Slots
- Detachable 89-Key Keyboard
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- 128K Cache Memory Optional
- 32MB Memory on Board Optional
- 1.2MB or 1.44MB FDD
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- Serial/Parallel/Game Ports
- 9.45"(H) x 7.9"(D) x 15.7"(W). 23LBS

$2,519 Best Buy

HDD	286-12	386SX	386/25	386/33	486/25
40MB	1359	1639	1929	2219	3109
65MB	1459	1749	2039	2329	3219
100MB	1659	1939	2229	2519	3409
150MB	1989	2269	2559	2849	3739
200MB	2019	2299	2589	2879	3969
345MB	2839	3119	3409	3699	4589

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Circle 610 on Reader Service Card (RESELLERS: 611)

ACCOUNTING AND CONTACT MANAGEMENT

Client Write-Up in OS/2

Financial Software Associates has released two OS/2 packages designed for CPAs and accounting businesses. The Client Accounting Gold Series, for client write-up, includes modules for general ledger, after-the-fact payroll and form 1099 preparation, and custom reporting. As its name suggests, the second package, Practice Management Gold Series, is for managing time and billing for multiple clients.

Both packages take advantage of OS/2's multitasking capabilities, letting you perform several activities for one or more clients at once, the company says. Although not Presentation Manager applications, the packages support overlapping windows and pull-down menus. TaxLink, which integrates Gold Series General Ledger data to tax-preparation programs, is also available.

The packages require at least a 286 running OS/2 1.0 or higher with 4 MB of RAM. A 386 with OS/2 1.1 or higher is recommended.
Price: Client Accounting: single-user, $1995; multiuser, $2495 to $3995. Practice Management, $1395 and $1695 to $2559, respectively.
Contact: Financial Software Associates Corp., 5150 Southwest Griffith Dr., Suite 200, Beaverton, OR 97005, (503) 626-8652.
Inquiry 1174.

Contact Management for the PC

Contact! Professional 2.3 has a word processor, calculator, telephone dialer, and support for multiple databases in which you can define up to 100 fields. You can use the program to sort contacts by name, company, ZIP code, or any other criteria and attach up to 16 pages of comments or historical information.

The program requires 640K bytes of RAM.
Price: $195; LAN version, $495.
Contact: Pyramid Solutions, Inc., P.O. Box 395, Stoughton, MA 02072, (800) 343-4677 or (617) 821-4673.
Inquiry 1176.

Emis I is an integrated sales, marketing, and telemarketing program. It combines client management, prospect tracking, and telemarketing functions.

Features include unlimited databases, custom forms, custom reports and letters, automatic follow-ups, unlimited call and contact history, word processing, mail merge, auto-dialing, form letter generation, and telescripting.

Emis II allows for unlimited databases.
Price: Emis I: $695; three-user license, $995; Emis II: $1995 and $2995, respectively; each additional user, $695.
Contact: Emis Software, Inc., 901 Northeast Loop 410, Suite 526, San Antonio, TX 78209, (512) 822-8499.
Inquiry 1177.

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6450603 (1MB)	502, 55SX, 70-E61, 70-121, P-70	$ 79.00
6450604 (2MB)	502, 55SX, 70-E61, 70-121, P-70	$ 150.00
6450608 (2MB)	70-A21, A61, B-21, B61	$ 155.00
78X8955 (128K)	25	$ 26.00
34F2933 (4MB)	55SX, 65SX	$ 525.00
6450605 (2–8MB)	All 70's and 80's (Board)	$ 525.00
6450609 (2–16MB)	50, 502, 55SX, 60, 65SX (Board)	$ 599.00
1039136 (1MB)	Laser Printer 4019, 4019e	$ 169.00
1039137 (2MB)	Laser Printer 4019, 4019e	$ 299.00
1038675 (3.5MB)	Laser Printer 4019, 4019e	$ 429.00

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DESKPRO 386/20-25 286e	1MB MODULE	113131-001	$ 139.00
	4MB MODULE	113132-001	$ 339.00
DESKPRO 386/20e-25e	1MB BOARD	113644-001	$ 189.00
	4MB BOARD	113645-001	$ 479.00
	1MB MODULE	113131-001	$ 139.00
	4MB MODULE	113132-001	$ 339.00
DESKPRO 386s	1MB BOARD	113633-001	$ 189.00
	4MB BOARD	113634-001	$ 479.00
	1MB MODULE	113646-001	$ 139.00
	4MB MODULE	112534-001	$ 339.00
PORTABLE III	512K KIT	107331-001	$ 70.00
	2MB KIT	107332-001	$ 165.00
DESKPRO 386/16	1MB BOARD	108069-001	$ 299.00
	2MB BOARD	108069-W/71	$ 399.00
	4MB BOARD	108070 001	$ 659.00
	8MB BOARD	108072-001	$ 999.00
DESKPRO 386 PORTABLE	1MB KIT	107651-001	$ 245.00
	4MB BOARD	107653-001	$ 799.00
SLT/286	1MB MODULE	110235-001	$ 209.00
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Faster Pizza Delivery Through Technology

You've probably heard of Query by Example, but a company in St. Louis has developed a system for determining the fastest pizza delivery route by example. Thanks to Fast Map, a trainable standalone system developed by Mid-America Technologies (Maryland Heights, MO), pizza lovers may soon get their pizza orders delivered to the home or office without delay, helping both customer and company.

The St. Louis Users Group for the Personal Computer saw a demo of the product, minus the actual pizza, at its November general meeting held in Washington University's Simon Hall auditorium. The system is about to be released after a year and a half of development and testing.

Robert Covington, director of research and development at Mid-America, said the company developed Fast Map because geographical mapping products, although fine for demographic analysis, can't produce route maps in under 10 seconds.

Fast Map ($5775) is a proprietary system that uses a touchscreen or mouse combined with a high-speed thermal printer. "After the call comes in—let's say it's 1524 Main St.—the clerk feeds in 1524 and the letter *M*," he said. "All the streets with the letter *M* with that street number potential show up onscreen. After another mouse or touchscreen entry, the address is pinned down and the map is printed."

Fast Map actually prints out two 200-dpi maps, one of the district and another of the delivery locale, along with text instructions. The map can tell in feet how far down the block the target address is located.

Mid-America uses a variety of sources for its district maps, including the U.S. Census Bureau and the U.S. Postal Service. Changes to routes are updated monthly, and users of the system can make changes to a map themselves by tracing a new route with their finger on the screen. Although the system was initially targeted for pizza delivery, you can use it for fire departments, police, florists, and any other type of routing.

One of the benefits of the program is that you can train it by example to adapt to a manager's preference for routes. The expert-system portion of Fast Map can learn from a manager that it should avoid roads that have potholes or construction. Fast Map can also be trained to use the banzai delivery method of taking full advantage of shortcuts. After all, Covington says, "Some people like to go through the alleys."

—Howard de Mere and Dave Andrews

What's the Scoop?

BYTE is interested in who said what at your latest users group meeting. Call (603) 924-2630.

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JUKEBOX COMPUTING

A sextet of CD-ROMs on-line makes for lively computing

It has been quite a month. First, we hosted two meetings of the Citizens Advisory Council on National Space Policy: we're supposed to provide some input to the Stafford and Augustine Commissions on Technologies for the Space Exploration Initiative and the general future of the U.S. in space. Council meetings are normally held at Larry Niven's home, but for a number of reasons they ended up here in Chaos Manor, which is *almost* large enough. The meetings were productive, but they generated a lot of material that has to be reported.

Then I was asked to be the dinner speaker at the annual meeting of the American Astronautical Association.

So, this weekend I have to write my part of the two Council reports; get this column in; turn in another journalism assignment; write my American Astronautical Association speech; and look up some data for the IRS. If that weren't enough, Niven and I have been going like gangbusters on two books, *Fallen Angels*, which is our gift to science fiction fandom, and *The Moat Around Murcheson's Eye*, a sequel to *The Mote in God's Eye*. We expect to have finished and turned in both books by the time you read this. So, provided that I survive it, this may be the most productive month of my life.

The Jukebox

We recently got, courtesy of the Bureau of Electronic Publishing, a Pioneer Electronic DRM-600 CD-ROM drive and changer. This is a box about the size of an external WORM (write once, read many times) drive (similar in shape to a somewhat long shoe box), which holds a six-pack of compact discs in a neat little removable holder. It is fairly easy to install the drive interface card in your machine and install the software in your CONFIG.SYS and AUTOEXEC.BAT files. In our case, I installed the DRM-600 in the Arche Legacy 386/33. One way I test new stuff is to install it in new machines.

Pioneer's instructions are complete, if a bit dense; you may have to read them over a few times, but there shouldn't be any difficulty. You can also hook up the DRM-600 to your Macintosh; it hangs directly on the SCSI port (no internal card is needed). I haven't tried that, but I have no reason to doubt it will work.

The DRM-600 is a dual-purpose affair; that is, you can hook the output into your stereo system and have a CD player whose audio quality I can't tell from the CD player in my Technics system, and, of course, you can use it as a CD-ROM drive. The software has provision for doing both. You specify how many CD-ROM drives you want, and the remainder will be audio drives. Each CD-ROM is configured as its own virtual drive. They don't get mixed up, because the audio drives will start at the bottom, while the CD-ROM drives start with the top of the stack.

Pioneer bundled in a neat software package called Jukebox (JUKE.EXE) that will control the audio drives. It's quite intuitive: no instructions are required, although I probably should have read the instruction book. There are several button-like options, enough to make me wish for mouse support, but there's no real need; it can be controlled just fine with the arrow keys. Of course, it makes little sense to tie up your computer as a CD player. . . .

We usually leave the stereo amplifier turned off, but we flip it on when the DRM-600 is plugged into the stereo. Actually, all I've used the DRM-600 audio system for is to play a CD called The CD-ROM Chronicles, which is a "talking book" about the history and future of the CD-ROM. It's well worth listening to for an overview of the subject.

There are quirks, though. For one thing, it's very difficult to get the DRM-600 to work with QEMM-386. It can be done, but finding out how took a few days. In fact, the procedure I followed was odd, and perhaps instructive.

I first got the DRM-600 running properly without Desqview. That done, I let the Desqview installer do its thing. This triggered an installer bug: the QEMM installation program tried to insert QEXT.SYS into my CONFIG.SYS file. That's all well and good if you have a 286 system, but for a 386 with 8 megabytes of memory, it's about as useful as a chocolate-covered wristwatch. I understand this happens more often than Quarterdeck Office Systems likes to admit. In any event, if the Desqview installation tells you it wants QEXT.SYS, eliminate the line.

When the installation was done, I had a system that appeared to run, but any attempt to access the DRM-600 CD-ROM drives locked up the machine and required hard reset. But as long as I ignored the DRM-600, the system worked. Sigh.

The next step was to run the Desqview Optimizer program. This diddled around and loaded various things in high memory. When it was done, I could get a directory off one of the CD-ROM drives—but invoking retrieval software locked up the machine.

About then I got disgusted and called Quarterdeck's technical support. Everyone was busy: not surprising. Eventually I got someone, and we went through some tests. I was advised to edit CONFIG.SYS to put the DRM-600 driver first, before QEMM.SYS. That eats up memory, and I didn't like doing it much; but it did work.

Then I took another look at the DRM-600 driver and realized that the DRM-600 installation had put an /E: switch in the configuration line. The DRM-600 can make use of expanded memory if it finds any. Alas, it can't make use of it if that memory is managed by QEMM386.SYS. Eliminating the /E: parameter let me put the DRM-600 device after the DEVICE = QEMM386.SYS statement, which lets the Optimizer program load it high, freeing more memory.

The upshot is that I have the DRM-600 running not only with QEMM386.SYS, but inside Desqview windows, which has the amusing result that I can actually have several CD-ROM windows open at once. Now clearly there's only one physical drive for the six CD-ROMs, so you can't run them simultaneously; but it's surprising how fast you can switch back and forth among them.

Of course, there's a sense in which it doesn't matter: the DRM-600 works fine, and I intend to set it up on a network, as described in last fall's column in the *IBM Special Edition*, and I won't be running Desqview on the network server anyway. Until we get the network set up though, it's fun to have the DRM-600 running under Desqview. Naturally, I've told it that all six drives are CD-ROM drives.

The Pioneer DRM-600 isn't cheap, but it works, and it's very convenient to have a bunch of CD-ROMs available without swapping. Recommended.

It's History

The Pioneer DRM-600 was interesting in its own right, but there was another, more urgent, reason for me to get it fired up: after five years, the Amdek Laserdek CD-ROM drive seems to have died, and I've just got a whole bunch of new CD-ROMs from the Bureau of Electronic Publishing.

The Bureau is a private firm, originally given a pretentious name in hopes that people wouldn't figure out that it was two guys in a garage; now, it's a fair-size outfit, and my chief source of information about CD-ROM events. If you don't have their catalog, send for it: even if you don't want to buy any CD-ROMs or drives, you'll be fascinated by the wide variety of stuff offered for sale in CD-ROM format.

The newest CD-ROM I got from the Bureau is their United States History. What they have done is take a hefty collection of books and documents on U.S. history, mostly in public domain, and run them through the DiscPassage CD-ROM retrieval software. The result is uneven, but it's still pretty good, including an official history of the U.S. Army, with excerpts from speeches, maps, and suchlike.

Most of the material was chosen because it was available, and it includes public documents, history books published around the turn of the century, and so forth. That's no great defect: many of the high school history texts written back then are more detailed, and much more readable, than the pap they sacrifice trees for today. It includes some Revolutionary War histories that are plain fascinating; maybe it was just me, but I found myself reading about the Battle of Cowpens and much enjoying the experience.

Much of the material was obviously keyed in, and, alas, not well proofread. In some documents, hardly a paragraph escapes egregious errors, misspellings, missing words, and even missing sentences; even Patrick Henry's most famous speech doesn't escape its share of typographical errors.

It's still a good effort, something that all high schools and colleges ought to

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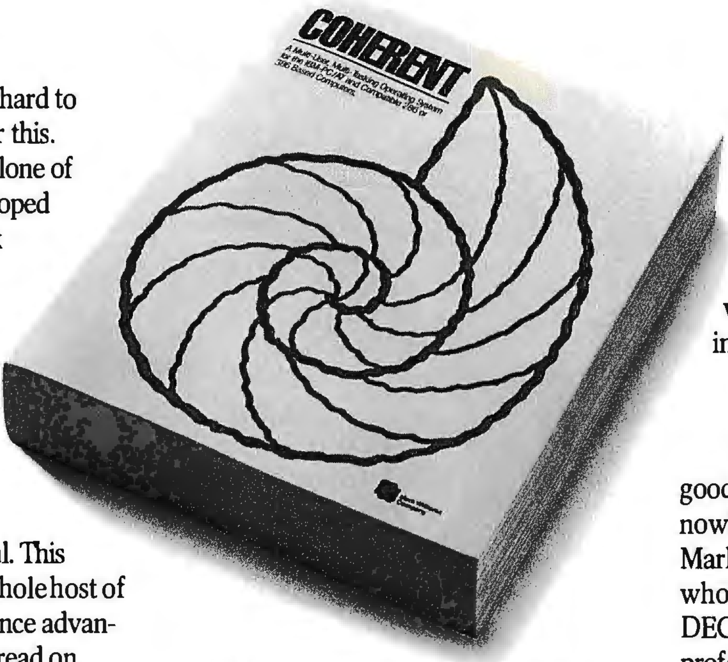

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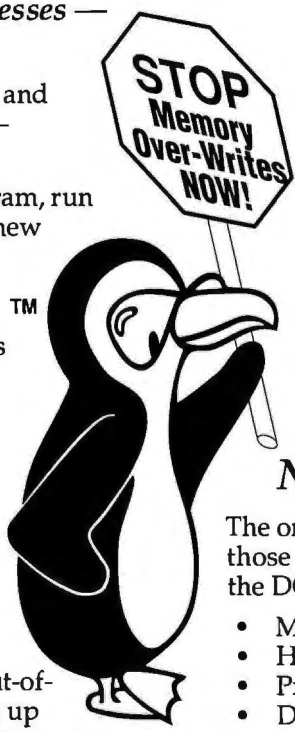

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have. That implies that high school and college libraries ought to have CD-ROM drives, and most don't, which is a real pity, because there is a great deal of material available on CD-ROM.

When CD-ROMs first came out, I thought this might become a way to put rare and original materials in the hands of scholars and students at smaller and less wealthy institutions; for instance, the Dead Sea Scrolls might be reproduced on a CD-ROM along with a good proportion of the material that has been published about them. Now that VGA is widely affordable, this becomes even more feasible, and I see the beginnings of it happening. The United States History CD-ROM is a long way from what I'd like it to have been, but it's a good start on where we ought to be going with this technology.

More CD-ROMs

When I began this column, I had the foolish conceit that I could keep up with the entire microcomputer world, hardware and software. I long ago lost that illusion. For a while, though, I thought I might be able to keep up with the CD-ROM explosion. Now I can't even do that. Every month I get up to a dozen CD-ROMs, and I am not getting all that are published. I can't even keep up with the CD-ROM drives now available. On that score, the Denon drives installed on the Zenith Z-386/25 continue to work fine.

Now I can't even keep up with the CD-ROM explosion. Every month I get up to a dozen CD-ROMs, and I am not getting all that are published.

Some recent (within the past six months) CD-ROMs in no particular order: Software Toolworks World Atlas, Oxford English Dictionary (older edition; no supplements), Grolier Encyclopedia Americana (illustrated), USA Factbook, CIA World Factbook, Agricola (the national database of agriculture), Multi-Media Birds of America, Quick Art (300-dot-per-inch TIFF images), Library of the Future, An Unabashed History of Photographic Erotica, MicroMedex Medical Technology, Microsoft Programmer's Library (the new edition), and Word Cruncher.

I could list a lot more; but as I was making the list, I noticed a curious thing. I made the list by grabbing a bunch of CD-ROMs off the shelf where I keep them, plus looking about at some of the others I have been testing; and I discovered that of the above, after the first few, just about every one of them is worth a comment; most, alas, inspire negative commentary.

The Software Toolworks World Atlas is pretty good. It doesn't go into enough detail, and you'd be better off with the *Times World Atlas*, but for quick scans of geography it's neat, and the retrieval software is fairly easy to use. The only negative comment I have is that I wish it gave more information; for what it does, it's all right. One comment, though: you *must* run the installation program. Attempting to invoke the program direct from the CD-ROM will lock up your system and require a hardware reset. The installation program works fine.

The Oxford English Dictionary is well worth having in any library, and most wordsmiths will like it. The retrieval software is fast, but best described as obscure, and there are no words past 1937 or so since it doesn't have the supplements; but this one gets a permanent place in my primary six-pack, if only for snob appeal.

The best thing about Textware is that it comes on the CD-ROM so you don't lose it. It's slow enough to amuse you while you grow a beard.

The Grolier Encyclopedia Americana is another in my permanent six-pack. Indeed, its retrieval software is some of the best, and as I use it more, I have come to be reasonably fond of the encyclopedia. On the other hand, Grolier's paranoia about that software is a continued irritant: the network version apparently will not work *except* over a network (and will not work with my network in any event), while the usual version deliberately commits suicide if you have a network card in the machine even if you don't use it over a network.

Incidentally, the way you use it with multiple CD-ROM drives is weird: first you must put the Grolier CD-ROM as the *first* one in the six-pack. Then you must log onto the Grolier CD-ROM and get a directory; now, before you do anything else, go to the subdirectory on the hard disk where you have the Grolier retrieval software and invoke it. That—and *nothing else*—works fine.

Of course, the Grolier retrieval software comes on a separate floppy disk, and it must be installed from a floppy disk. The same Grolier CD-ROM works with both Macs and PCs, but unlike what Quanta Press publishes, Grolier doesn't furnish both: you have to buy one or the other. Oh, well. They tell me they're redoing some of their software and will distribute updates for free.

The USA Factbook and the CIA World Factbook from Quanta use Textware retrieval software. The best thing you can say about this program is that it comes on the CD-ROM so you don't lose it. This stuff is slow enough to amuse you while you grow a beard. The installation program is truly horrible. First, it wants you to tell it precisely where you want everything. Next, it will not create a subdirectory: you must create that subdirectory and log onto it before going over to log onto the CD-ROM preparatory to running the installation. You also have to figure that out from the error messages you get when the system fails to install properly.

Once you install and run Textware, you get few clues as to what is on the CD-ROM, and invoking the index gets you a *long* wait, after which it solemnly informs you of how many entries there are for each of hundreds of numbers, like $1,234,563,888 (1 entry). Doing page-down gets more lists of numbers, a very long wait again, and then more numbers. At this point, I wasn't even to the "A's" and gave up. Apparently, you must already know what's in the database to search for it; a curious concept indeed.

If you want the material that's in the database, you can try the Factbook CD-ROMs, which do have good information on them; but even on a 33-MHz 386 it's slow. Textware also leaves some memory-resident stuff in your machine, so you need to reset after using it. Trying to run a different Textware CD-ROM without resetting will get you memory errors, so you have to reset anyway. On the other hand, these CD-ROMs come with a separate disk to run the same CD-ROM on the Mac, where there are far fewer problems.

Agricola, the national database of agriculture, is also from Quanta, but the retrieval software is Romware, which works much smoother than Textware and is actually usable. There are some decent help screens and a general introduction to what you're doing. I wish the other databases Quanta publishes had used this instead of Textware.

The Multi-Media Birds of America CD-ROM uses DiscPassage retrieval software. I have many other CD-ROMs that use this system, including United States History and Sherlock Holmes on CD-ROM. CMC, which is the developer

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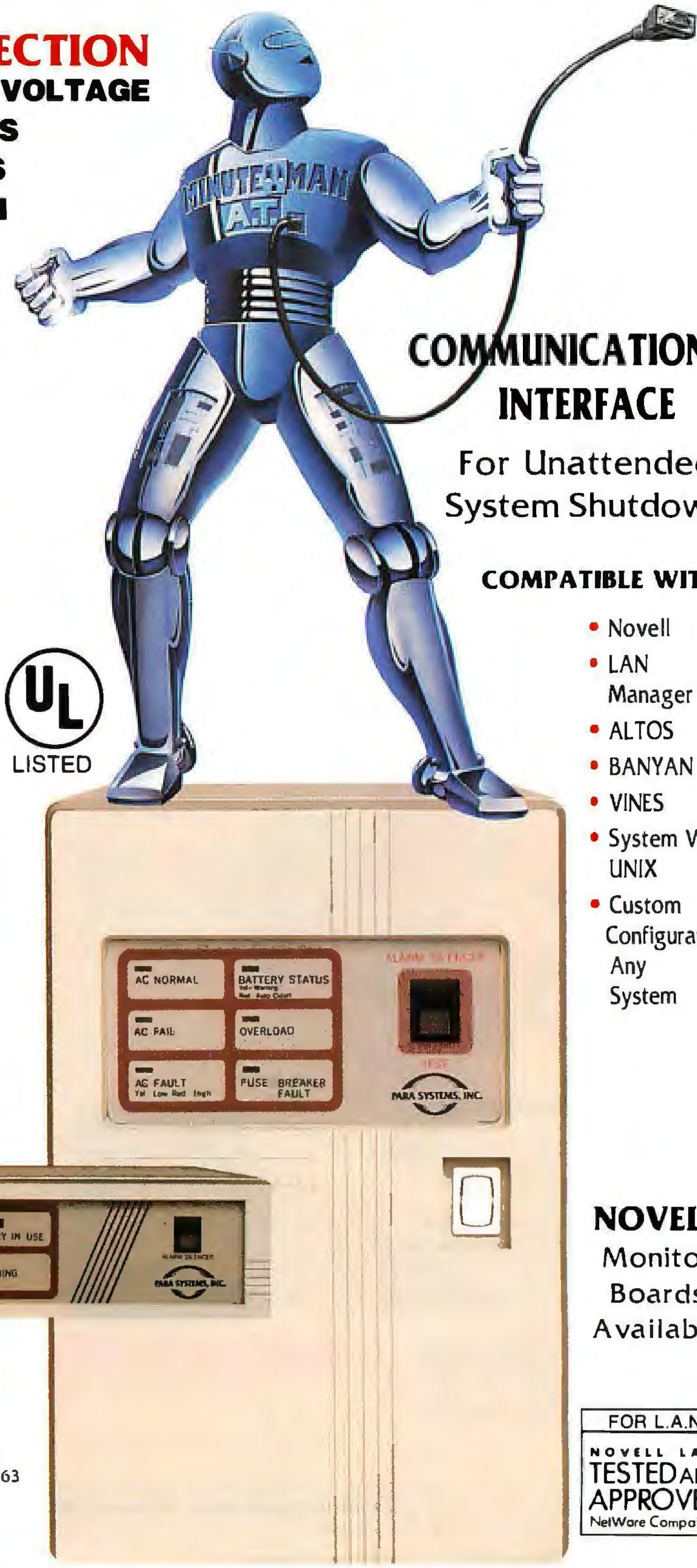

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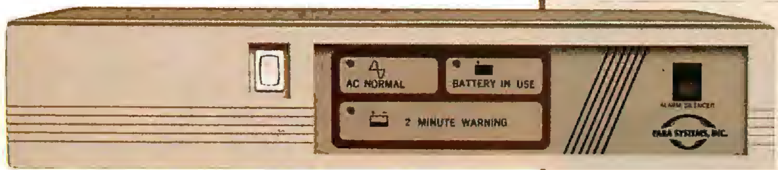

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of DiscPassage, also publishes a line of medical literature CD-ROMs, which I believe is their major business. DiscPassage isn't elegant, but it is good enough. It needs better introductory screens, and I could improve the help screens. Even on the Arche Legacy 386/33, it's very slow in building VGA images, and, alas, many DiscPassage CD-ROMs begin with a VGA picture.

The DiscPassage system badly needs a quick way to find out from the CD-ROM what data resources are on it, although that partly depends on the way in which the CD-ROM database developer arranged things. However, DiscPassage is able to handle illustrations (unlike Textware, which is as likely to have half the image off-screen as not, as I found when trying to examine the Great Seal of the State of Iowa). The DiscPassage search-and-retrieval indexing is good enough, and while it's not blindingly fast, it's not real slow either.

When you install DiscPassage, it creates a batch file. You need to edit that to tell it which drive the CD-ROM will be on, and you will have to change that if you move that CD-ROM. However, once DiscPassage has logged onto a DiscPassage CD-ROM, you can, from within DiscPassage, change to another CD-ROM drive or, alternatively, swap CD-ROMs in the present drive and log onto that. Again, it doesn't do this elegantly, but it does do it.

The Quick Art CD-ROM has 2200 images on it, but if there's any retrieval software for it, I've been unable to find it. Since the images are in TIFF, you can go looking for them with one of the Mace Grasp tools or one of the little public domain image-viewer programs, but finding an index to the images is a problem.

I have the same difficulty with the Library of the Future: it apparently has a lot of really nifty stuff, but what there isn't is retrieval software. I suppose I got a copy of that on some kind of floppy disk, but, if so, it has submerged itself in the chaos stream. Doubtless it will wash ashore one day, as may the Quick Art retrieval software.

The moral of this story is easy to see: it doesn't hurt to put the retrieval software on the CD-ROM itself. It doesn't take up much room, and it won't get lost. DiscPassage comes that way; each new CD-ROM seems to have a later version, but they're all backward-compatible with all the earlier CD-ROMs, and if one ever weren't, you'd still be able to read all the earlier CD-ROMs with the programs that came with them.

The contents of An Unabashed History of Photographic Erotica weren't particularly noteworthy—I'd call them puerile rather than erotic—but the retrieval software is remarkable. It doesn't work very well, alas, but it's elegant, with VGA images as part of the control software. They come up surprisingly fast. The software attempts to show a series of slide shows. It also shows details of photographs. You use the plus and minus keys to move back and forth within a slide-show sequence.

After a while that gets pretty boring, or did for me, but part of that is the pictures shown: gross anatomy has never been one of my stronger interests. I really would like to see this software used to produce a CD-ROM of, say, the paintings in the Florentine Uffizi.

MicroMedex Medical Technology is interesting because it uses Reference Technology retrieval software. That's pretty good stuff. Alas, the latest Reference software I have is several years old,

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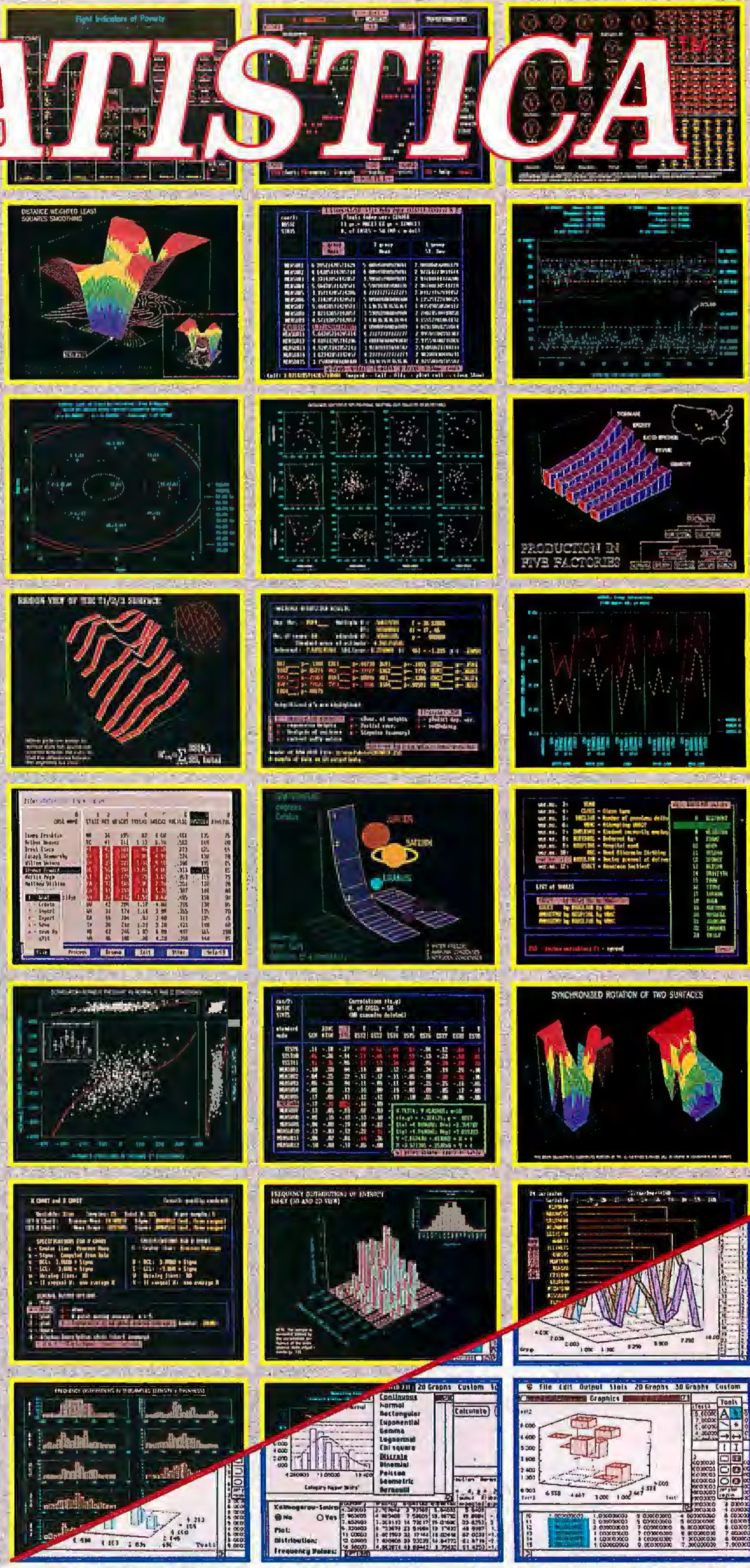

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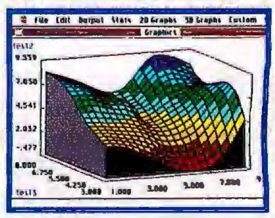

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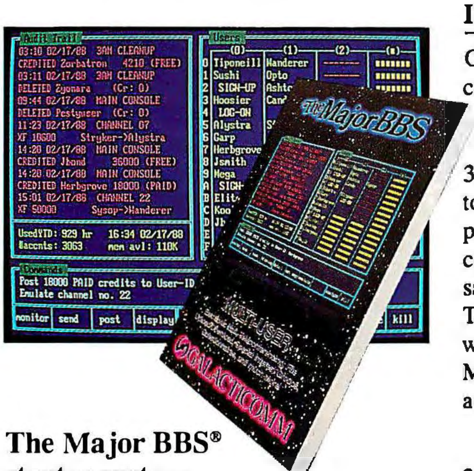

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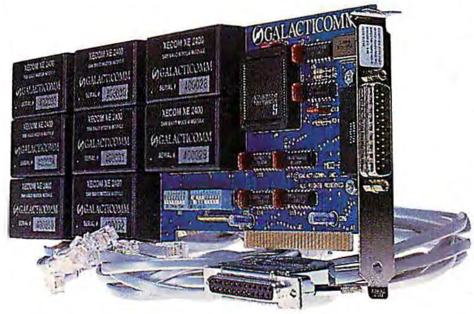

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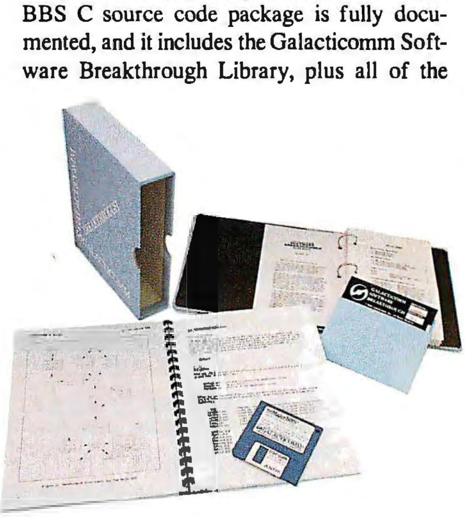

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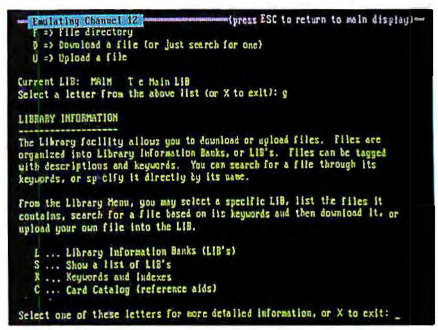

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The Entertainment Edition of The Major BBS has everything that the starter system does, plus Quest for Magic (a multi-player interactive text adventure game), Androids! (a multi-player arcade-style ANSI-graphics game), Flash Attack (a futuristic tank and laser battle for multiple players with IBM PC's), and the Action Teleconference Link-Up, which includes private "chambers", action verbs (grin, wink, nudge, etc.), the ability to link to other systems for huge multi-system teleconferences, custom entry/exit strings, user-configurable profiles, and much more. This Edition supports the Flash™ Protocol (where most of the game functionality is on the user's

and it doesn't have drivers for either the Denon or the Pioneer CD-ROM drives, and thus I can't install either MicroMedex or the McGraw-Hill Science Encyclopedia, which also uses Reference. MicroMedex digests medical journals and has such things as the Poison Index. I gather it's considered indispensable in some emergency rooms. Our last update was about 1987, and there are no updates to the software, so you can't use these CD-ROMs on the newer drives. Pity.

Microsoft Programmer's Library is important to programmers. Microsoft now puts out their C development kits, programs and documents, on CD-ROM: if you're a serious programmer developing applications for OS/2 or Windows, or if you're a heavy user of any Microsoft compiler, get yourself at least one CD-ROM reader and the Microsoft CD-ROMs. You'll be more than glad you did. Microsoft Bookshelf is a permanent one on my basic six-pack; if I did more programming, Programmer's Library would be another.

Finally, there is Word Cruncher Disc Volume One, subtitled "A meledy of significant documents, literature, and information on CD-ROM." (I don't know if "meledy" is a kind of pun on *medley* and *melody*; it's what they printed on the face of the CD-ROM.) A few issues ago, I was rather unkind to this retrieval software. After trying to work with some of the other stuff that's out there, particularly Textware, I revise my opinion.

Word Cruncher isn't elegant, but you can learn it, and at least it's not slow. Changing colors and manipulating the text is often awkward, and the text is generally presented on-screen in a less-than-aesthetic manner, but for all that, it works, and it doesn't drive you nuts to install it. I really would hate to have to read very much from it, though. I understand they are coming out with a new version shortly. If they can keep the speed and make the formatting more elegant, they will have something.

Anyway, that's a tiny sample of the CD-ROMs available now. This technology is coming of age.

Decisions, Decisions

When microcomputers first came out, there was a spate of decision-aid software. Most of it was pretty crude. Some simply forced you to make a number of preferences and then took a weighted average; nothing you couldn't have done with pencil and paper. Some was more sophisticated but was harder to use.

Expert87 is sophisticated and also relatively easy to use. Mind you, it's not a toy, but a professional tool, and you won't learn it in 5 minutes. On the other hand, you can learn it by working with examples, not by reading a large boring manual.

The program bills itself as "Artificial Intelligence." What it will do is make explicit the decision factors you use and form them into a rule-based system. I wouldn't call that AI, but then I've been reading Roger Penrose's *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*, and I tend to agree that most of what is called AI isn't.

Anyway, Expert87 has provision for bringing in other experts and encoding their views, and then combining them into a consensus system. It has ways of examining a series of decisions to determine bias or inconsistency. As far as I know, these capabilities are unique to Expert87.

When, donkey's years ago, I learned

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operations research and systems analysis, I was taught that the major value of these disciplines was to make decision factors explicit: not just which airplane to send on what mission, but *why* this one was better than that one, or at least why we thought so. That led to some hairy fights in evaluation board meetings. I'd have much liked to have had this program available to help get out in the open precisely what each member thought was important and why.

It's a little hard to say just who needs this program. In a sense, no one does. On the other hand, anyone who's curious about the decision process, or who has to make a lot of decisions and doesn't always know why some are made the way they are, or who wants to try to build an expert system and hasn't the foggiest notion of how it's done, probably does need this.

Expert87 is unlike any other program that I've seen. Provided that you invest enough time in it to see what it's doing, and how, the payoff in your increased understanding of the decision process is likely to be worth the time and money; and you may use it to build a useful expert system to help make decisions.

Carpenter's Dream

Every so often I get a program that isn't fancy. Often the packaging is downright hokey. Most such programs are worthless, but I do try to look at them, because once in a while I find one that is so good, and so useful, that I can't quite believe it.

This is one of them. It sure isn't fancy; but it sure does do what it says it will, and there's no trick to learning it, either.

Carpenter's Dream—for classroom use, there is also an expanded version called Remodeler's Dream—simply and efficiently makes all those pesky calculations that drive you nuts when you're trying to cut wood to fit a complex space. Want to put in stairs? Add a roof? Hip roof? Gables? Get this program, spend a few minutes thinking about it, and start plugging in numbers. The result will be a table of materials to buy (e.g., 21.5 sheets of plywood or 80 rafters at 16 feet each). Another part of the program calculates the sizes to cut to, exact sizes, to $\frac{1}{16}$ inch.

Remodeler's Dream also estimates how much paint you need for a room of a given size and a bunch of other stuff.

Either of these programs will save a great deal of time and energy, not to mention wasted materials. If you're going to do construction or remodeling, get one. You won't be sorry. Recommended.

RollerMouse

For some reason, this seems to be the month for hardware. The odd thing is that a whole bunch of machines arrived in a series of decreasing sizes.

First was the Arche Legacy 386/33, very much a high-end machine. Ours has an 80387 math chip, 8 MB of fast memory, a 300-MB hard disk drive, both 5¼- and 3½-inch floppy disk drives, a 100-MB tape cartridge drive for backup, hardware disk caching, and a partridge in a pear tree. We set it up with the Pioneer DRM-600 and the Sound Blaster audio board.

When it came time to add a mouse—I confess that we always install a mouse now—I found we were out of mice, but there was a large trackball affair called a RollerMouse on the table, so Alex used that.

I'm not precisely sure why, but I didn't expect to like it; and I was wrong. I like it quite a bit. Indeed, if it would fit on my under-desk typing shelf, I'd consider installing it on my main machine.

The RollerMouse is Microsoft-compatible, meaning that it's a two-button mouse. In fact, it has four buttons: two big ones, which correspond to the usual mouse buttons, and two smaller ones, which activate click and drag mode, so you don't have to hold down a button to do drag operations. It takes just a bit of getting used to, but it's surprising how fast you not only learn to use this, but find it becoming natural; or at least both Alex and I found this to be true.

Naturally, Alex decided to do some extensive testing of RollerMouse compatibility, meaning that he put up Railroad Tycoon and built a big Western U.S. railroad empire. Actually, games are no bad test of mouse compatibilities; anyway, we've had this in use for a few weeks now and haven't found any problems, and we both still like it. If you're weary of rodents but need a pointing device, look into RollerMouse.

Anyway, the Arche Legacy 386/33 was the first and largest of the machines we've set up recently. Except for the Cheetah Gold 486, the Legacy is the fastest machine in the house; it's a lot faster than the Cheetah 386/25. This is a well-made, tough, sturdy, and powerful machine. You will definitely be hearing more about the Arche Legacy.

The Arche Legacy is a *big* machine, big enough to cover a desk. I gather it can be had in a tower configuration, and that might well be preferable for a machine of this size.

It's a Brick

The Ergo Brick is a computer you have to see to believe—indeed, some of the Citizens Advisory Council people didn't believe it when they saw it. The Brick measures just 8 by 11 by 3 inches high; it will literally sit on a piece of letter-size paper.

Inside it is a full 386SX computer, with 1 to 8 MB of memory in standard single in-line packages (Ergo sells them for $200 per megabyte, or you can shop around for a better price), a 44-MB hard disk drive (you can get larger ones, up to 212 MB), an optional math chip, a 2400-bps modem, an EGA/VGA port, two serial ports, an external bus port, an external power supply, and a whole mess of software all tuned up to run with the system. Ergo Computing believes in Desqview, and they have that all set up when you buy the machine: just turn it on.

The result is a machine you can carry around in a briefcase, which is what this was designed to do. Tom Spalding, Ergo's president, has a study that shows that most people use a laptop in only two or three places, and hardly ever use one while traveling. The Brick is intended to go home with you from work; to save carrying weight, you can keep a keyboard, monitor, and power supply in each location. In addition, by the time you read this, they'll have an LCD screen about the size of the computer.

The Brick looks like a toy, but it's a powerful machine, not quite the equal of the Arche Legacy or the Cheetah 386/25 I'm writing this on, but more than a match for any 286 and most 386SX machines. At 8 pounds, it's a lot less weight to carry than my Zenith SupersPort SX laptop, although that 8 pounds doesn't include keyboard and monitor.

You can buy a stripped-down Brick, but if you buy a fully loaded machine, Ergo will bundle it with a lot of software: QEMM-386 and Desqview, askSam, Borland's Sprint word processor, and the Quattro spreadsheet. It also comes with a mouse. I'm not fond of the keyboard, which has the Caps Lock next to the *A*, but we had no trouble installing a Northgate OmniKey keyboard on it.

I have had the Brick for only a few weeks, but everyone who sees it falls in love with it. We've got it set up with a Princeton Graphic Systems Ultra-14 monitor, and it fascinates visitors. The Brick isn't cheap, but if you have a kid going off to college, you might contemplate getting one of these; the 386SX will be current for another few years. Ergo has tuned up the Brick and its bundled software to be easy to use and understand (askSam will actually talk to you for a tutorial); and because the Brick is small and easily carried, it won't be any problem to move from place to place, and it can even be carried home for the holidays. Recommended.

MathCAD

I don't have space to do this program justice, but I wanted to mention it as a complement to the Brick: if you have a student going off to engineering school, run, don't walk, to your software dealer, get a copy of this program, and get that future engineer accustomed to using it. Engineering school math is tough, and while MathCAD can't do everything, it's amazing what it can do: not just in solving problems, but in helping you understand what you're doing.

There's a sense, though, in which liberal arts students need MathCAD even more than science majors: playing with this program is a sure cure for innumeracy, and the program is easy enough to use that if you get in the MathCAD habit, you may well find yourself playing with numbers. The program takes all the sting out of that.

Mathematica is more sophisticated and has better graphics capabilities, but for all-around usefulness, you simply cannot beat MathCAD. Highly recommended.

Winding Down

I'm coming to the end of this column, and I haven't got started on the piles of stuff lying around here.

While we had the Arche Legacy open to receive the DRM-600 interface board, we put in a Sound Blaster board as well. This bills itself as the ultimate sound board for your PC, and for once that's not all hype.

This interface board not only plays stereo sounds such as are increasingly provided with games, but it comes with highly sophisticated software that will let you program in sound. You can make the program read ASCII files to you, for instance, and while you may have to fiddle with the spelling on complicated words, it's surprising how good you can make that text sound.

The Sound Blaster normally plays through a Radio Shack speaker pair—the ones we use are their $29.95 amplified speakers (Radio Shack part 40-1267) that run off four C batteries. I presume I could take the audio output of the DRM-600 and feed it into the Sound Blaster, and let that board run the speakers, but I haven't done that yet.

You can also play sounds into the board. It will digitize them. Then you can call those sounds back up. Have your computer talk to people in your own voice.

There's a lot more, and I hope to get to it next month; meanwhile, if you're looking at high-end sound boards for your

ITEMS DISCUSSED

Arche Legacy 386/33 .... $5625
Arche Technologies, Inc.
48881 Kato Rd.
Fremont, CA 94539
(800) 422-4674
(415) 623-8100
Inquiry 1151.

Carpenter's Dream 3.0 .... $49.50
Remodeler's Dream $99
Workhorses, Inc.
805-B 14th St.
Golden, CO 80401
(800) 777-2477
Inquiry 1152.

The CD-ROM Chronicles $18.95
Meridian Data, Inc.
5615 Scotts Valley Dr.
Scotts Valley, CA 95066
(408) 438-3100
Inquiry 1161.

DRM-600 .... $1495
Pioneer Electronic Corp.
1058 East 230th St.
Carson, CA 90745
(213) 513-1016
Inquiry 1153.

Ergo Brick $2495
Ergo Computing, Inc.
One Intercontinental Way
Peabody, MA 01960
(508) 535-7510
Inquiry 1154.

Expert87 .... $495
Magic 7 Software
101 First St., Suite 237
Los Altos, CA 94022
(415) 941-2616
Inquiry 1155.

Mass-Store Copy $95
Informative Technologies
1718 M St. NW, Suite 292
Washington, DC 20036
(202) 675-4528
Inquiry 1156.

MathCAD $495
Applications Packs $99
MathSoft, Inc.
One Kendall Sq.
Cambridge, MA 02139
(800) 628-4223
(617) 577-1017
Inquiry 1157.

Office Star $199
Traveling Software, Inc.
18702 North Creek Pkwy.
Bothell, WA 98011
(800) 343-8080
(206) 483-8088
Inquiry 1158.

RollerMouse
IBM XT, AT, and PS/2s $129.95
IBM PC bus $149.95
Apple II and Mac $119.95
CH Products
970 Park Center Dr.
Vista, CA 92083
(619) 598-2518
Inquiry 1159.

Sound Blaster $239.95
MIDI Connector Box $79.95
Voyetra Sequencer MIDI Software $129.95
Brown-Wagh Publishing
130-D Knowles Dr.
Los Gatos, CA 95030
(800) 451-0900
(408) 378-3838
Inquiry 1160.

United States History CD-ROM $395
Bureau of Electronic Publishing
141 New Rd.
Parsippany, NJ 07054
(201) 808-2700
Inquiry 1162.

PC, think hard about Sound Blaster.

There's Office Star, the small-office connectivity system from Traveling Software: it's a means for connecting LapLink or DeskLink to several computers at once, giving file transfer and printer-sharing capability up to 100 feet between machines. It works through serial ports, it's easy to set up, and, like everything else Traveling puts out, it works about the way you expect without your having to dig through manuals. More on this one next month.

Finally, there's Mass-Store Copy, a program to make copies of WORM and other optical cartridges even though you have only one WORM drive. You'll wear your arm out swapping disks to copy a really big one, of course.

This program desperately needs an EXCLUDE command; that is, copy all EXCEPT *.BAK AND FOO.*, as an example, because backup WORM drives tend to be cluttered up with files you don't really want to copy onto the new WORM. We have two WORMs, on two separate machines, and use LapLink or Office Star to link them and copy from one to the other. If you don't have two WORM drives, you likely need to have this program.

The game of the Month is Centurion from Electronic Arts: you won't play it as long as you play Railroad Tycoon, but it's still fun and the graphics are great. The sound is awful, but so what.

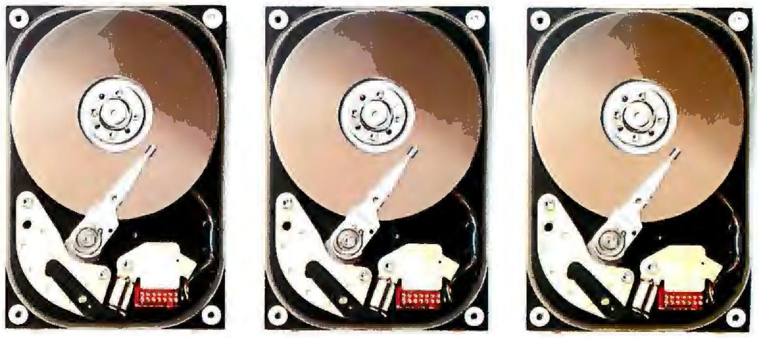
I won't call it the book of the month, but *Falkenberg's Legion* by Jerry Pournelle is now out in paperback from Baen Books; this includes my CoDominium stories, the ones about the unlikely end of the Cold War and an uneasy alliance between the U.S. and the U.S.S.R.... The real book of the month is George Gilder's *Microscosm: The Quantum Revolution in Economics and Technology* (Simon & Schuster, 1989). Gilder was a bit late discovering the electronic revolution, and much of what he says won't be at all new to BYTE readers, but he does put it all down in one place, and some of his arguments are interesting. (For a review of *Microcosm*, see the February 1990 Print Queue.)

Now it's 3:00 a.m., and Niven is due here at 11:00; we'll take a hike in the Hollywood Hills and talk over what we're doing, and we should have 4000 words done by dinnertime. *The Moat Around Murcheson's Eye* is *moving*. And I'm dancing as fast as I can.... ■

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."

THIS SHOULD

This may be hard to believe, but there really is such a thing as a portable PC that can do everything a conventional desktop can.

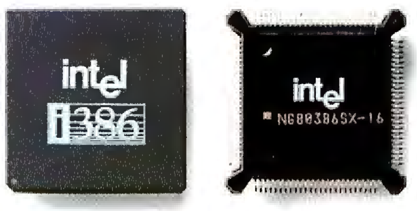


Some people can't imagine squeezing a 40,100 or even a 200MB hard disk into a portable PC. But when they take advantage of all that storage capacity, they find it hard to imagine life without it.

In fact, there's not just one, but an entire line of them. They're called Toshiba Portable Desktops,™ and they'll forever change the way your company looks at power and productivity.

To get more information or a free Portable Desktop productivity survey, call 1-800-477-1616.

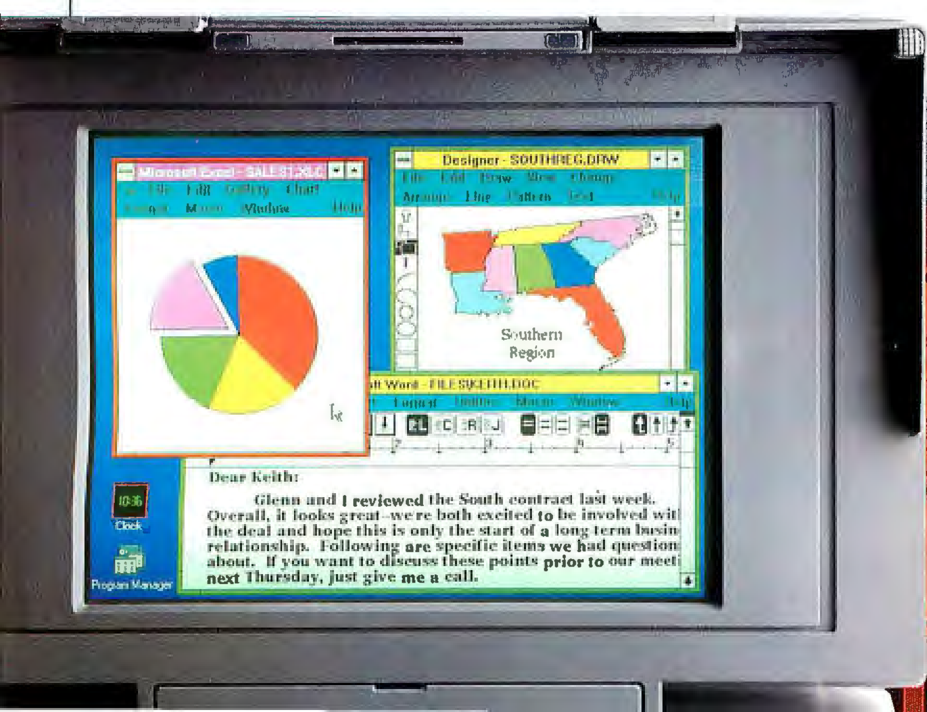
True, some business people may have trouble grasping the notion of desktop power in a portable, but when you give it some thought, it's the next logical step in computers.

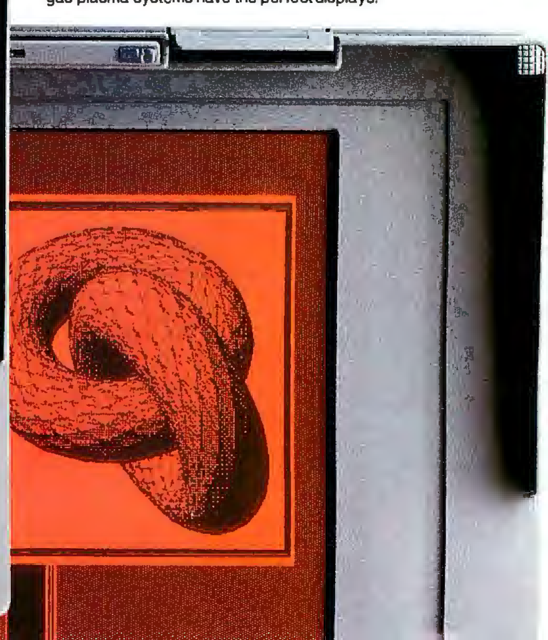


There once was a day when microprocessors this powerful were unheard of in a portable. Luckily for people who crave raw power and computing speed, that day is over.

With 386™ and 386™SX microprocessors, our Portable Desk-

For those who think a PC just isn't fully functional without a color display, we developed our second-generation LCD color screen. For those who think basic is better, our VGA gas plasma systems have the perfect displays.





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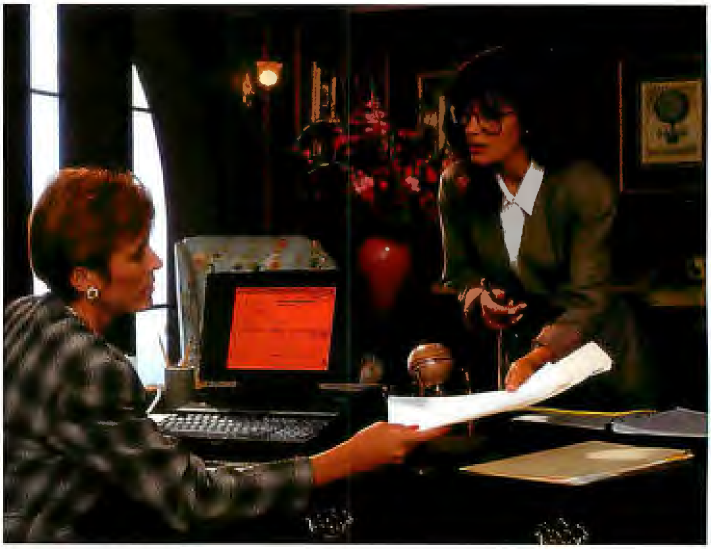
Okay, let's suppose you suddenly discover your company filled with powerful Toshiba Portable Desktops.

Now what?

First of all, your people can do everything around the office they've been doing with their desktop computers.


Giving your people instant access to vital information can keep them doing what they do best. Working smart.

Then your key employees can turn after-hours time into productive time, since their dining room tables and breakfast nooks can serve as off-site workstations.


Employees can even improve their productivity in the familiar surroundings of their own office. Only now they'll have more desk space to work with.

Your top people can add impact to their presentations with a wealth of information and computing power at their fingertips. And the story can repeat itself—with equally impressive results—everywhere from an office 3,000 miles away to a conference room that's a mere 30 feet down the hall.

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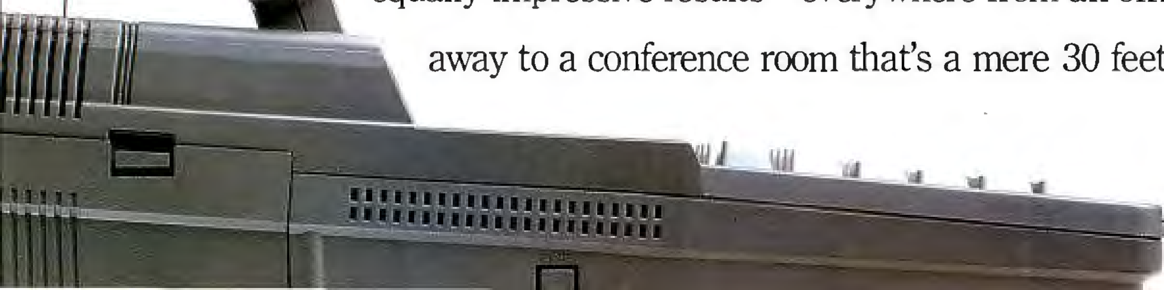

WHERE DO YOU GO FROM HERE?

Giving your key employees a Portable Desktop means they'll have the flexibility to work when they need to, where they want to.

When people have access to computing power outside their office, presentations are more powerful and groups are more productive.

And yes, all that productivity can even take place within the confines of your own office desk (while using up considerably less of your desk space, we might add).

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Now all of your best people can be doing a better job than they ever could when they were chained to conventional desktop PCs.

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People said it was just a matter of time before someone built a line of portable PCs this powerful. They just didn't know it would happen so soon. With our Portable Desktops, we've successfully combined the power and functionality of desktop PCs into slim, portable packages that give you everything you need to get ahead in business.

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18.7 pounds, 20MHz 80386 with 80387-20 coprocessor socket, 2 internal IBM-compatible expansion slots, 40MB hard disk with 25msec access or 100MB hard disk with 25msec access or 200MB hard disk with 16msec access, 2MB RAM expandable to 14MB, gas plasma VGA display with 16 gray scales, 1.44MB 3½" diskette drive.

T5200C

18.9 pounds, 20MHz, 80386 with 80387-20 coprocessor socket, 2 internal IBM-compatible expansion slots, 200MB hard disk with 16msec access, 2MB RAM expandable to 14MB, passive matrix VGA full-colorscreen, 1.44MB 3½" diskette drive.

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To get more information or a free Portable Desktop productivity survey, call 1-800-477-1616.

T3200SX

17.0 pounds, 16MHz 80386SX with 80387SX-16 coprocessor socket, 2 internal IBM-compatible expansion slots, 1 dedicated modem slot, 5 built-in ports, 40MB hard disk with 25msec access or 120MB hard disk with 19msec access, 1MB RAM expandable to 13MB, gas plasma VGA display with 16 gray scales, 1.44MB 3½" diskette drive.

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DON'T TAKE OUR WORD FOR IT. GET A SECOND OPINION.

What do other companies know about our Portable Desktop PCs that you don't? If you had a copy of our free productivity survey, you'd know. For example, you'd know that 93 percent of portable users said that they'd never go back to using a conventional desktop. You'd know they've reported substantial increases in productivity. And you'd know why they place so much value on the flexibility and freedom their portables have to offer. Toshiba Portable Desktops. They're no longer a matter of convenience, they're a matter of survival.

To get more information or a free Portable Desktop productivity survey, call 1-800-477-1616.

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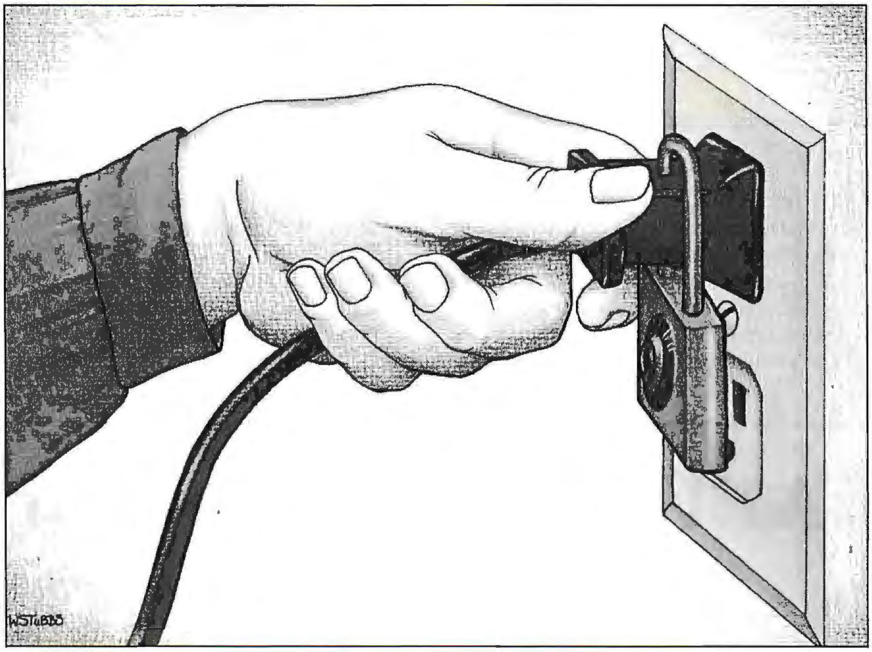
THE POWER MAN COMETH

Do you need an on-line or off-line UPS to protect your LAN?



There's no question that Virginia Power knows when I'm on deadline. Once before, the electric utility that serves Northern Virginia had frustrated delivery of Down to Business by parking down the street and killing the power each time I got about two-thirds of the way through my column. That was the day I discovered tape backup units. This time, though, I was ready for it.

Once again, I was well along in a project when the familiar orange truck drove up, the same crews opened access covers in the street, and the power went off. This time, though, I kept right on working. The Samsung/Novell 386AE file server kept right on running. The Gateway 2000 386/25 and the Zenith Z-386/33 kept on running, as well. Even the Telebit T2500 modem stayed connected to BIX. When the power returned 20 minutes later, I was still working, my productivity and my data unaffected.

In my office, I have the file server and the Gateway 2000 attached to a Para Systems Minuteman 1200SS uninterruptible power supply. The Zenith and the modem receive their power from a Viteq 386/LAN on-line UPS. During the time I've looked at these devices, both UPSes have supported the file server, as well as my other office equipment. This collection of devices has included the telephones, the fax machine, and (inadvertently) a laser printer.

Once upon a time, a UPS was considered an exotic piece of equipment. Mainframes used them, often in the form of a diesel generator out back, with a motor generator that used stored mechanical energy to smooth out any brief power losses. Smaller installations used batteries and inverters, but all these devices were considered too expensive to be used with personal computers. That concept was fine, of course, until businesses discovered that they depended on personal computers as much as, or more than, they did on their mainframes.

Now, some (but not most) businesses are using UPSes to protect some of their personal computers. Now that many of these same businesses are installing LANs, the need has become greater, and the risk that businesses run by not using UPSes has likewise become greater. A network file server is more vulnerable to power loss than is an individual workstation.

Server Vulnerability

Most network file servers are simply personal computers that have been loaded with file server software and modified by the addition of large hard disks and some extra memory. It's not their design that makes them more vulnerable to power loss, but rather their use.

Because they support many users, file servers access their hard disks much more often than do individual personal computers. Thus, when the power goes out, there is a greater likelihood that the file server will be involved with writing information to the hard disk, or that the disk cache will contain information that needs to be written to disk.

There are times when a power loss during a disk write can trash the file server fairly effectively. Depending on the design details of the computer being used as the server, a very brief interruption may or may not be serious. Some computers can tolerate a brief flicker in the power supply; others are sensitive to any irregularity. Peripheral equipment, such as modems, are much more affected by power fluctuations. It's not unusual to see a modem go off-line due to a power

ITEMS DISCUSSED

Minuteman 1200SS $1500
Para Systems, Inc.
1455 LeMay Dr.
Carrollton, TX 75007
(214) 446-7363
Fax (214) 446-9011
Inquiry 1221.

386/LAN $1895
Viteq Corp.
10000 Aerospace Rd.
Lanham, MD 20706
(301) 731-0400
Fax (301) 731-5995
Inquiry 1222.

change—a situation that a computer will ignore completely.

Off-Line? On-Line?

An intense and ongoing controversy concerns whether engineers should design off-line or on-line UPSes. They design an off-line UPS for times when the power is interrupted and the switch to batteries needs to take place very quickly. The idea is that if the changeover is fast enough, the equipment attached to it will never balk at the interruption.

Engineers design an on-line UPS for situations in which the battery will always supply the power. The power from the electric company simply charges the battery. When the power goes out, the battery charging stops, but you don't have to switch power supplies.

In theory, if your equipment is very sensitive to power fluctuations, then an on-line UPS is more likely to keep you operating smoothly. Most personal computers seem to be able to tolerate the brief fluctuations caused by the changeover to off-line battery power. Other devices with less hefty power supplies might have a problem, though.

In practice, however, I haven't noticed any difference between the way equipment functions on the off-line Para Systems Minuteman and the way it functions on the on-line Viteq. Despite the best that Virginia Power could do, both UPSes kept all the equipment attached to them up and running without a glitch. This might be partly due to the Minuteman's 1-millisecond switchover time. Most equipment can't spot a power interruption that brief.

Incidentally, I was able to sustain a connection to BIX during the times when the power was off. This is a good indication that the transfer was a smooth one, because, in the past, I've found that even the smallest problem with power was sufficient to abort a modem connection.

Amazing Grace

Of course, in a network environment, there's more to a UPS than good batteries and a smooth transfer of power. A UPS just provides power for a relatively brief time during an interruption of electricity from the utility company. Eventually, the batteries run down and the file server is still left without power. You can extend the time that the UPS provides power by buying a larger one, but you must also spend a lot more money.

Fortunately, most network operating systems support monitoring the state of the UPS. Thus, when the power company disconnects you, the UPS will signal the network operating system, which will then signal the users and the network administrator.

continued

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"Normally, it's a bit hard to pick the most impressive item at Comdex [Spring 1990], . . . This time it was easy, . . . the hyperSTORE/1600."
-Jerry Pournelle, Byte Magazine, September 1990

"PSI has created the power user's ultimate Lego set for disk controllers: the hyperSTORE/1600"
-Alfred Poor, PC Magazine, June 12, 1990

"The real-world result will be blazing record handling from within a data file as well as unstoppably fast program loads."
-Bill O'Brien, PC Magazine, February 13, 1990

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Normally, this signal from the UPS also tells the network server to begin shutting itself down as gracefully as possible. The disk cache will be written to disk, open files will be closed, and processing will stop. You can then turn off the file server safely, or let it run down when the UPS batteries finally fade.

Monitoring is usually performed by a special card that you can install in the file server. Some Novell NetWare servers, however, can monitor the UPS through a plug in their disk coprocessor board. In the case of the Minuteman, Para Systems provides special software that lets you connect the UPS to a serial port on the file server. The server and the UPS can communicate through the serial connection. In other words, once the file server has been shut down, the UPS can also shut itself down. Thus, it can preserve some of its power in case there's another power interruption before you can charge the UPS completely.

Getting Charged

Most people who have LANs know that UPSes exist. Why, then, do so few protect their LANs properly? The reason, of course, is that many LAN users haven't figured out the true value of their network and the information it contains. In fact, the true value of your LAN may total almost as much as the entire value of your business.

When you figure the value of your LAN, you have to consider more than just the utility it provides. While the communications support is important, remember that after the LAN has been in use for a while, it begins to be the repository for the information your company needs to operate. Think where you'd be without your accounts receivable, your customer list, or your employee records. Spending less than two grand to protect these assets is cheap insurance.

So Long, but Not Goodbye

This is the next-to-last installment of Down to Business, which I've been writing for nearly three years. Don't get too excited; you're not getting rid of me that easily. Starting in March, Down to Business will be replaced by a new column called The Business Connection. I'll also be writing the new column.

This change is due to the interest you have shown in the business-related coverage in Down to Business. My new column will continue this tradition, but it will do so with an expanded format, giving you more information, more depth of coverage, and more business computing news, as well as opinions about what's happening in this environment.

One of the most exciting changes will be an expanded emphasis on the use of networks in business, especially in the rapidly growing field of enterprise computing. I hope that you will find these changes as exciting as I do. The years till now have been wonderful, and I'm looking forward to bringing you even more valuable information as BYTE's business coverage continues. ■

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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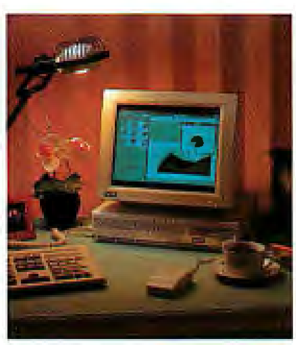

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Living with Windows 3.0 and OS/2 2.0

This is a report from the future. By the middle of this year, people will be using both OS/2 2.0 and Windows 3.0. Since Windows 3.0 on a 386 and OS/2 2.0 both provide fairly stable platforms for DOS multitasking, as well as sporting a graphical user interface (GUI), there will be an obvious question of which to use. The PC trade magazines will all have cover stories about which is better.

You don't see this happening now because OS/2 2.0 is still in beta testing; 99 percent of the current (September 1990) version 2.0 users are programmers.

I'm not sure why Microsoft is being so reticent about releasing OS/2 2.0—it's as stable as, if not more stable than, a good number of commercial products. In fact, I use it every day as my DOS launching pad. It's neat in that it not only lets me run my day-to-day OS/2 applications (WingZ and PageMaker, which is better under OS/2 than it is under Windows), but I can also run my DOS applications (e.g., the Q editor), either in a Presentation Manager (PM) window or a fully concurrent full screen.

721K-byte Free Space in DOS

But that's not all, not by a long shot. I can actually tell version 2.0 to emulate CGA video, giving my Q editor DOS session 721K bytes of memory. That means that once the Q editor is loaded, it shows me 647K bytes of free space—and recall, this is a simple DOS application that is not aware of OS/2.

Yes, yes, I know that any native OS/2 application could easily address megabytes and megabytes. But native OS/2 applications are still a mite scarce, and besides, I already own my DOS applications. If OS/2 2.0 can let me stretch their useful lives out a bit, that's fine; it gives me a little more time while I'm waiting for the flood of OS/2 programs.

OS/2 2.0 lets you do more than tag on more conventional memory. It will *limulate*, attaching as much expanded memory to your session as you'd like. (I've seen an Extended Memory Specification emulator demonstrated, but it's not included in the beta version yet.) You can optionally copy ROMs to RAM for more speed. You can control idle detection, a feature whereby OS/2 puts inactive programs to sleep, saving CPU cycles. These are just a few of the options, and it's not finished yet.

The most amazing thing I have seen under version 2.0 is how it handles video games. Really. One sure way to find the soft parts in most multitaskers is to run highly graphical games or communications; they can stop the system dead.

I'm looking at a game called Star Control running in CGA mode as a window of about 3 by 4 inches. I can see the entire game screen, albeit reduced in size, in the window. When windowed, a graphical program does not run. But flip the program to a background full screen, and while I write this, computer-controlled armies wipe each other out. Try this with just about any other multitasker: instant lockup.

So Why Do I Still Run Windows?

Like many of you, I hated Windows 1.0 and 2.0. I rely heavily on Micrografx Designer, however, and Designer does not run without Windows, so up to now I just grinned and bore it. But Windows 3.0, well, that's another story. You know something's different when it first comes up. Heck, I didn't even know my VGA could *make* that shade of blue! It's more than just silliness, however—the thing really is easy to look at.

continued

ILLUSTRATION: MICHAEL MCLAUGHLIN © 1991

The ease of changing and storing color schemes is convenient. I use it all the time when I change to monochrome to capture Windows screens. In contrast, OS/2 just makes things harder than ever. Once you find a color scheme, you back it up by making a copy of OS2.INI, the configuration file that stores that kind of information. The OS2.INI file is kept open, however, and the file system won't even let you back it up: You've got to reboot under DOS to copy the file.

That's my first reason for still using Windows: better aesthetics than OS/2 has. Again, the final version of 2.0 hasn't appeared yet, so I can hope that it will look as pretty as Windows.

Boy, would I be annoyed if I were an OS/2 developer! Pay all that money to develop for OS/2 and then have Microsoft drop a nicer-looking, cheaper GUI on the market. "Just trust us," Microsoft said to developers.

I still use Designer under Windows because, sadly, Designer's OS/2 version stinks. It's slow and lacks features such as auto-trace—an ideal application for memory-rich OS/2. The Windows version, on the other hand, is quick (as long as you avoid outline fonts and don't mind the bugs in the LaserJet font handling) and makes full use of the Windows 3.0 DOS extender. It can import 500K bytes of AutoCAD DXF files, although large imports are time-consuming.

Here's a case where it's a real shame that I've got to stay in Windows. Once the "importing..." box comes up, Designer is useless until the import is over. A hypothetical Designer under OS/2 could be designed to be multithreaded—one thread could handle the import while another could continue to accept and process user commands.

That's the big difference between the versions of PageMaker for Windows and OS/2. When they're run on the same machine, you end up spending more time looking at the hourglass when running the Windows version than you do under the OS/2 version. OS/2's multithreading capabilities in tandem with good OS/2 programming on Aldus's part makes the OS/2 PageMaker preferable. Sadly, the vast majority of OS/2 programs don't exploit this feature yet.

Discussion of PageMaker brings up the main sticking point for both Windows and OS/2: printing. Print a simple LaserJet graphic, and the print manager goes out to lunch. I dread printing large documents under either system, and I can't afford to outfit all my laser printers with PostScript to speed up the process.

The other reason I run Windows is memory. One of the machines on my desk has 4 MB of RAM, not enough to run the OS/2 2.0 beta version (it needs 6 MB—fear not, it's only temporary in the beta version). Under Windows, 4 MB gives me enough cushion for a 1.5-MB cache and plenty of memory left over for applications. This isn't as much of an obstacle as some writers make it out to be, however. With memory at about $80 per megabyte, it's only laziness that keeps me from putting in another 4 MB.

Perhaps the most compelling current reason for Windows over OS/2 is its relative richness of applications. Again, both Windows 3.0 on a 386 and OS/2 2.0 will multitask normal DOS programs, but what about programs that exploit the GUI environment itself?

I end up using Crosstalk for Windows, because it's easy and I have used Crosstalk for years. It lets me do downloads while drawing with Designer, and when minimized, the Crosstalk icon even

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I can scan an image into PC Paintbrush, Scanning Gallery, or a host of other programs under Windows, while there *still* isn't an OS/2 driver for my ScanJet Plus yet. And, yes, it seems a minor point, but when I'm waiting for something to finish under Windows, I'm now able to pull up Reversi and get shellacked again. I'm now putting some of my seminar presentations in ToolBook, and I plan to show them as VGA screens projected from a laptop. I sure wish there were a ToolBook for OS/2.

OS/2 should come with as many goodies as Windows does. Windows Write hasn't cost Microsoft one single Word for Windows sale—why not port Write to OS/2 and give it away with PM? Ditto Paint, Cardfile, Calculator, Terminal, and, yes, the games, too. Remember, OS/2 costs almost 10 times as much as Windows. If Microsoft is not going broke selling Windows, it certainly can bundle a few accessories with PM. Giving away a BASIC interpreter with DOS 1.0 didn't eliminate the market for compiler products—it *created* one by giving people a taste of what they could do on their PC.

Thus, I'm still between worlds. Ultimately, I'll spend more and more time in OS/2 2.0 rather than Windows. The 32-bit flat-memory structure (not available to Windows programmers) will swing the balance of program speed in its favor.

Programmers will finally figure out how to write multithreaded OS/2 code ("stamp out hourglasses in our time!"), and we will read about developers jealously speculating about the possibilities of threads for Windows 11.0. OS/2's native support of Bézier curves will mean a simpler life for those of us who are tired of having to generate (and store) megabytes of downloadable fonts. You get used to being able to name files BYTE.september.column.version.2, instead of BT0990V2.TXT; the High Performance File System is nice.

It looks more and more likely that version 2.0 will directly execute Windows 3.0 programs; that would be the best of both worlds. But for now, either Windows 3.0 or OS/2 2.0 is a whole lot better than what I had last year. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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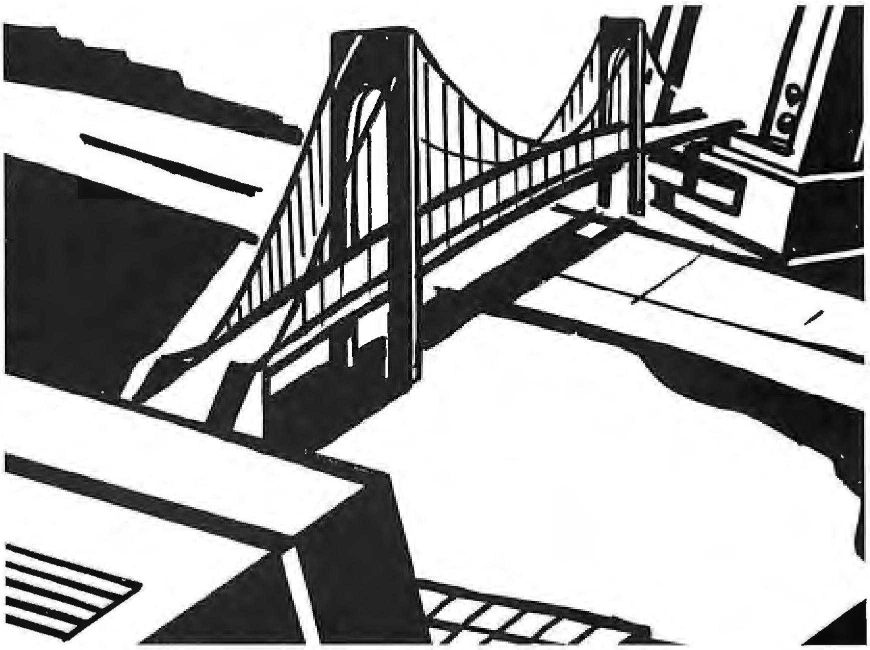

Last month's prediction about inexpensive PC-based workstations is already starting to come true, and you probably have most of the hardware right on your desk. This month I'll also take a brief hands-on look at the new and much-improved SCO Unix and a somewhat longer look at how VP/ix can keep DOS on your desk when you take the plunge into Unix.

SCO Unix Update

Last January, I recommended SCO Xenix as a good platform for 386-based systems that didn't need true AT&T Unix compatibility because it was "extremely fast and stable." I still think that Xenix is a good, mature product that has benefited from numerous refinements over the years. But I didn't wax enthusiastic about SCO's Unix 386 product, because my experiences with it have been less than heartwarming.

However, virtually all the problems I had had with it, and some I hadn't even found yet, were solved last week when I received the latest update for SCO Unix. Officially called SCO Unix System V/386 3.2.2, it took a full year for SCO to write and test.

It was worth the wait. The new version is not only quite a bit faster than the previous version, it is almost as fast as Xenix, which is a much smaller operating system.

The kinds of improvements I found show that someone has been doing a lot of work on speeding up the internals of the kernel, since things like system calls, memory access, and disk throughput have improved markedly. The new version even supports SCSI CD-ROMs in both High Sierra and ISO 9660 formats. They also give you more of an opportunity to relax some of the C2 security restrictions than before. (For more information on C2 security, see "Safe and Secure?" in the May 1989 BYTE.) Finally, release 3.2.2 comes with the Korn shell, a significant improvement over the regular Unix shell, which I am starting to really appreciate.

While I obviously haven't had the new Unix long enough to see whether it will stay up for a solid month without crashing, as Xenix does, it appears to be quite stable. I've been working with it carefully in an attempt to find unfixed or new bugs. What I've found instead are many small, subtle (and unheralded) improvements.

For example, there are more identical files that are delivered as links to each other, rather than copies. Also, shared libraries were used to rebuild the system's executable commands. Both of these factors indicate a high degree of care in building the system for distribution (and, incidentally, save a great deal of disk space). It's the equivalent of a mechanic looking inside a car engine and finding stainless-steel Allen bolts instead of cadmium-plated hardware.

The only problem I have now is trying to figure out why I can no longer talk to my Telebit modem at 19,200 bps.

DOS Good, Too

Some DOS and even Unix users might not realize it, but there is a way to move up to Unix and keep all your investments in DOS training, programs, and procedures. VP/ix, from Interactive Systems, runs on the company's 386/ix, as well as SCO Unix and Xenix. It uses the 386's built-in "virtual 8086" facility to emulate the complete IBM PC environment, including DOS 3.3.

You can simply type `vpix` at the Unix prompt to get the familiar DOS C>

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SCO Xenix
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Inquiry 1005.

VP/ix
Interactive Systems Corp.
2401 Colorado Ave.
Santa Monica, CA 90404
(213) 453-8649
Inquiry 1006.

X-Pac
Integrated Inference Machines
1468 East Katella Ave.
Anaheim, CA 92805
(714) 978-6776
Inquiry 1007.

prompt. Thereafter, for all intents and purposes, you are running DOS. You have all the commands normally delivered with DOS, including BASIC. You can also execute any Unix command from the DOS prompt, and even pipe the output of a Unix command into a DOS command (or vice versa).

If you have installed Unix properly on a system that was already running DOS, you can switch to drive D and find that all your previous DOS files, applications, and directories are still there! Using the DOS ASSIGN command can fix even this small difference, mapping your DOS hard disk files to the familiar C drive. Then you can execute any of your commands in the normal manner, without even caring that you are running Unix. I have nicknamed `vpix` to the name `dos`, so I can type either one of these commands.

Apart from bringing up the DOS prompt, which might be most comfortable for inveterate DOS users, you can also type something like `vpix -c 123` from the Unix command prompt. This gets VP/ix to load your DOS Lotus 1-2-3 executable immediately, so that you are literally running a DOS program from the Unix prompt. I go a step further on my system, by writing little six-line Unix shell scripts that do some housekeeping on the way in and out of DOS. Here's an example:

```
VPIXCNF="/ips/vpix/123.cnf"
export VPIXCNF
mesg n
disable oki >/dev/null 2>&1
/usr/bin/vpix -c E:/123.bat
enable oki >/dev/null 2>&1
```

The first two lines set up a configuration file for VP/ix, telling it what devices will be needed by the DOS session and how to find them in the Unix file system. While it's unnecessary to create one for every application, I find it useful because I can

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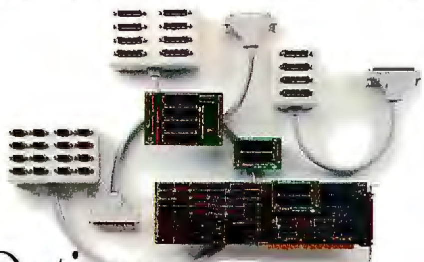

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assign specific devices, such as laser printers, for specific purposes.

The `mesg n` prevents other users from sending real-time Unix messages to my screen while I'm running a DOS application, which might confuse matters. Disabling and reenabling the particular printer-spooling device, as I do in lines 4 and 6, aren't necessary either, because you can use the Unix printer spooler as your DOS printer. Only line 5 is really required.

The beauty of this approach is the name of the shell file, in this case `/usr/local/123`. I merely have to type `123` from the Unix prompt, and I'm in the spreadsheet, without having to even know I'm working with DOS.

And what about drive E? That's another of my improvements. Drive E to DOS is mapped to `/ips/vpix`, and it's literally a directory in my Unix file system. Some versions of DOS might be limited to 32 megabytes, but drive E can be the size of my hard disk. Since all the files reside under the Unix file system, they can be backed up on tape as part of my regular backup procedure.

Even better, DOS applications benefit from the memory caching and structure of the Unix file system: Most run faster (especially file-oriented applications) and more stably than on native DOS. I've had VP/ix running for years with major applications such as Ventura Publisher (yes, even the new version with a bus mouse and extended memory), Quicken, and ArcList, a professional mailing package with 50,000 names and addresses on-line.

VP/ix isn't the only DOS solution on the market. There's a similar product called DOS/Merge from Locus Computing, which runs on other 386-based Unix systems, as well as SCO's Open Desktop. DOS/Merge's main claim to fame is that it's supposed to work as is with "foreign" devices, such as scanners: no device drivers needed.

PCs as X Terminals

OK, I *swear* I didn't know about this when I wrote last month's column. I predicted we'd see inexpensive PC-based workstations that could just plug into an Ethernet line and run X Window System software. So, this month I found out about X-Pac from Integrated Inference Machines.

The X-Pac is a single board that turns your normal PC (AT or higher, with EGA graphics or better) into an X terminal. The package includes a serial mouse, a serial port, 2 to 16 MB of extended memory, and an Ethernet port (both thick and thin cable). You also get a TCP/IP kernel, an Ethernet driver, an X server, and a copy of Check-It software to help set up the system.

It sounds like a lot of things to deal with, but they tell me it's been designed as a drop-in solution to the obvious problem of, "Now that we're using Unix and workstations, what do we do with all these PCs?" It works as a Windows application with Microsoft Windows 2.1 or higher, and you can set it up so that you just click on an icon, and—poof!—you're running an X terminal to Unix in a window. And, in case it's not obvious, you still retain all the utility and software of your good old PC.

Don't Call Me, Call Them

It's been brought to my attention that some readers have been calling UUNET Communications Services for more information after reading last July's column. The only trouble is, they've been calling UUNET's voice line using their modems.

If you want to speak to someone at UUNET, call (703) 876-5050. To use the anonymous UUCP connection, you have to set your Unix system (in the `/usr/lib/uucp/Systems` or `L.sys` file) to call the organization at (900) 468-7727 with the log-in name of "uucp" (no password) and execute the following command on your system:

```
$ uucp uunet!/help /usr/spool/
    uucppublic
```

This will get you all the information you need. It should work at any data transfer rate, and will cost you 40 cents per minute. If you just want UUNET's fax, try calling (703) 876-5059. ■

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."*

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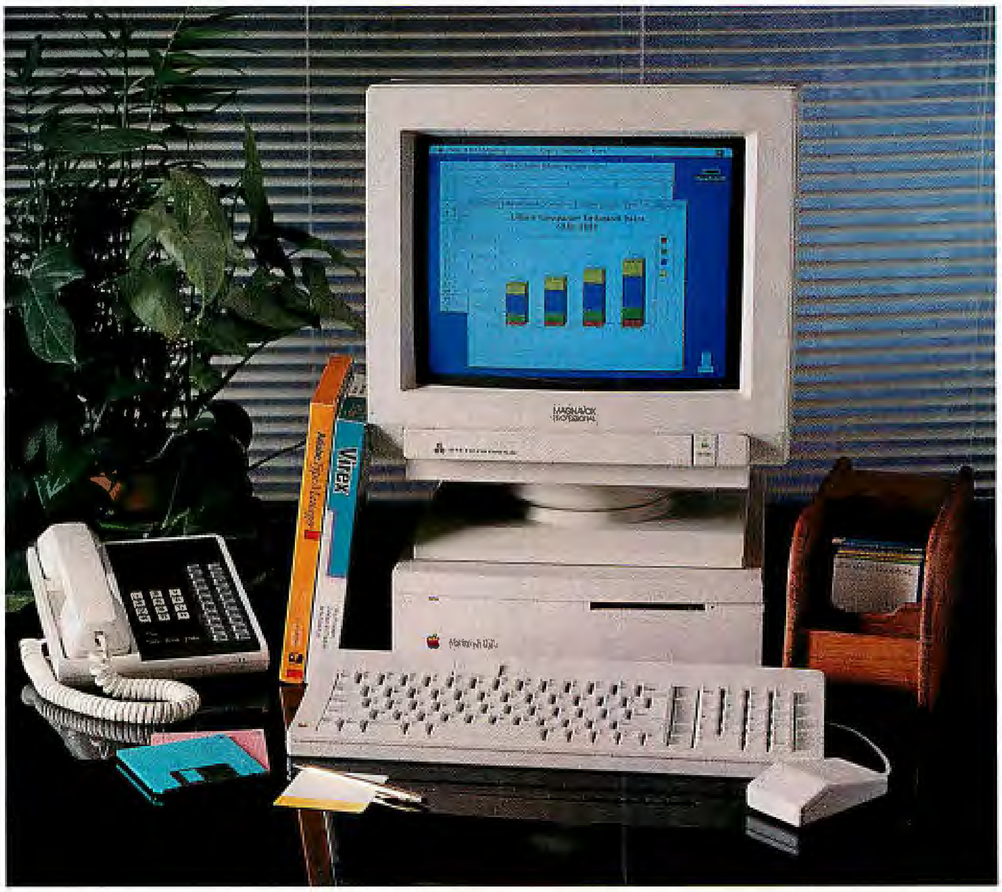

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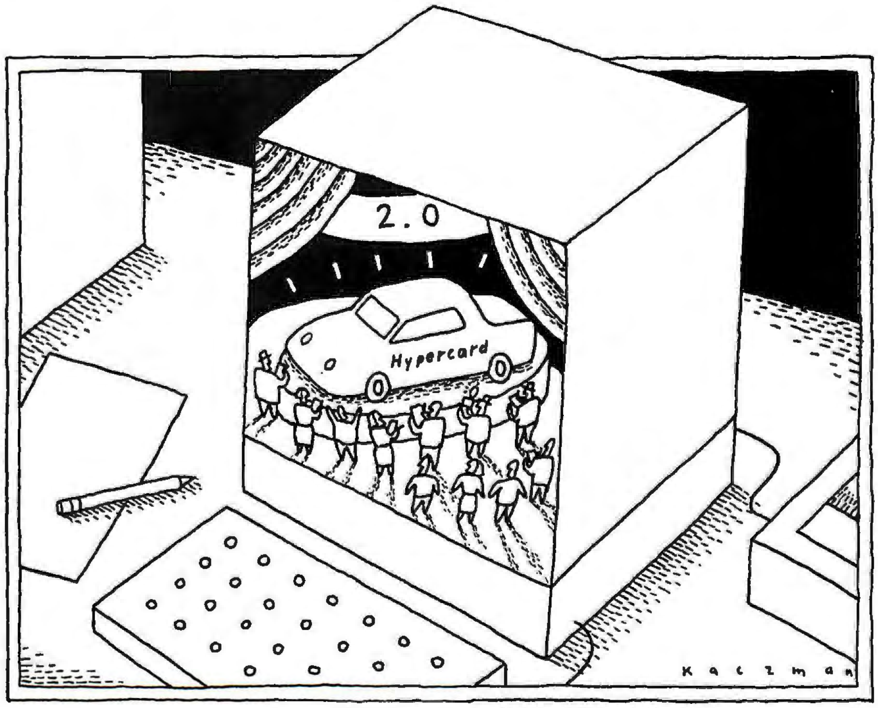
THE MAC AND PERSONAL PROGRAMMING

With HyperCard 2.0, users finally get the support they need



By now the dust surrounding the introduction of HyperCard 2.0 has finally settled. Naturally, Apple couldn't upgrade its best software without stirring up a tempest in a teapot. All the hullabaloo that "Apple had abandoned its customer base" when it turned over the development and marketing of HyperCard to Claris has now calmed—and the truth is out. HyperCard 2.0 is so much better than version 1.2.5 that it's hard to understand how we got by using that earlier release.

Here are the facts, then, to clean up this controversy. Apple is still bundling "real" HyperCard 2.0 (i.e., you can write and edit scripts in HyperTalk) with every Mac sold. The only difference between the HyperCard 2.0 you buy from Claris ($49 if you're upgrading from a previous version; it costs more for new customers and less for site licensees) and the bundled version is the support material, not the HyperCard 2.0 binary.

Apple has stripped down its giveaway version to fit on a single 1.44-megabyte floppy disk and packaged it with a slim 30-page getting-started manual. Apple has also hidden scripting from novices, so that you have to explicitly turn on user levels 4 and 5 (i.e., authoring and scripting). Otherwise, it's the same. Identical.

Claris's version 2.0 meets the needs of HyperCard programmers much better than earlier Apple versions. It has five floppy disks of help and support stacks, three big manuals, the official guide to scripting, and Claris's free and first-rate telephone customer support. Apple was ill-equipped to handle this support element on its own, and it's the biggest reason that serious HyperCard programmers have reason to rejoice, even if what used to be free now costs a few kopecks. Real software, with real support, has a nasty habit of costing real money.

How good is HyperCard 2.0? Extremely fine, thank you very much. It's made me forget about pretenders to the throne of personal programming tools (e.g., Plus, ToolBook, and SuperCard). Sure, there are still things those systems can do that HyperCard 2.0 can't. But HyperCard has a momentum built up that's hard to stop, and version 2.0 helps reestablish that momentum. Consider the following version 2.0 improvements:

- An optimized file format makes stacks smaller and better behaved. (Earlier stacks require a conversion that is *not* backward-compatible.)
- Support for variable card sizes, ranging from 64 by 64 pixels up to 1280 by 1280 pixels in 32-pixel increments.
- Multiple, resizable, and scrollable card windows that follow the standard Macintosh document window style. You can open up to 17 stacks simultaneously.
- Styled fields that hold text of multiple fonts, sizes, and styles.
- Hot text—the ability to respond to a user's interaction with text within a field.
- A group text style that "glues" together words or characters within a script. This prevents a text string from being misinterpreted as several separate commands.
- A dramatically improved printing scheme (including individual field printing), which means you don't need third-party add-ons like Reports anymore.
- A HyperTalk "compiler." This is actually an incremental compiler that converts scripts into executable code. No stand-alone application is

generated. You still need HyperCard to run a stack, but the compiled scripts run much faster than the old interpreter mechanism did.

To go with the compiler, you get a real script editor (actually, it's an XCMD) and an interactive debugger—complete with script checkpoints. These checkpoints can be made temporary or permanent, depending on your development needs. You can also peek at each message as it's generated with the Message Watcher; likewise, you can watch variable values change with the Variable Watcher. HyperCard 2.0 implements both watchers as external windows that look something like stripped-down message and variable inspectors.

Perhaps the most important change to HyperCard 2.0, helping it reclaim its position as the top personal programming tool, is user-definable message inheritance.

Perhaps the most important change to HyperCard 2.0, though, and the one that helps it reclaim its position as the pre-eminent personal programming tool, is user-definable message inheritance. Unlike the previous versions, where you couldn't touch the cast-in-concrete inheritance path of HyperCard stacks, you can now insert your own stacks into the inheritance path that work the same way as the Home stack.

This way, these new stacks can make their stack scripts and resources available to any other stack in the path. The new HyperTalk command, `start using`, does this simply:

```
on openStack

start using stack ''Don's hard
disk: My Test Stack''

end openStack
```

Similarly, you can remove a stack from the inheritance path with the `stop using` command:

```
on closeStack

if the stacksInUse contains ''My
Test Stack'' then stop using stack
¬ ''My Test Stack''

end closeStack
```

You can insert only 10 stacks this way.

HyperCard 2.0, you should note, is still just object-like, not a true object-oriented-programming (OOP) system. It still lacks polymorphism and unrestricted inheritance. Also, encapsulation can be violated as you see fit. And don't expect to find anything like true Class, Methods, or Object Browsers.

Still, HyperCard 2.0 has come a long way since its version 1.0 days. HyperCard 2.0 isn't Smalltalk or C++, and I'm glad it's not. It's much easier to use than these OOP languages, and you get some personal Mac programming done quickly.

Kudos to Apple for finally getting it out the door and into our hands. I look forward to many new services, special versions, and accessory stacks, now that Claris has taken over HyperCard's development. Stay tuned.

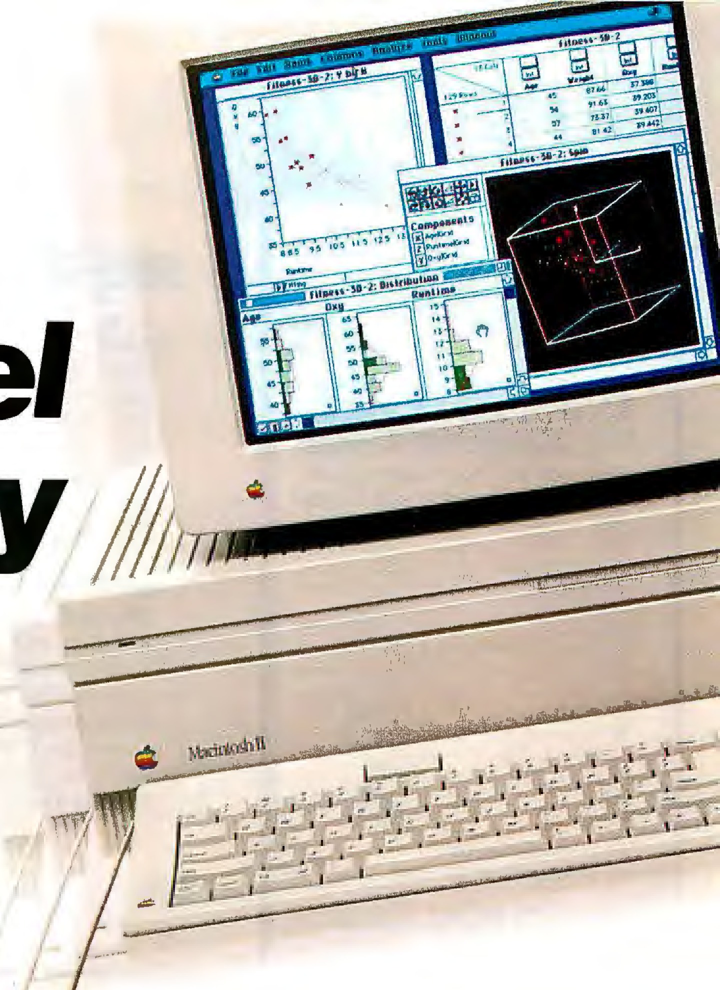
Tips of the Month: Healthy Disks and Good Software

Several months back, I reported on a useful utility for keeping track of all the files on your hard disk—On Location. This program, which functions as a start-up INIT and is controlled by a desk accessory (DA), keeps an active index of all your files, updating itself in the background when necessary.

The beauty of this active index becomes clear the first time you use it. It's much faster than the mediocre Find File DA that Apple supplies, and it lets you search your files both by filename and file contents. The string-searching capabilities of On Location make it easy to find the exact file you want by zipping through their collective contents incredibly quickly.

Despite all its capabilities, On Location 1.0 was a flawed product. The most serious flaw was the unpredictable failure of indexes when you tried to use them. Since it could take On Location a few hours to generate a new index from scratch (for a big disk), you can imagine just how inconvenient this made using the software.

I'm happy to report that version 1.0.2,



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HyperCard 2.0 (Bundled version that lacks authoring manuals or example stacks; free with any Mac.) Apple Computer, Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010 **Inquiry 1147.**	**Norton Utilities for the Macintosh 1.0** .... $99 Symantec Corp. 10201 Torre Ave. Cupertino, CA 95014 (800) 441-7234 (408) 253-9600 **Inquiry 1149.**
	On Location 1.0.2 ....$129.95 (Free to version 1.0 owners.) On Technology, Inc. 155 Second St. Cambridge, MA 02141 (617) 876-0900 **Inquiry 1150.**

which is available free to all version 1.0 owners, fixes this damaged-index problem without any apparent side effects. If you own version 1.0 and haven't received your free upgrade yet, call On Technology to get fixed up right away.

Despite On Location's handy indexing prowess, keeping your hard disks organized and in good shape often requires more help. Over the last few years, I've put utilities like Disk First Aid, Symantec Utilities for Macintosh (SUM) I and II, and Mac Tools to good use in keeping my disks optimized or repairing ones that died.

This past summer, though, I needed something different: I tried to resurrect a Mirror Technologies 130-MB hard disk drive that had bellied up two years ago. All my old favorite utilities failed to revive this beast, until I found help from an unlikely source: Norton Utilities for the Macintosh. Although Peter Norton Computing is now owned by Symantec, Norton Utilities for the Macintosh offers different solutions to fixing disks than does SUM II.

In my case, I used the Format Recover, FileSaver, and Unerase utilities to recover a substantial portion of the old files (all MacWrite 4.6 and Microsoft Word 1.05 files) from the Mirror Technologies drive, which I quickly transferred to a brand-new GCC Technologies HyperDrive 430S.

I'll be putting Norton's other utilities to the test over the coming months. For now, Norton has my thanks for letting me excavate "ore" from a mine I thought was long played out.

Finally, I've got good news for Nisus advocates. Nisus is fast, extensible, and programmable. It has a superb grep facility, and it even has good desktop publishing capabilities, if you have a need for such things. But it's never been perfect. Now, with version 3.01, perfection is several steps closer.

Nisus 3.01 fixes a slew of nagging little bugs, including some screwy screen updating, and it revamps the menus and ruler layout. George Lewak, Paragon Concepts' president, led the redesign. He has done a great job of listening to his die-hard customers by adding important new features and modifying the interface without stripping Nisus of its originality. If you'd like to try a word processor that doesn't forget that dealing with words is the first thing to get right, you should check out Nisus. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is the author of a new book, Using Filemaker Pro *(Simon & Schuster/ Brady Books). He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."*

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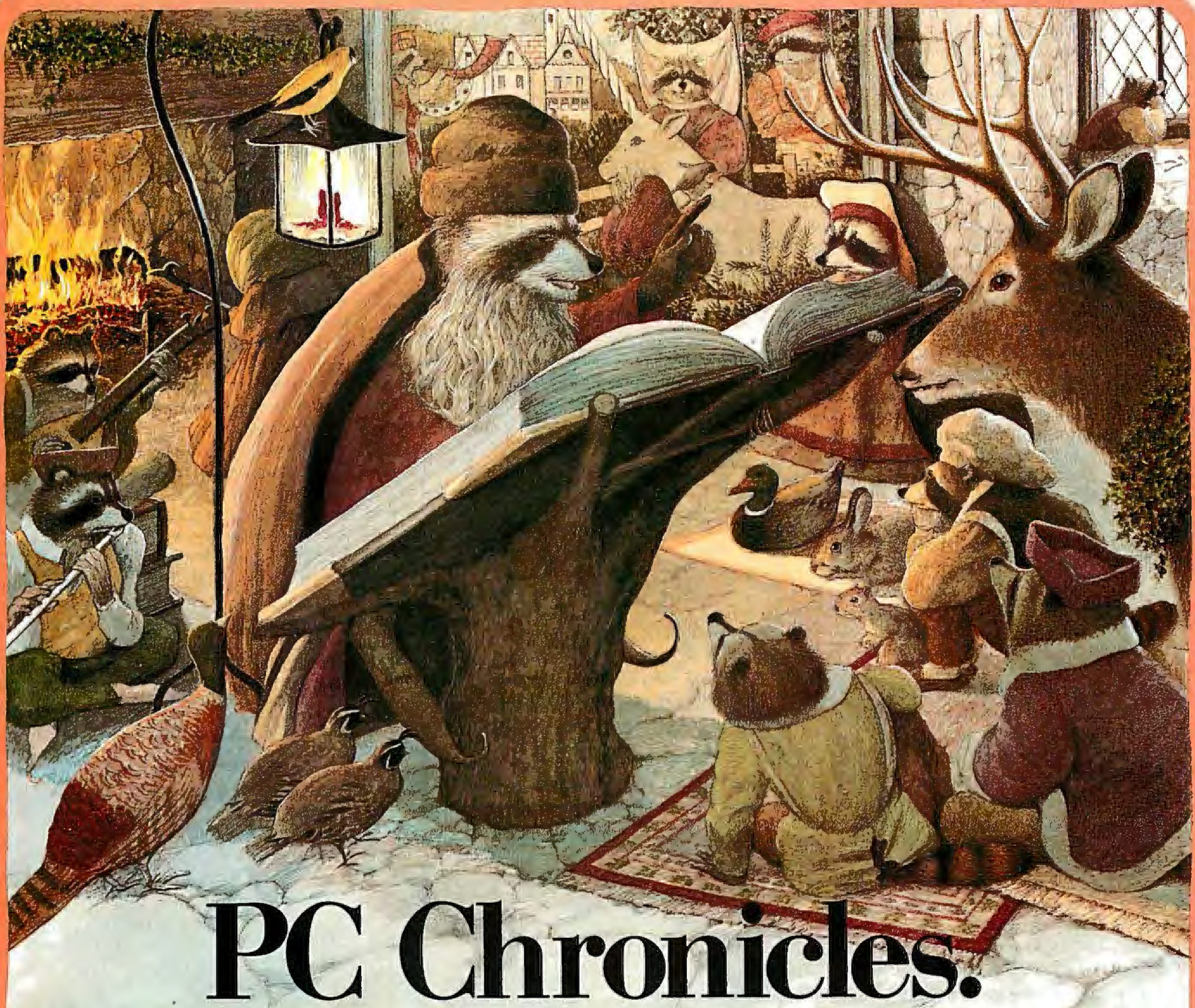

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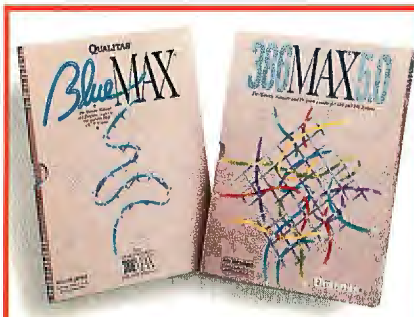

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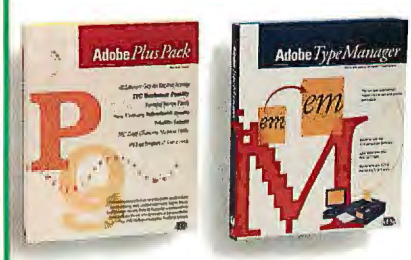

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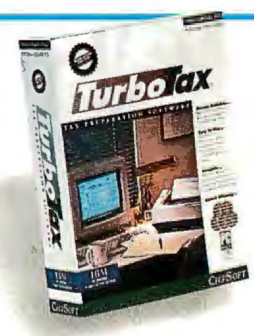

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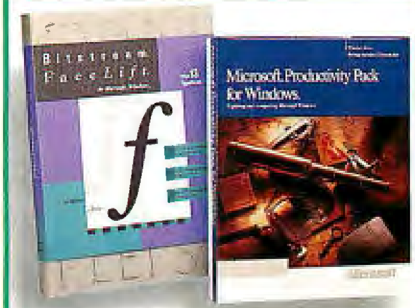

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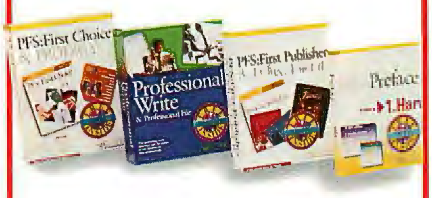

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6397 ▣The Norton Backup 1.1 .... 105.
3146 ▣The Norton Utilities 5.0. .... 125.
3425 ☐Q&A 3.0 .... 229.
Systems Compatibility ... NCP
8215 ▣Outside In 1.0 .... 65.
6564 ☐Software Bridge 4.1 .... 79.
TIMESLIPS ... NCP
2987 ☐Timeslips III 4.0 .... 195.
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7577 ☐PC-FullBak + 1.12 .... 52.
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6791 ☐WordStar Prof. 6.0 .... 279.
XTREE ... NCP
6161 ▣XTreePro Gold 1.4 .... 85.
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5231 ▣Phonics Plus .... 22.
3433 ▣Algebra Plus Vol 1 *(ages 13+)* ... 27.
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True BASIC, Inc. ... NCP
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7595 2 Meg Expansion for HP LaserJet IIP or III.............. 165.
7012 Beyond Memory Board for PS/2 Model 70 *(2 Meg)*............ 169.
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917 LQ-1050 *(136 col., 264 cps, 24 pin)* call
5184 LX-810 *(80 col., 180 cps, 9 pin)*... 185.
7775 Equity LT-286e Laptop......... 1995.
7774 Equity LT-386SX Laptop....... 3069.
5th Generation ... 1 year
7157 Logical Connection Plus 512k.... 599.
Hayes ... 2 years
2307 Smartmodem 2400............ 349.
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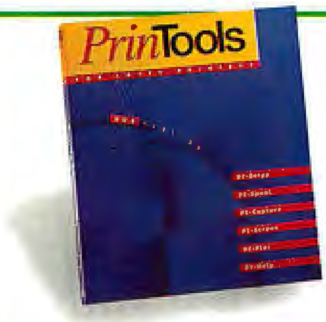

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4542 2400 Baud Internal Modem for PS/2. 229.
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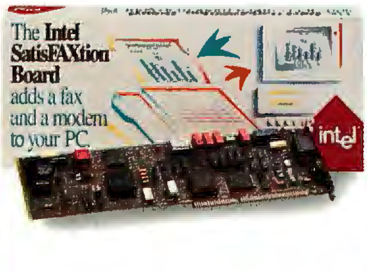

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3292 5¼" DS/HD 1.2Mb Disks *(Qty. 10)* . . . 19.
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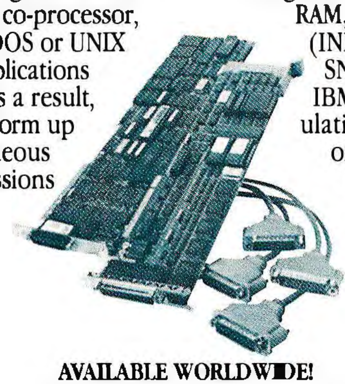

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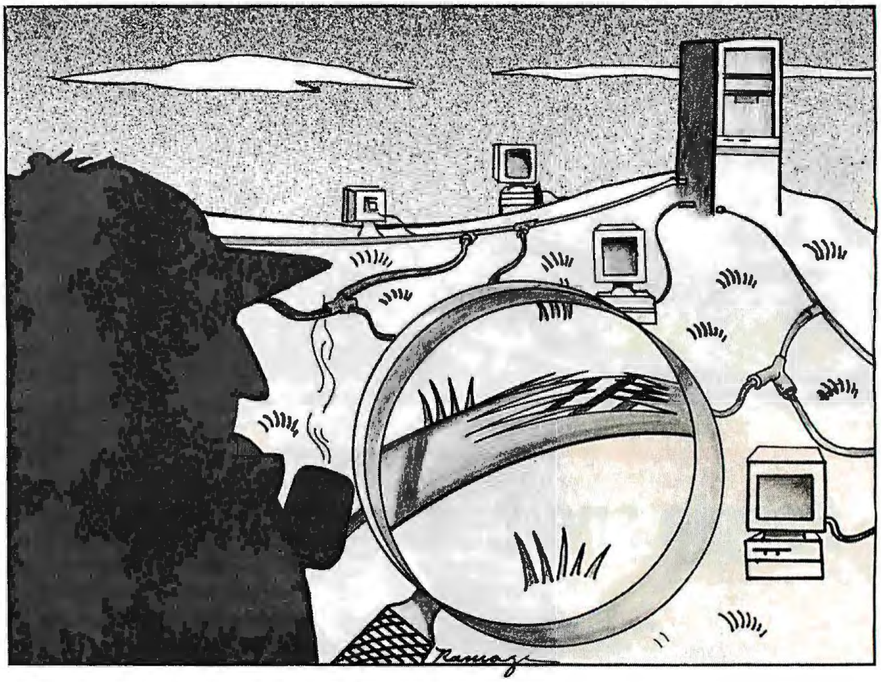
NETWARE TROUBLES

When NetWare works, it works well. But when it doesn't. . .



Something's wrong. Users stream into your office, complaining that the network's not working properly. You walk over to the NetWare server monitor and see the message `User RALPH exceeded outstanding NCP search limit.` Or maybe you see `Warning-FAT entry 0123 marked used with no file.` If your luck has run out, you may see the dreaded `General Protection Interrupt` message—your file server has died. Now what?

Perhaps the problem is more subtle—and more insidious. Your network grows slower and slower as more users run more applications and create more network traffic. Cable or network adapter faults begin to occur intermittently, leaving you in the dark as to why some workstations get dropped from the network or why the network just seems to slow down once in a while for no apparent reason.

NetWare is an excellent network operating system. I use it both at home and at work, and I rarely have trouble. But when there are problems on a NetWare LAN, they can be difficult to diagnose and resolve. You can acquire a hefty toolbox of hardware and software to help locate and solve problems; no single product addresses all the common illnesses that befall a NetWare LAN. Even armed with a bulging toolbox, you will find that common sense and a methodical approach are your best tools when your LAN fails.

The Server Goes South

NetWare tries to recover gracefully when you have to reboot a server with the power switch. But what if it refuses to reboot, or crashes immediately after the reboot? First, look for a failed power supply or uninterruptible power supply (if you don't have one for your server, get one). Power problems are the source of many server failures. One symptom is a server lockup, often with a parity-check message, a `General Protection Interrupt` message, or another fatal error message at the server monitor.

In some situations, the batteries that sustain the CMOS setup information may be the culprit. Put in fresh batteries and reset the CMOS data if you get boot errors. The next thing to look for is a bad RAM chip, a bad motherboard, or a bad hard disk drive controller. Don't spend time looking for the bad chip; users are waiting for you. If you have a medium- to large-size LAN, you should have spare boards—perhaps even a spare server—that you can quickly substitute. If your LAN is small, find a local computer dealer who stocks parts for your server, and make friends with the repair people.

Another culprit may be the server hard disk drive itself. Hard disk drives, especially the high-capacity drives designed for file server use, take a beating, and they're a common point of failure. Be prepared to replace the hard disk drive, if need be. And be sure you've got backup copies of the server data.

As preventive maintenance, or to help solve a disk/file problem on the server, brush up on VREPAIR, Novell's version of CHKDSK. It looks for problems in the NetWare file system, including bad blocks (i.e., disk surface faults) and corrupted file allocation tables.

The steps I've just mentioned are simply commonsense extensions of standard PC repair techniques. The NetWare server is, after all, a PC. What if you decide, however, that the problem lies somewhere in the network itself?

Network-Level Problems

When a server seems to boot OK but doesn't attach itself to the network (e.g.,

ILLUSTRATION: ALFRED RUMAGE © 1991

you see initialization or configuration error messages at the server, or the SLIST command from a workstation doesn't display that server in the list of up-and-running servers), make sure that the server network adapter is securely installed. The next step is to swap another network adapter card into the server. If the adapter (including its cable connector) is not at fault, you will need to substitute a different network cable to the server. If the problem persists, backtrack to the hub/repeater/transceiver/Multistation Access Unit and try a different port or a completely different unit.

A time-domain reflectometer can locate cable faults quickly. A TDR evaluates the electrical characteristics of a wire with sonar-like techniques, telling you cable distance, impedance, susceptibility to noise, and, of course, the distance between you and a short circuit or a break. Microtest's $1495 Cable Scanner is a good TDR that works on twisted-pair and coaxial cable and supports Ethernet, ARCnet, and Token Ring protocols.

Meanwhile, Back at the Server

The sometimes-cryptic messages displayed on the server monitor can convey information, a warning, or an actual error condition. How do you tell? Make sure you have a copy of the Novell *System Errors* manual in a handy place. The explanations that it provides go a long way toward telling you exactly how serious a particular problem is.

You should look critically at recent changes to your LAN if problems crop up. Despite Novell's valiant attempts to make the NetWare installation/setup process friendly and bulletproof, a configuration error during NETGEN can wreak havoc on your LAN at a later time. It is also possible that the NetWare system files have become corrupted. You may need to reinstall NetWare to fix a problem.

What if your file server hasn't crashed but has simply run out of disk space? Or your network has slowed to a crawl and users are complaining? Running out of space or directory entries will idle a server just as quickly as a failed RAM chip. You can use the NetWare utility VOLINFO to monitor disk space and the number of free directory entries. (The number of directory entries, specified at NETGEN time, is the maximum number of directories that you can create on a NetWare 286 server volume. NetWare 386 overcomes this limitation—it dynamically allocates them.) The trick, of course, is remembering to run VOLINFO on a regular basis.

continued

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(800) 526-9675
(602) 971-6464
Inquiry 1105.

The Sniffer $24,000
(includes Compaq
Portable 386)
Network General Corp.
4200 Bohannon Dr.
Menlo Park, CA 94025
(415) 688-2700
Inquiry 1106.

TXD Diagnostic Software................$195
Thomas-Conrad Corp.
1908-R Kramer Lane
Austin, TX 78758
(800) 654-3822
Inquiry 1107.

Tools of the Trade

Performance troubles are the hardest to pin down and solve. They can also be the most expensive. The Sniffer, from Network General, costs about $24,000; a typical unit consists of a Compaq 386/20 portable, capture/analysis software, and a set of protocol interpreters. (Network General sells the capture/analysis/interpreter software separately for $12,500.)

The Sniffer stores message traffic as a disk file and lets you analyze the result. It can inject extra message traffic if you want to place a load on the network to see how it behaves. The software lets you filter and select message traffic by source, destination, and protocol type. You can see inside the messages. You can even see a skyline histogram of message traffic showing frame counts or byte counts by time period, along with network use. The Ethernet version can also reveal certain kinds of frame-level errors.

The Sniffer captures a wealth of data, but analyzing that data is a daunting project. In some cases, it can take several hours and a fairly complicated Lotus spreadsheet to figure out the cause of a performance problem.

Thomas-Conrad's TXD Diagnostic Software (which costs $195 for a site license) operates at a higher level than the Sniffer. TXD uses the built-in diagnostic facilities of IPX/SPX to let you see frame counts, error counts, and other statistics regarding your NetWare LAN. (Internally, IPX/SPX maintains over 200 diagnostic and statistical data items that TXD can reveal.) TXD performs point-to-point tests, as well as broadcast tests, on a one-time or continuous basis. It does a good job of mapping your entire network—even across bridges.

Although TXD can produce a 300K-byte report file for a 50-node network, errors and problems are fairly easy to spot. The TXD manual includes a helpful chapter on specific network problems and suggested solutions.

TXD doesn't see message traffic at the same level as the network adapter; it has to rely on network errors being reflected in the IPX/SPX statistics that it gathers. Once you've located a workstation with excessive error counts, it's not difficult to swap network adapters or cables until you've located the problem.

If the network has a bottleneck—somewhere—and is just slower than it ought to be, you have your work cut out for you. You'll need to become familiar with how many users are concurrently logged on, the applications they're running, and the impact of those applications on the network. Major bottlenecks include the server hard disk drive, memory, processor, and network adapter; the network substrate itself; and even the workstation CPU and network adapter. How to track down these bottlenecks is best left to a future column.

If It Ain't Broke. . .

If you are like me, all you want to do is get the network back up and running smoothly, or just speed it up a bit. But you need a grab bag of tools and techniques—and spare time—to even start the job. I'd like to see a single, simple tool that just watches for major events (e.g., a dead server, a cable fault, low disk space, or excessive traffic) and gives me advice on what I can do about the problem. A monitor program could highlight the problem, suggest steps to take, and provide an on-line reference that I could search. It could even tell me the other tools I need to use to pinpoint the problem. Such a NetWare-oriented tool would go a long way toward making me and my network users happy. ■

Barry Nance manages a 50-node NetWare LAN. The author of Network Programming in C *(Que Publishing Corp., 1990), he is the IBM Exchange editor on BIX—you can reach him as "barryn."*

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

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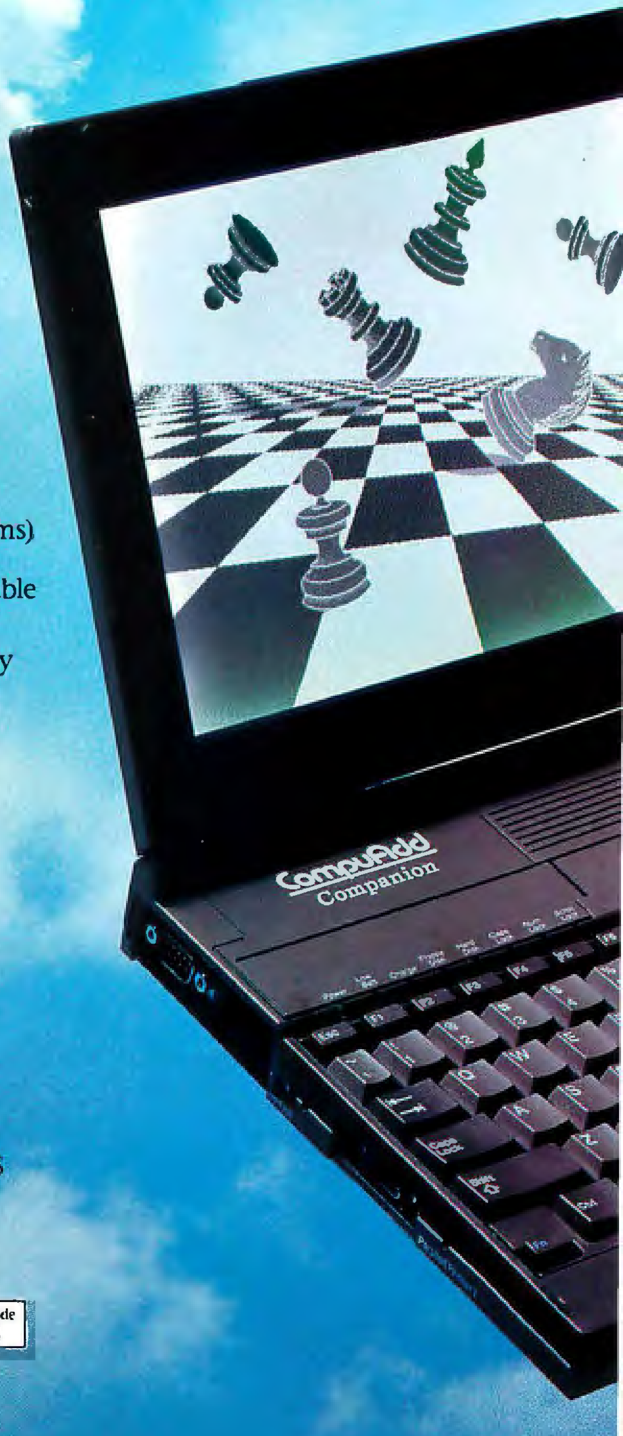

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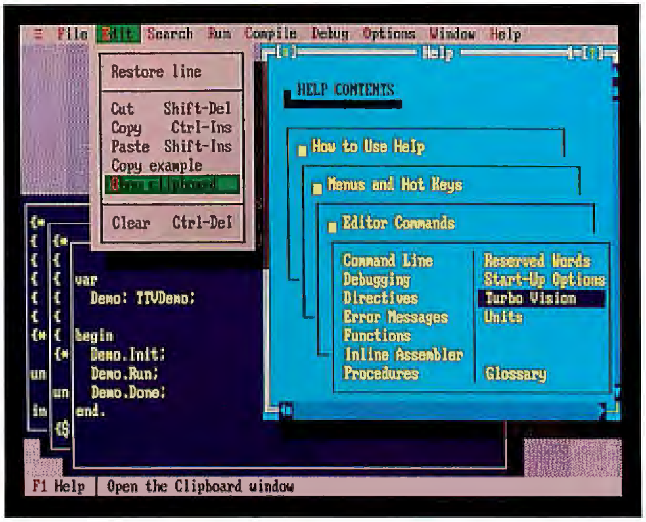


Turbo Pascal 6.0 Almost Adds Windows

Turbo Pascal 6.0 from Borland International lives in a nowhere land between the houses of DOS and Windows. One of the biggest requests Borland gets from Turbo Pascal programmers is for a Microsoft Windows version of the program.

Borland has made some vague commitments toward Windows for its programming languages, and the first signs of these show up in Turbo Pascal 6.0. The biggest single change to the language over version 5.5, which introduced object-oriented programming (OOP), is the addition of a powerful and flexible set of object-oriented tools, called Turbo Vision, for programming text-based windows, menus, and dialog boxes.

Turbo Vision is a truly revolutionary way to program text-based applications for PCs. It lets ordinary programmers make their programs look like those written by professionals (e.g., Microsoft Works or PC Tools). Turbo Vision provides a huge library of windows, menus, dialog boxes, and other interface features for the programmer to draw on.

As an example of their power, a program shorter than 200 lines can be used to open up multiple windows, each showing the text of any disk file. Any number of these windows can be opened at once, and they all are movable, resizable, and scrollable. They can be controlled by mouse or with the keyboard. The same program also includes menus and a status line with items selectable by pointing and clicking. The user interface is consistent, so that applications written using Turbo Vision will operate consistently and have the same "look and feel."

Programming Turbo Vision requires a good understanding of OOP principles, as well as an understanding of how an event-driven environment must operate. For that is what Turbo Vision is: an event-driven environment, just like Microsoft Windows and the Macintosh user interface. Fortunately, Borland does a fair amount of hand-holding in the manuals to get new users up to speed, both in OOP and in how to make use of Turbo Vision. But don't expect to get up to speed too quickly. In its own way, Turbo Vision is almost as complex as Microsoft Windows.

Turbo Pascal 6.0 also has a new integrated development environment. Similar to the one in Turbo C++, it allows multiple windows with different files to be open at once. Not too surprisingly, the interface looks like it was created using Turbo Vision and has the same status lines, background, menus, and windows. It operates quickly and retains all the Control and editing keystroke combinations of the previous version. I found the ability to work with multiple files at once and use a mouse helpful.

An in-line assembler lets programmers enter assembly routines using real assembly instructions rather than having to enter hexadecimal codes, as previously. Turbo Pascal 6.0 has better support for linking in object files, making it easier to add assembly routines of all kinds.

Other new features make Turbo Pascal even more suitable for use as a professional, robust language for developing DOS applications. One of these is a command-line compiler that works in protected mode on 286 and 386 systems and makes use of all the extended memory in your system to let you compile really big applications. This is available only in the Turbo Professional package, however.

Borland has also added a few new compiler directives. The most significant one causes the compiler to generate 286 code rather than generic 80x86 code. This results in smaller programs that run only on 286 or 386 systems. No check is made, so such applications will just crash on 8086-based computers.

Turbo Pascal 6.0 is a welcome extension to the line. It introduces powerful object-oriented and event-driven interface features to programmers, while continuing to improve the overall performance and effectiveness of the language. Making use of Turbo Vision will be good practice for any future version that may let us program in the even more complex Microsoft Windows environment.

— ***Owen Linderholm***

THE FACTS

Turbo Pascal 6.0
$149.95

Turbo Pascal Professional 6.0 (with Turbo Assembler, Turbo Debugger, and Turbo Profiler)
$299.95

Requirements:
IBM PC, PS/2, or compatible with 512K bytes of RAM.

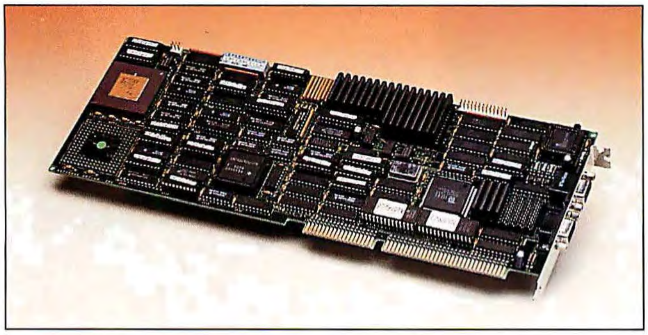
Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 1163.

High-End Graphics for the Frugal

If you have the uneasy feeling that your speedy 386- or i486-based system isn't quite as fast as you expected, you've probably run into a phenomenon that might be termed "graphics indigestion." With today's emphasis on graphics-based applications (e.g., Windows 3.0 and OS/2), it's become increasingly evident that standard VGA cards are a drain on system speed. Since they share CPU cycles with your application, they slow everything down.

Faster graphics cards, such as those based on the 8514/A graphics standard, haven't exactly taken the market by storm, primarily because they are expensive and difficult to install. Graphics cards based on Texas Instruments' burly TMS34020 graphics processor have been available for a few years, but you've had to pay a high price for the power, with even the lowest-priced versions tipping the budget scales at about $2500 each.

With the introduction of its **Volante AT1000** board, National Design has lowballed the competitors with a 34020-based graphics card that retails for a relatively paltry $995. The preproduction board I tested brought a new dimension to Windows 3.0 (as well as other graphics applications), giving me 1024- by 768-pixel resolution and 256 displayable colors on my 8514/A-compatible monitor. But what was most dramatic was the overall increase in graphics speed. When I opened several windows and ran concurrent graphics applications, the display speed didn't slow down the way it would with a standard VGA board.



THE FACTS

Volante AT1000
$995

Requirements:
IBM AT or compatible with a free 16-bit ISA slot.

National Design, Inc.
9171 Capital of Texas Hwy.
Houston Building, Suite 230
Austin, TX 78759
(512) 343-5055
Inquiry 1164.

The Texas Instruments Graphics Architecture that's the heart of 34020 power (and compatibility) is a standard application interface that allows applications to upload all graphics code to the Volante board, speeding up the graphics and leaving your system's main CPU to do what it does best. As boards based on the 34020 (and its lower-cost cousin, the 34010) become available, TIGA drivers are slowly becoming more prevalent. The AT1000 comes with drivers for X Unix Windows, AutoCAD, and Windows 3.0; and you'll see more drivers coming down the pike soon.

Installing the Volante was a bit more involved than installing a standard VGA board. A DIP switch controls interrupts and I/O address, and there's quite a bit of support software, although the installation utility is mainly automatic. The Volante also incorporates a VGA controller for applications that don't use TIGA or 8514/A, and you must run a utility that switches the board to TIGA.

To get 34020 power in a low-cost board, you have to make some compromises. The AT1000's 1024- by 768-pixel mode does rely on interlacing the display, meaning there is a discernible flicker. But I didn't find it objectionable. National Design has a higher-end board, the AT1200, that uses a noninterlaced display, but it costs $2495. (A VMEbus version is also available.)

Of course, you'll need an 8514/A-compatible monitor to go along with your AT1000, but monitor prices have come down dramatically in the past year. All in all, the Volante AT1000 is a harbinger of the next generation of graphics boards that bring true graphics power to the PC platform. VGA, step aside.

—*Stan Miastkowski*

The T1000 Slims Down

Most of the current crop of trendy little notebook computers weigh about the same, cost about the same, and sport the same standard features. So why look at the **Toshiba T1000LE**? Well, for years my road-time companion has been the 10-pound T1000 laptop, and we've always gotten along well. It's now time to lighten my luggage by trading a laptop for a notebook, and I thought it would be nice to stay in the same respected family. Given that I was in for few surprises, my main considerations were power and quality of the display.

Incidentally, the T1000LE weighs 6.5 pounds and has 1 megabyte of RAM, a 20-MB hard disk drive, and a 3½-inch floppy disk drive—all you need to keep working on the go. It also comes with an AC adapter and one internal rechargeable nickel-cadmium battery pack. DOS 3.3 is installed in ROM. You can add the usual extra RAM (up to 9 MB total), a replacement battery pack, an external 5¼-inch floppy disk drive, and a 2400-bps modem.

The T1000LE supports VDISKS (virtual disks), which let you use conventional and expanded memory to simulate a disk drive. The advantages include increased speed and power savings. The system supports the standard DOS VDISK, as well as Toshiba's own Hard RAM (actually, CMOS RAM). The difference between the two is that Hard RAM will save its contents even when power is turned off—unlike VDISK, which loses all data when power is lost. Hard RAM uses expanded memory, and you set it up using the simple utility program.

At the core of the T1000LE is the 8-bit CMOS Intel 80C86 running at 9.54 or 4.77 MHz. The ability to switch to slow speed came in handy as a power-saving feature, although it didn't buy me much time since I'd already run the battery down. Indicator lights along the front of the unit resemble those on its higher-end cousin, the T2000SX. The battery indicator lights glow green when all is well, but they switch to amber when you're running low or flash red when you're really running out of power. There's also an audible beep, but you can turn it off as a simple way to save power.

The display is a 640- by 400-pixel sidelit supertwist LCD with CGA-compatible graphics. I found it to be adequate—at least it's a vast improvement over the T1000. I was able to tolerate the display for hours at a time, as well as read it under poor lighting conditions.

If I were purchasing this system for writing on the road, I'd opt for the second battery pack, which goes where the optional modem goes. Of course, I'd like to have both modem and second battery pack, but an external modem does just fine.

After using the T1000LE extensively for a week, I couldn't make it miss a beat. Running it at full speed (9.54 MHz) without implementing any other power-saving features, it lasted for 3 hours on battery power alone, and I could fully recharge it overnight. I guess I have talked myself into it—this one's a keeper.

—*Anne Fischer Lent*

THE FACTS

Toshiba T1000LE
$2499

Options:
2400-bps internal modem, $349

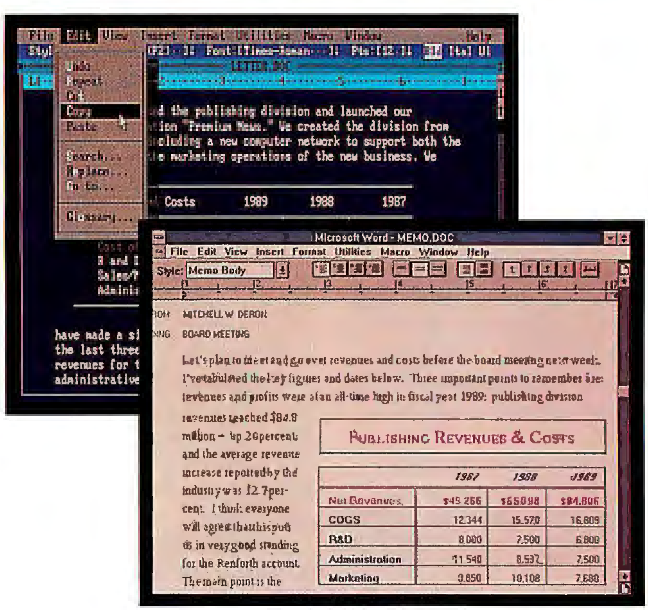
Toshiba America Information Systems, Inc.
Computer Systems Division
9740 Irvine Blvd.
Irvine, CA 92718
(714) 583-3000
Inquiry 1165.

A Pair of New Words from Microsoft

With the release of **Word 5.5** and **Word for OS/2**, along with the existing Word for Windows, Microsoft is mounting a three-pronged attack on market-leader WordPerfect. Word 5.5 takes the bold step of tossing out the old user interface in favor of a new, incompatible, but more standardized appearance and behavior. With this new version, the labels have changed, but the concepts have not. At the same time, Word for OS/2 is only the second full-fledged word processor for that much-maligned "operating system of the nineties" (DeScribe was the first).

The previous release of Microsoft Word for DOS, version 5.0, used the same menuing scheme as all releases dating back to 1983, a two-level descending tree that sat at the bottom of the screen and was activated with the Escape key. In version 5.5, Microsoft has implemented a character-based interface, compatible with the Common User Interface, that ties the three PC versions of Word (i.e., DOS, Windows 3.0, and Presentation Manager) together into a common fold, with compatible file structures.

Version 5.5 lets you access pull-down menus at the top of the screen with the Alt key and includes terms familiar to anyone who uses a graphical user interface: File Open, Edit Paste, and so on. In fact, the top-level menus are identical to those in Word for Windows and Word for OS/2. Once inside the menus, however, many dialog boxes contain options and syntax borrowed



THE FACTS

Word 5.5
$450; upgrades: $50 from version 5.0; $75 from versions 1.0 through 4.0

Word for OS/2
$495; upgrades: $50 from Word for Windows; $150 from Word for DOS

Requirements:
Word 5.5: A DOS system with 384K bytes of RAM (512K bytes is recommended).
Word for OS/2: OS/2 1.21 or higher.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
Inquiry 1166.

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For Europe, circle 266 on Reader Service Card

For Americas & Pacific, circle 267 on Reader Service Card from earlier versions of Word. The result is a hybrid that is surprisingly easy to use.

Microsoft is also hedging its bet for loyal Word users. The company ships two complete versions of Word for DOS in each package: one with the new interface, and one with the old. You can share files between the two, but you have to translate macros. In addition, Word 5.5 lets you selectively preserve some elements of the old interface (e.g., function-key assignments).

Version 5.5 offers few new features because Word was already rich with them. One important addition is a "ribbon" at the top of the screen that shows at a glance which style sheet and fonts are in use. It lets you change the settings by pointing and clicking, without using the menus.

In Windows for OS/2, Microsoft is providing a logical upgrade path from the character-based interface of version 5.5 through Word for Windows to Presentation Manager. In fact, Word for OS/2 is virtually indistinguishable from the Windows version, with the same three-dimensional look and feel and switchable ruler and ribbon displays that let you quickly switch among fonts, styles, and layouts.

What's different? Word for OS/2 is faster and smoother than version 5.5 or (especially) the Windows version. It obviously takes advantage of OS/2's multithreading capabilities; and, of course, you can use OS/2's true multiprocessing to run multiple copies of Word for OS/2. You can also use the OS/2 High Performance File System for even better speed, along with the long filenames.

Overall, the benefit for customers is a reduction of training time to move from version to version. Word offers all the advanced features that power users need, including outlining, indexing, style sheets, an integrated spelling checker and thesaurus, mail merge, page preview, and document management. But individual word processor preferences are highly subjective. Whether the three versions of Word will upset the WordPerfect juggernaut remains to be seen.

—Andrew Reinhardt and Stan Miastkowski

Create and Lay Out Documents with Taste

It's hard to pin a label on **Taste**, a new $150 Mac application from Delta Point, the folks who brought us MindWrite (a word processor) and DeltaGraph (a graphing/plotting application). It seems to be an amalgam of word processor, page-layout application, and database manager.

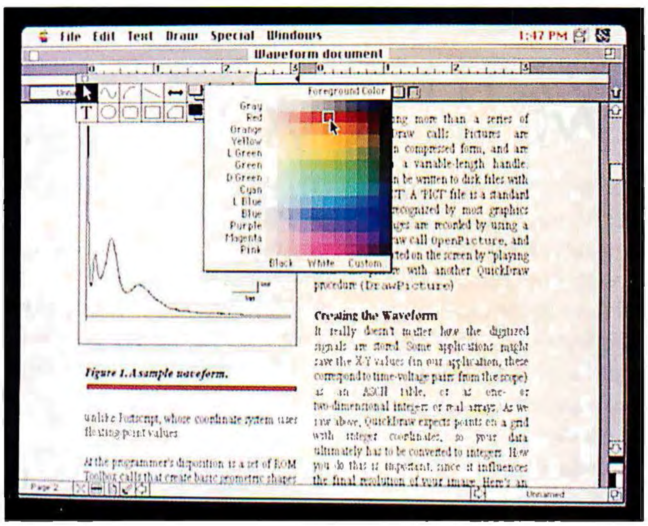
Taste resembles a word processor in that you can write or import text. A menu selection allows you to display a document's invisible characters, which eliminates those maddening problems that occur with embedded control characters when you import a file from another computer. It also does a word count on either the entire document or a selected text block.

As a page-layout application, Taste allows you to import various documents using XTND. Clicking on a layout icon at the bottom of the document window lets you assign the number of columns the document will have, determine if hairline rules separate the columns, and arrange the spacing of the page's columns, headers, and footers.

Taste uses text and draw layers to help you integrate graphics in a document. With a draw module active, you can import EPSF or PICT images and scale them to fit on a page. You can have text wrap around or within a graphic element, and you can draw a colored box around text to highlight it, as in a text box. A page-preview selection lets you view one or more pages at a time, which can be useful for examining portions of the document as a thumbnail layout.

The database portion of Taste is more of a personal data manager: It performs mail merge and can operate as an address book. Taste's address book can dial numbers for you. It can be handy if you don't have a modem connected to your Mac.

I tried Taste 1.0A3 on a Mac IIci with 4 megabytes of RAM, an 80-MB hard disk drive, a SuperMac Technology Spectrum/24 PQD video board, and a 19-inch monitor; a Mac IIsi with 5 MB of RAM, an 80-MB hard disk drive, and an AppleColor RGB monitor; and a Mac Plus with 2 MB of RAM and a 20-MB hard disk drive. It was able to import an Encapsulated PostScript Format (EPSF) file from Adobe Illustrator 3.0 and flow two-column text around it on all the machines. Taste had no problem operating in the 32-Bit QuickDraw environment and printing to a LaserWriter.



THE FACTS

Taste
$149.95

Requirements:
A Mac with 1 MB of RAM and a hard disk drive running System 6.0.2 or higher.

Delta Point, Inc.
200 Heritage Harbor, Suite G
Monterey, CA 93940
(408) 648-4000
Inquiry 1167.

Taste balances three products in one by achieving modest goals. No, it's not a complete database application—nor does it try to be. But it lets you use a database as an address book.

It's not a complete word processor, but it has enough useful tools (e.g., word count) to make it a good one. Taste doesn't pose a threat to either Aldus PageMaker or Quark XPress, but its ability to place EPSF files and add graphics lets you create some good-looking documents at a fraction of the price. If Delta Point can get some of the rough edges out of the product, it will be worth a look by those who need premium output on a small budget. ■

—Tom Thompson

Born not to run.

Citrix's New Multiuser OS/2

OS/2-based workgroup computing without a LAN

■

Jon Udell

Multiuser OS/2? It makes a lot of sense. Throughout its short life, OS/2 has been an operating system with an identity crisis. Billed originally as the heir apparent to DOS and then Windows, OS/2 has so far been unimpressive in that role. Mainstream PC users now stampeding to Windows 3.0 (and eagerly awaiting DOS 5.0) clearly prefer incremental change to the quantum leap that OS/2 represents.

More recently, the action has been shifting to the LAN arena. Here, OS/2 gets billed as a network operating system and as the platform for server-based applications with which DOS and Windows clients will communicate. In the long run, you'll likely see both kinds of OS/2 systems: high-end desktop workstations and network servers.

But there's a third way. Citrix Systems, a team of IBM refugees led by OS/2 guru Ed Iacobucci, has extended OS/2 into the multiuser territory occupied by Unix, Xenix, QNX, Theos, and a variety of DOS-based operating systems. And the fledgling company has taken the right approach. Citrix Multiuser starts with OS/2 1.21 sources licensed from Microsoft and weaves in a terminal subsystem, user-oriented security, resource auditing, and the ability to address up to 256 megabytes of memory.

Citrix comes on four disks—one less than OS/2 1.21 (and dozens fewer than SCO Unix). How can Citrix's beefed-up OS/2 be smaller than the standard IBM/Microsoft version? There is one conspicuous omission: Presentation Manager (PM). You won't be running WingZ, PageMaker, or Corel Draw under Citrix Multiuser. You'll have to stick with character-mode applications like WordPerfect, Lotus 1-2-3, Word, HyperAccess, Oracle, Paradox, and R:base.

Granted, these aren't the hottest programs available for OS/2. But, in combination with custom software, they're a good fit for the needs of small- and medium-size retail and service businesses. If that's your game, glamorous bit-mapped graphics may not be high on your list of priorities. You want low cost per seat, central control, simple installation and administration, and rock-solid stability. That's what Citrix has to offer.

Setting Up Shop

I installed Citrix Multiuser on a 12-MB Compaq Systempro equipped with an eight-port Digiboard PC/Xi multiport adapter. The system uses unmodified OS/2 device drivers and should therefore support any multiport board for which an OS/2 driver exists. Citrix doesn't introduce any special disk utilities: You use FDISK and FORMAT, just as you normally do under OS/2.

The boot partition does have to be a High Performance File System partition, since Citrix (like LAN Manager) uses extended attributes to track access rights on a per-file, per-user basis. Secondary partitions can be file allocation table or HPFS, but Citrix can secure only HPFS partitions.

Citrix supports a variety of PCTERM terminals (i.e., terminals with standard 84- or 101-key keyboards that transmit PC scan codes instead of ASCII characters). Terminals for which Citrix provides drivers include the ADDS 2025, the IBM Model 3151, the Kimtron KT-70, the Link Technologies MC2 and MC5, the TeleVideo Systems Models 950 and 965, and the Wyse WY-150.

The `config terminal` utility, a full-screen interactive program that works like all the Citrix configuration tools, makes quick work of tweaking RS-232C communications settings. When all goes well, the terminal you're configuring wakes up and presents a `Login:` prompt.

When it does not—as happened to me once—you've got some detective work to do. In general, Citrix makes setting up terminals at least as easy as the multiuser DOS systems I've seen—and that is, in my opinion, far easier than with Unix.

On the other hand, all these systems depend on cables and connectors, just as LANs do. Tracking down a faulty component isn't necessarily any easier with a multiuser system than with today's modular LANs.

PCTERM isn't the only terminal option. Teco, a Taiwanese manufacturer, has developed a new species of terminal that implements some of the OS/2 video I/O functions in its ROM. Citrix provided me with an engineering prototype of this terminal, which should be available this quarter at a list price of about $800. The VIO protocol speeds operations like scrolling, since the host can simply send a `VioScrollUp` command to the terminal instead of a screen of data.

Citrix says additional optimizations reduce the load on the host and lessen communications traffic. For example, if an application calls `VioGetBuf` to get the address of the logical video buffer, changes the contents of that buffer, and calls `VioShowBuf` to redisplay it, the terminal and host will conspire to exchange only the data needed for the update.

Teco terminals also support color text. Color is important, even in character mode. Color-coded data-entry screens can make life a lot easier for the folks who have to use them.

I'm willing to buy Citrix's argument that there's a sizable market for character-only multiuser systems, and I applaud the support for color text. I'm troubled, though, by the lack of mouse support. If you think that an effective graphical user interface (GUI) requires a bit-mapped screen, take a look at a program like FoxPro, which works just like FoxBase+ for the Macintosh.

Watching FoxPro users, I've noticed that those without mice seldom take advantage of one of the program's best features: the ability to interactively resize and reorder columns of data. A version of FoxPro for OS/2 (there isn't one yet, by the way) would lose much of its luster without mouse support. Some PCTERM terminals do come with extra serial ports that can drive mice, and Citrix agrees that it would be a good idea to put that capability to use in a future release.

continued

PHOTOGRAPHY: PAUL AVIS © 1991

Multiuser OS/2 from Overseas

Stan Miastkowski

As unique as it is, Citrix Multiuser is not the only player in the field. In fact, a company based in France has had a multiuser OS/2 available since January 1988. Memsoft now has set up a sales office in the U.S. (One Park Place, 621 Northwest 53rd St., Boca Raton, FL 33487, (407) 997-6655). It is now trying to carve out a market niche for its product, called PolyMod2.

Sales manager Gerard Gatt told me that Memsoft takes "a *very* different approach" from Citrix to bringing multiuser capabilities to OS/2. Where Citrix "reengineers OS/2," PolyMod2 exists as "a layer over OS/2"—as a separate program. Gatt says that this lets Memsoft's product "work with any version of OS/2, from 1.0 to the upcoming 2.0."

At first blush, PolyMod2's features and abilities look nearly identical to Citrix Multiuser's, letting you access multiple character-based OS/2 applications from ASCII terminals. But PolyMod2 does add some intriguing bells and whistles to the basic concept.

Gatt underlines PolyMod2's connectivity features, letting networked PCs (and even Macs) connected to a PolyMod2 OS/2 system run OS/2 applications using a 40K-byte TSR program. Even more interesting is that Windows 3.0 users can dedicate a window to PolyMod2's emulator and run OS/2 as a windowed application.

In addition, PolyMod2 can interconnect multiple OS/2 machines without the need for a network. This lets the system administrator equalize the load on the system, dedicating OS/2 machines to processor-hungry applications. Furthermore, PolyMod2 can connect those multiple OS/2 machines via modem, resulting in a low-cost wide-area network.

PolyMod2 is slightly more expensive than Citrix Multiuser. A 10-user system sells for $1600 (and you need a copy of OS/2). It also requires an additional 2 megabytes of RAM over OS/2 requirements. (The usual total is 6 MB.)

Memsoft has been around since 1979, first developing MEMDOS, a LAN for Apple IIs. A privately owned company with 64 employees, it grossed a comparatively small $10 million last year. Gatt claims that PolyMod2 is installed on over 10,000 OS/2 systems in France, representing (he says) 40 percent of that country's total installed base of systems running OS/2.

Ironically, Citrix's big-bucks rollout has the potential of increasing the overall market share for OS/2 multiuser systems, giving Memsoft a push in its hunt for market penetration.

Gatt also had some interesting things to say about the worldwide OS/2 market, confirming repeated rumors that OS/2 is considerably more popular outside the U.S. than in. He says that overseas, companies are "buying OS/2 as a solution" because users have a "longer-term orientation" than those in the U.S., expecting to "use existing systems for 5 to 10 years." Gatt also says that because Windows 3.0 is perceived as a "short-term solution," it hasn't generated much interest overseas.

Stan Miastkowski is a BYTE senior news editor. He can be contacted on BIX as "stanm."

Batten Down the Hatches

Citrix's security subsystem models itself loosely on that of LAN Manager: The same user, group, administrator, and guest categories apply. Tight security is the norm for users. The default group membership confers rights to a home directory (`\usr\username`) and to a minimal set of OS/2 and Citrix utilities. With `config access`, you can elaborate those rights as needed. It represents files and directories in outline form—like a character-mode version of OS/2's File Manager. As with LAN Manager, you can control rights to directories or to individual files.

Wild cards add a nice flexibility to the basic scheme. Suppose you've got the groups Accounting and Sales and a user called Joe. For a given directory or file, you can adjust rights for Joe.Accounting (Joe, when using his Accounting log-in), *.Accounting (everyone in Accounting), or Joe.* (Joe, regardless of how he logged in).

Names of directories and files with implicit (i.e., inherited) rights show up between curly brackets; names with explicitly assigned rights appear between square brackets. That's helpful when you're trying to sort out transitive relationships. Another convenience is that `config access` can always offer a pick list of user and group names, so you need never type the names.

Another tool, `config profile`, collects information about users and groups: passwords, resource limits, resource auditing, and log-in restrictions. As you'd expect, a user's profile inherits from a group profile and can then be customized. Adjustable limits include the number of log-ins, sessions, threads, file handles, and semaphores, and the amount of (virtual) memory. However, Citrix doesn't enable an administrator to limit the amount of disk space that a user or group can consume. A profile includes a "first program" field that defaults to a character-mode Program Selector (remember OS/2 1.0?).

If you want to create a single-purpose user account, you can substitute the name of an application. For example, when I specified Joe's first program as `123.exe`, Joe could do nothing except run Lotus 1-2-3. When Joe quit 1-2-3, Citrix logged him off. Generally, you'll want to leave the Program Selector in place and use per-user start-up files to tailor users' environments.

Citrix adds an interesting wrinkle to system security. A number of OS/2 application programming interface functions are secure under Citrix Multiuser. That's because even with strict user-oriented security, a program could conceivably become a rogue. Using an OS/2 function like `DosOpen` with the right (or wrong!) arguments, a program could gain unrestricted access to the disk. Citrix therefore protects such entry points. If a program must legitimately use them, you can create a "user alias" for it and grant the necessary API access by way of that alias.

Pile On the Programs

I tested a number of programs, including Brief, Slick, WordPerfect, HyperAccess 5.0, Lotus 1-2-3, and Paradox. I also ran programs I compiled with the Microsoft C 6.0 and JPI Modula-2 compilers. Although everything ran without complaint, I did encounter a few quirks when transplanting single-user programs to the multiuser environment. It's sometimes necessary to distinguish between files that can be shared by all users and those that must be duplicated for each user. That's true when you run an application on a LAN, too; finding out what belongs where can involve a good bit of trial and error.

VIO can be an issue as well, depending on how a program handles the screen. When I compiled and ran a JPI

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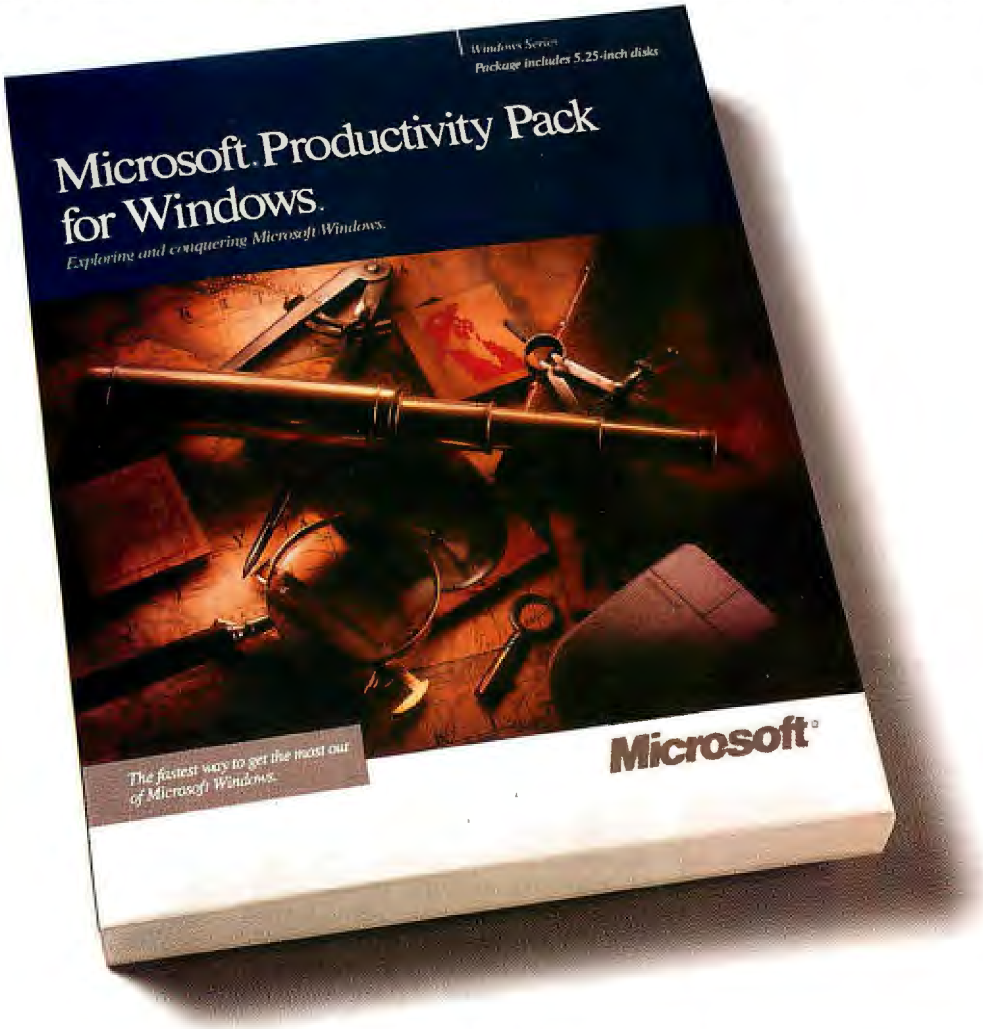

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demonstration program that uses character-mode graphics to simulate automobile traffic, Citrix slowed noticeably. Three concurrent instances of the simulator brought the system practically to its knees.

Inspecting the program, I found that it writes characters and attributes one at a time in a tight loop. That's not a problem for single-user OS/2 communicating with the video buffer at bus speed, but for Citrix, which talks to terminals at 38,400 bps or less, it's disastrous.

The solution is to use line- and screen-oriented update routines. Of course, the JPI demonstration is far from a typical Citrix application. Still, some commercial OS/2 applications do operate a character at a time, according to Citrix. Software vendors interested in the multiuser OS/2 market will certainly want to avoid that pitfall.

Hidden dependencies on PM can also cause problems. I had no trouble installing SQL Server and firing up a server process, but I couldn't get any of the associated tools to work with it from another session. Although `saf` (Server Administration Facility) and `isql` (the interactive Structured Query Language interpreter) operate in character mode, they failed to load under Citrix, complaining about a PM-related dynamic link library (DLL).

Apparently, the dependency extends to `dblib`, SQL Server's C library, since a bare-bones test program ran into the same wall. This surprised both me and Microsoft, but not Citrix. In beta testing, the company has come across several such PM dependencies, and it has even implemented PM stubs to enable programs to run in spite of them. As of this writing, Citrix had tested Oracle successfully but had not yet tried SQL Server. Presumably, it will be a candidate for the stub tieatment. Again, software developers interested in Citrix should take note.

Off-the-shelf OS/2 programs also derive unique benefits from Citrix Multiuser. Most notably, they're far more efficient in their use of memory. Although shared DLLs can help conserve memory under single-user OS/2, they typically don't serve that purpose. How often does a user need two instances of Lotus 1-2-3 or Microsoft Word? Under Citrix, however, multiple instantiation of programs is the norm. And the memory saving that shared libraries can realize is dramatic.

Lotus 1-2-3 release 3.0, for instance, gobbles nearly a megabyte of RAM when you start it up. But each successive instance shares an 800K-byte chunk of common code and data, thus requiring only an additional 200K bytes of memory. To put it another way, five copies of 1-2-3 running on five separate single-user OS/2 machines will use 5 MB of RAM; five instances of 1-2-3 under Citrix will use less than 2 MB. That's an impressive feature that current incarnations of Unix and multiuser DOS can't match.

Why Citrix?

In an era dominated by networks and GUIs, Citrix Multiuser may seem like an anachronism. But value-added resellers and consultants who earn their keep delivering packaged business solutions will see it for what it is: a practical option. Clearly, Citrix faces stiff competition. If you require DOS applications, you'll go with a multiuser DOS system. When IBM finishes OS/2 2.0, a future release of Citrix built on top of it could become the multiuser DOS system of choice, but there's no DOS support now.

Likewise, if you're already a Unix expert, I doubt that Citrix will persuade you to switch. While simpler to install and manage, Citrix lacks Unix's rich assortment of tools and applications. Morever, until someone figures out how to make PM work with a remote display, OS/2 (and therefore Citrix) can't hope to compete with Unix's networkable GUI, X Window System.

Nevertheless, I suspect Citrix Multiuser will appeal widely enough to succeed. If you hired me to automate an opthalmologist's office or a small travel agency, I'd seriously consider using Citrix to do the job. Why? Because I'm just the sort of person who'd seek out a middle ground between DOS and Unix. OS/2 has so far proven to be more of an operating system than most individuals need or want. But, as Citrix ably demonstrates, that extra capacity can well serve the needs of a group. ■

Jon Udell is a BYTE senior editor at large. You can reach him on BIX as "judell."

THE FACTS

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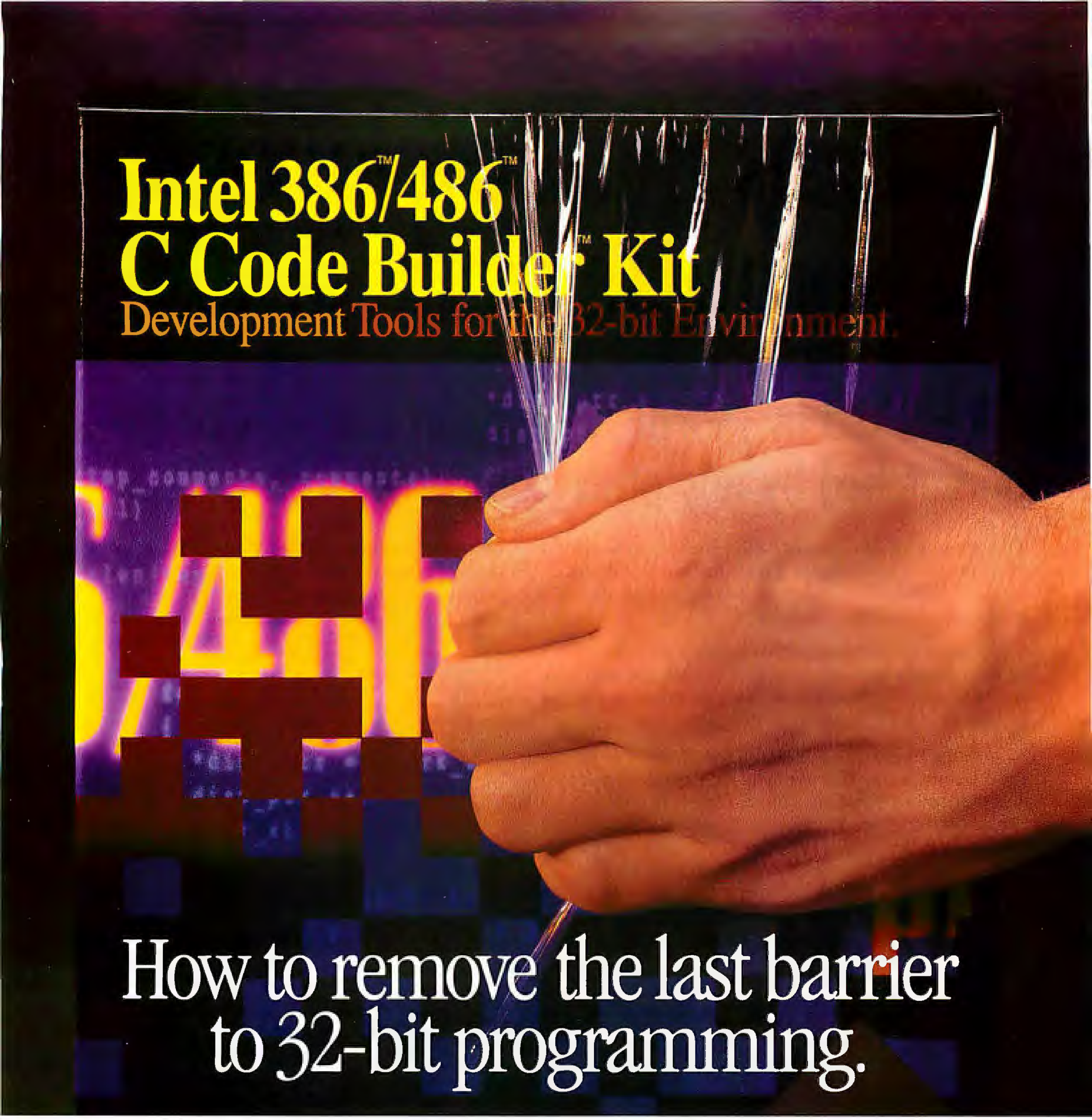

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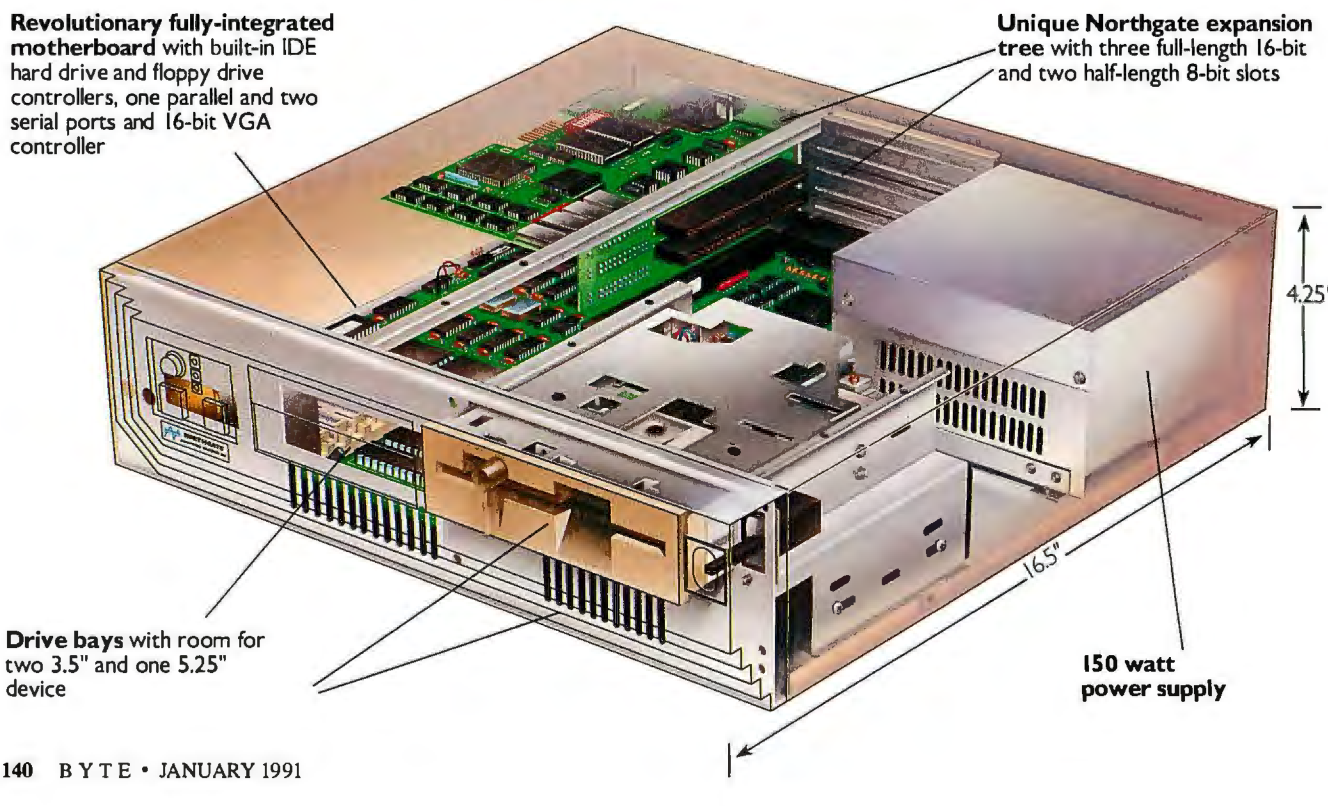

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Please complete all appropriate sections, providing at least two years residence and employment history. If you are self-employed, please be sure to complete section d. **THIS IS NOT A CREDIT AGREEMENT!** One will be sent to you upon authorization of an account. (This Form Must Be Signed To Process Your Order.) All Financed Purchases Are Subject To Credit Approval. **If You Have Any Credit Questions, Please Call For Assistance.** Thank You!

A married person may apply for individual credit. I am applying for (check one box, please):

☐ JOINT CREDIT with another person. Complete entire application.
☐ INDIVIDUAL CREDIT complete only individual section.
☐ INDIVIDUAL CREDIT but rely on income of another. Complete entire application.

*If you are a married Wisconsin applicant, you must provide your spouse's information as indicated, even though your spouse may not be signing the contract.

NOTICE TO WISCONSIN APPLICANTS
You must disclose your marital status:
☐ married
☐ unmarried
☐ legally separated

a. Personal Information

NAME ____________ HOME PHONE (____) ____________
SOCIAL SECURITY NUMBER ____________ DATE OF BIRTH ____ / ____ / ____
PRESENT ADDRESS ____________ CITY ____________ ST ______ ZIP ______
DATE OF RESIDENCE MO. ______ YR. ______ BUY☐ RENT☐ OTHER☐ ____________
PREVIOUS ADDRESS ____________
EMPLOYER ____________ DATE OF EMPLOYMENT MO. ______ YR. ______
MONTHLY GROSS SALARY $ ____________ BUSINESS PHONE (____) ____________
PREVIOUS EMPLOYER ____________ DATES OF EMPLOYMENT ______ TO ______

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as basis for repaying the obligation.

ADDITIONAL MONTHLY INCOME $ ____________ SOURCE ____________

b. Credit Information

PLEASE TELL US IF YOU HAVE: CHECKING ACCOUNT (Y/N) ______ SAVINGS ACCOUNT (Y/N) ______
BANK LOAN (Y/N) ______ HOW MANY? ______ VISA (Y/N) ______ HOW MANY? ______
MASTERCARD (Y/N) ______ HOW MANY? ______ FINANCE COMPANY LOAN (Y/N) ______ HOW MANY? ______
DEPT. STORE CHARGE CARD (Y/N) ______ HOW MANY? ______ CREDIT UNION ACCOUNT (Y/N) ______ HOW MANY? ______
OTHER MAJOR CHARGE CARDS (Y/N) ______ HOW MANY? ______

c. Joint Applicant's Personal Information

JOINT APPLICANT'S NAME ____________ HOME PHONE (____) ____________
SOCIAL SECURITY NUMBER ____________ DATE OF BIRTH ____ / ____ / ____
ADDRESS ____________ CITY ____________ ST ______ ZIP ______
DATE OF RESIDENCE MO. ______ YR. ______
JOINT APPLICANT'S EMPLOYER ____________ DATE OF EMPLOYMENT MO. ______ YR. ______
MONTHLY GROSS SALARY $ ____________ BUSINESS PHONE (____) ____________
NAME AND ADDRESS OF NEAREST RELATIVE NOT LIVING WITH YOU ____________
____________ RELATIONSHIP ____________

d. Self-Employment Information

BUSINESS NAME ____________ BUSINESS PHONE (____) ____________
TYPE OF BUSINESS ☐ Proprietorship ☐ Partnership ☐ Corporation IN BUSINESS SINCE ____________
YOUR ANNUAL INCOME FROM BUSINESS Gross $ ____________ Net $ ____________
PERSONAL BANKER'S NAME ____________ BANKER'S PHONE (____) ____________

e. Customer Authorization

I authorize Northgate Computer Systems or its assignees to investigate credit records and to report my performance hereunder to credit agencies. I hereby certify that the following information is furnished to you for the purpose of obtaining credit and is true and correct of the best of my knowledge and belief. There are costs associated with the use of this credit card. To obtain more information about these costs, call us at 1-800-548-1993 or write to P.O. Box 59080, Minneapolis, MN 55459-0080.

NY—A consumer credit report may be requested in connection with this application or in connection with updates, renewals or extensions of any credit granted as a result of this application. If I subsequently ask for this information, I will be informed whether or not such a report was requested and, if so, the name and address of the agency that furnished the report.

OH—THE OHIO LAWS AGAINST DISCRIMINATION REQUIRE THAT ALL CREDITORS MAKE CREDIT EQUALLY AVAILABLE TO ALL CREDIT-WORTHY CUSTOMERS AND THAT CREDIT REPORTING AGENCIES MAINTAIN SEPARATE CREDIT HISTORIES ON EACH INDIVIDUAL UPON REQUEST. THE OHIO CIVIL RIGHTS COMMISSION ADMINISTERS COMPLIANCE WITH THIS LAW.

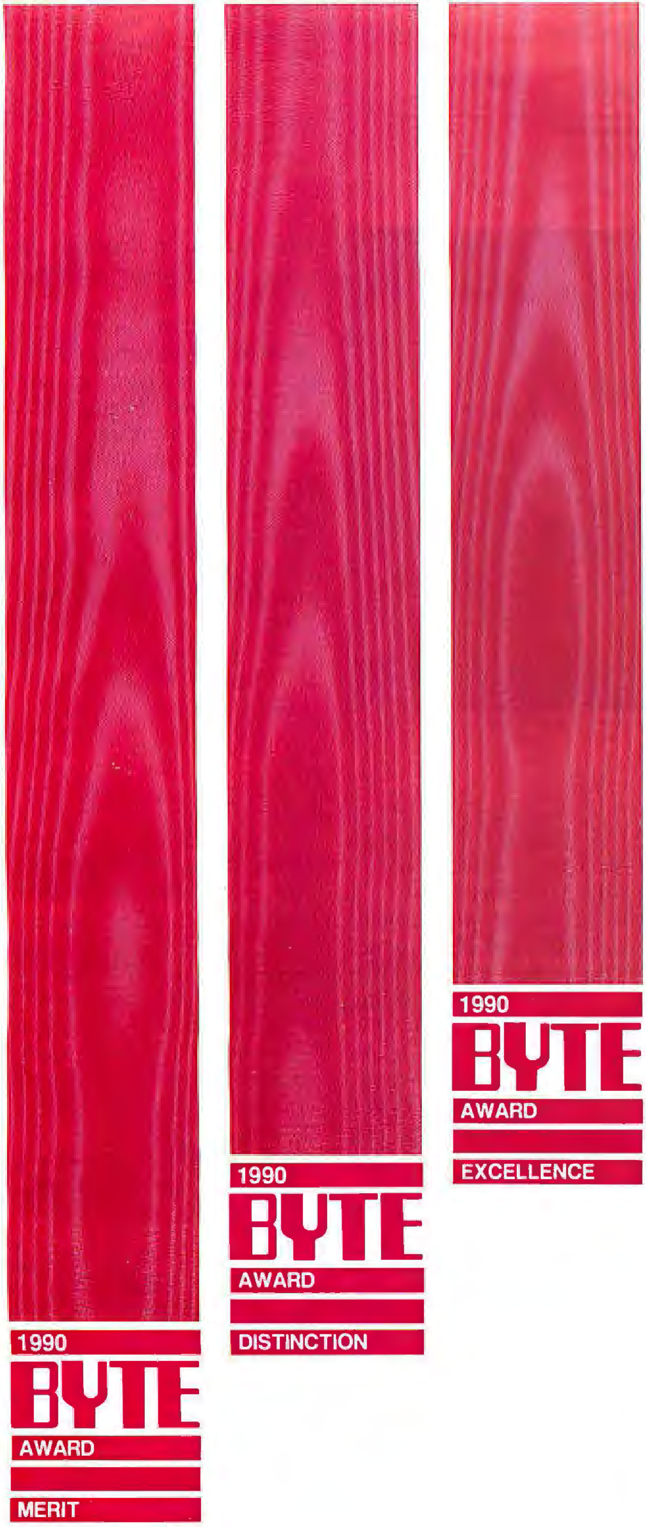
APPLICANT'S SIGNATURE ____________ DATE ____________

JOINT APPLICANT'S SIGNATURE ____________ DATE ____________

FOR MARRIED WISCONSIN APPLICANTS:
I acknowledge that the obligation described herein is being incurred in the interest of my marriage or family.

BUYER'S SIGNATURE ____________ DATE ____________

*This is a credit application. Upon approval, a credit agreement will be sent to you for your signature. This agreement must be signed and returned to activate your account.



COVER STORY

THE 1990 BYTE AWARDS

The Winnahs!

More of them.

New category.

The economy may be slowing down, but 1990 proved that there has been no letup in the number of exciting, innovative new products and technologies for personal computers. In the past year, we've seen an extraordinary leap in the processing power of systems across every major platform, significant upgrades to proven products at lower prices, and emerging product categories that are opening up new applications to personal computers.

Most significantly, standard DOS faced its most serious challenges ever. Unix became more attractive—in looks, price, and ease of use—to rank-and-file end users. Apple introduced powerful systems on the high end and affordable ones on the low end. And Windows 3.0 sold over a million copies. Clearly, the personal computer industry is still a fascinating, dynamic enterprise.

The BYTE Award recipients are chosen by BYTE editors based on these criteria: It is a product or technology that is innovative, that has significant impact on its respective market niche, that advances the state of the art, or that provides a superior price-to-performance ratio. We have three award categories, which, in order of importance, are Awards of Excellence, Awards of Distinction, and Awards of Merit, the last of which is new this year. Award categories for each product listed here were assigned according to vote totals. Of all the products nominated, BYTE editors voted 67 worthy of awards—three times the number chosen last year. The new category accounts for only part of the number. The rest we attribute to a richer lineup of candidates.

Whatever your preferred computing platform, you'll find something to cheer about in the list of 1990 BYTE Award winners.

PHOTOGRAPHY: MURRAY ALCOSSER/THE IMAGE BANK © 1991

1990 BYTE AWARD

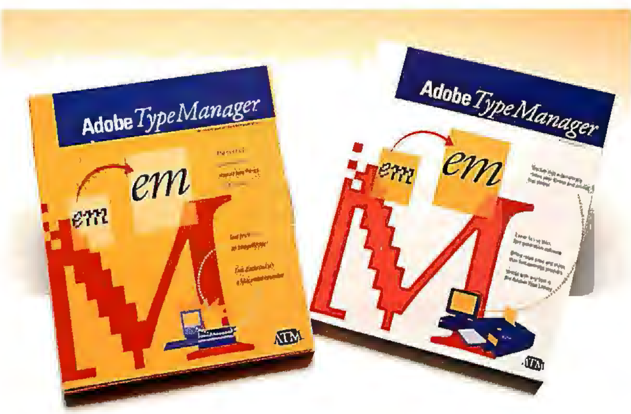
EXCELLENCE

Windows 3.0, *Microsoft*

Windows 3.0 is the first usable graphical user interface for the IBM PC to meet with widespread, enthusiastic acceptance by the DOS-based computing public. Because of its achievement, developers now have a discernible platform and growing installed base for which they can develop easier-to-use GUI applications.

The majority of nontechnical professionals and business users work faster, learn more quickly, and are generally more productive using a good GUI—something the Mac has already proven. Windows 3.0 isn't perfect, as many early users have discovered, but its potential is clear. The sheer strength of its presence ensures a lasting impact on the industry. And its bundled Solitaire game isn't half bad, either.

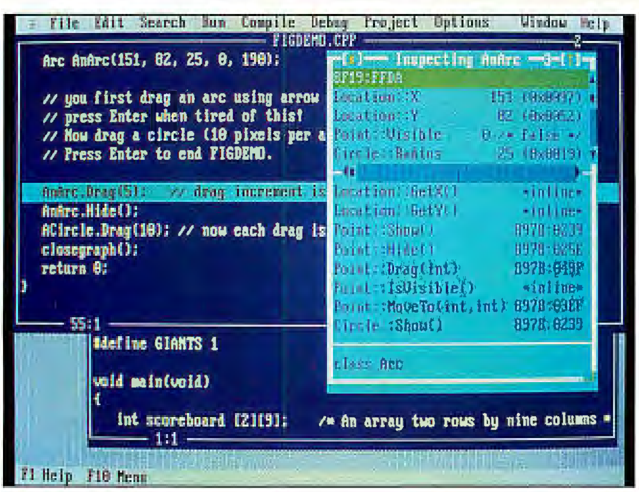
Adobe Type Manager 2.0, *Adobe Systems*



ATM displays PostScript Type 1 font outlines as high-quality bit-mapped text on a Mac screen at large resolutions. ATM 2.0 offers better performance on a 68000-based Mac. Besides being useful for page layout involving large typefaces, it's a boon to those using non-PostScript laser printers. ATM's large character bit maps can be sent to these printers, providing high-quality output. Those using fax boards on the Mac can have their documents imaged at 200 dots per inch, producing excellent results at the receiving fax.

Furthermore, ATM recently jumped platforms to the Windows 3.0 environment. This version produces great-looking text on a Hewlett-Packard LaserJet. While you wait for TrueType in Apple's System 7.0 and Microsoft's OS/2, ATM 2.0 provides a solid, reasonably priced solution now.

Turbo C++, *Borland International*



Borland's introduction of Turbo C++ legitimized the language for thousands of PC C developers. Professional programmers have been avoiding C++ because of the lack of good tools, and Borland's Professional bundle includes everything that even the fussiest programmer has to create and debug commercial C++ code. The profiler isolates poor-performing sections of code—a must for large, performance-sensitive projects. The assembler brings low-level power to bear, and the robust debugger understands C++ classes. Once installed, all these tools combine to create what may be the most powerful single-vendor DOS development environment available.

TravelMate 2000/ Sharp PC-6220/ CompuAdd Companion, *Texas Instruments, Sharp Electronics, and CompuAdd*

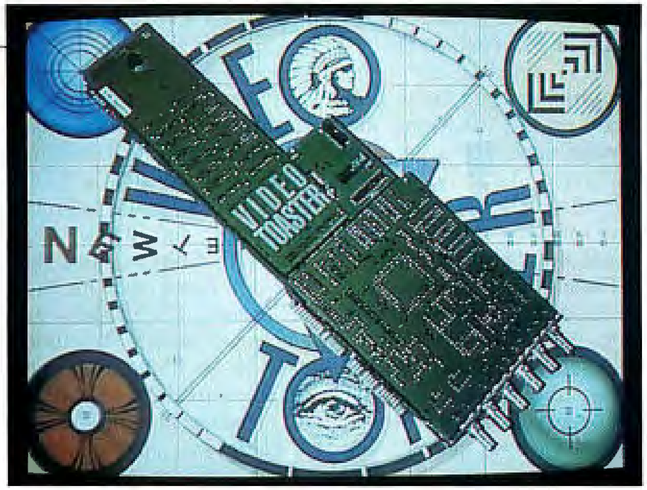
Despite minor problems with the casings, several BYTE editors consider these portables, all built in the same

1990 BYTE AWARD OF EXCELLENCE

Video Toaster, *NewTek*

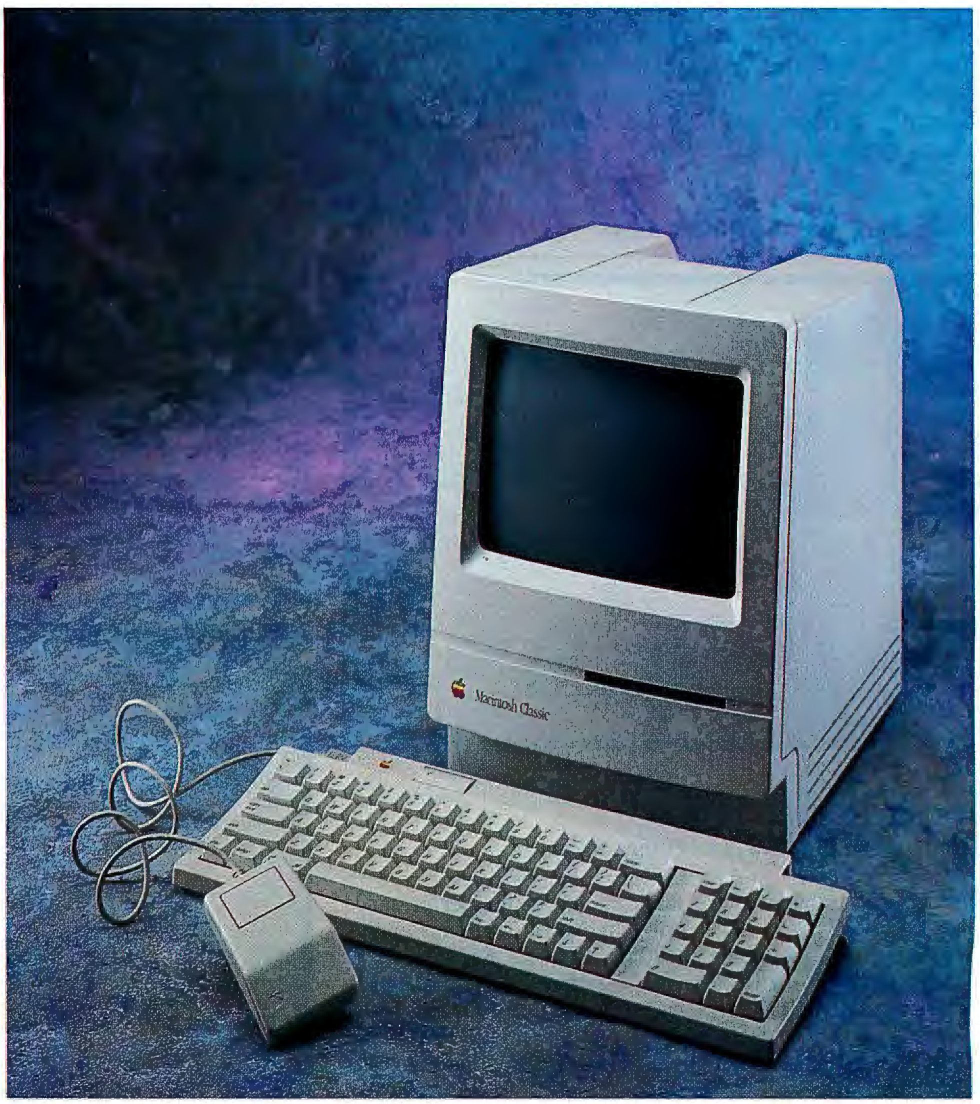
One of the coolest video/graphics products of the year, NewTek's hardware/software package turns the Amiga into a sophisticated, broadcast-quality video-editing system. Video Toaster provides tools for real-time manipulation of incoming live video, including a frame grabber; a color-processing engine for producing color negatives, effects such as solarization and posterization, and color filters; dual frame buffers for rendering realistic three-dimensional images; 24-bit animation software; 24-bit paint software; a character generator for putting text on top of video frames; a production switcher to handle transitional effects; and more.

Thanks to its four custom chips, NewTek has packed all these studio facilities into one add-in board. All the computerized imagery and digital effects you see on TV can be done with this package. Turning a personal computer into a workstation for manipulating broadcast-quality video is no big deal anymore. But when the cost is only $1595, it is a big deal. If you had to separately buy all the equipment to do everything that Video Toaster can do, you'd wish Ted Turner was your daddy.



Macintosh Classic, *Apple Computer*

Apple has really delivered the Cheap Mac. Power users will sneer, but for $1500, you can now get a Mac with 2 megabytes of memory, a fast 40-MB hard disk drive, built-in networking, the world's most stable graphical user interface, and the performance of an SE. (Historical aside: In 1984, the 128K-byte Mac cost $2495.) You won't design the space station with this machine, but you can do most of the things people use personal computers for, and do them nicely. ∇



Texas Instruments plant, to be the best they've ever used. Each has more than enough power for any reasonable laptop application, a very good screen, a fast hard disk drive, a great form factor (it really does fit inside a briefcase), lots of power/weight options (2, 3, or 5 hours of power, depending on the combination of internal/external battery you select), quick recharge, and a good price. These computers are winners. They may be the first laptops since the Tandy Model 100 to really deliver the promise of affordable, portable computing.

1990 BYTE AWARD EXCELLENCE

Compression Master and CL550 Image Processor Chip, *C-Cube Microsystems*

Editor's note: *Just as this issue was going to press, we learned that C-Cube is discontinuing the Compression Master board. It will continue to sell the chip to other developers, however.*

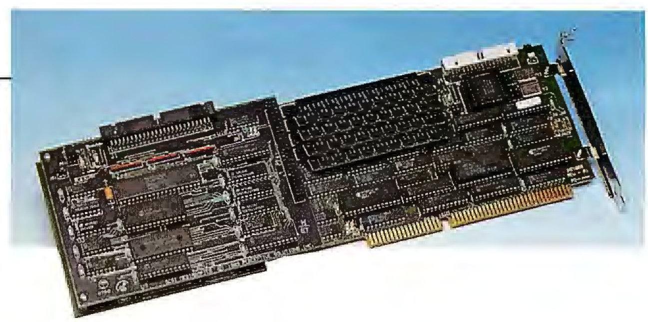
Graphics put an incredible strain on the CPU, bus, and storage device of a personal computer. Luckily, there's this thing called compression. One company at the forefront of compression technology is C-Cube Microsystems, with its CL550 image processor chip, which implements the JPEG compression algorithm.

C-Cube has put its data squeezer chip onto add-in boards for both the Mac and IBM PC compatibles. The Compression Master boards can compress images by as much as 75 to 1. An image file reduced to $\frac{1}{24}$ its original size shows no visible degradation. This is good, essential technology for anyone working with images, and that doesn't mean just desktop publishers, CAD users, and electronic artists. You don't have to be doing four-color graphics to quickly fill up an 80-megabyte hard disk drive.

There are other compression boards on the market, many of which use the CL550. But none are as inexpensive as the Compression Master at $995. C-Cube is quickly gathering a following. Major software houses have promised to support the company's Image Compression Interface, including Adobe, Quark, Autodesk, and Electronic Arts. If C-Cube can produce enough of the CL550 to meet demand (the chip has been in short supply), the company could set the standard in this user-helpful technology.

hyperStore/1600 Caching Controller, *Perceptive Solutions*

The hyperStore/1600 is solid as a rock and *fast*. Caching is a complicated technology, and the folks at PSI seem to know more than any of their competitors. PSI's product has a unique design that lets you run any or all of the common hard disk drive interfaces from one controller board. Not only is it the fastest controller available, it's the most flexible, too.

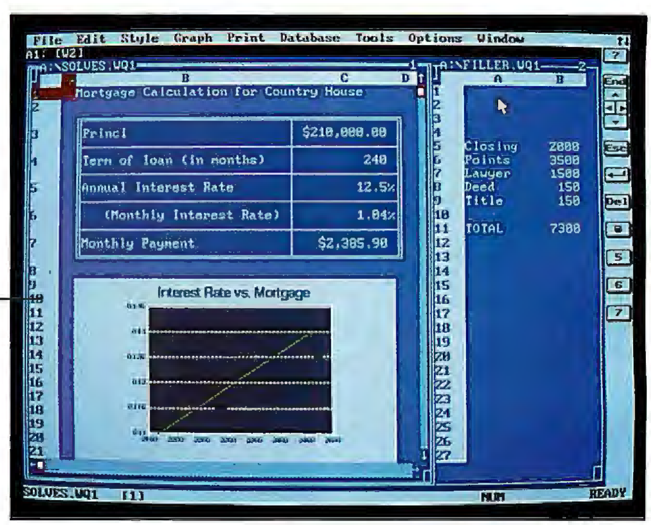


Photoshop, *Adobe Systems*

The best 24-bit pixel editing package of the year, Photoshop from Adobe Systems has excellent color-correction controls and a good set of editing tools for cropping, filtering, and resizing images. It's also very fast. In addition, it can import images of just about every format, such as TIFF, Amiga HAM files, and CompuServe GIF. Once you've modified the image, you can then save the image in any of these formats. Photoshop makes the entrance requirement for any software for the 1990s.

Quattro Pro 2.0, *Borland International*

Quattro Pro provides more features and better performance than Lotus 1-2-3 at a lower price, and yet it still runs on any DOS machine, including an 8088 XT with 512K bytes of RAM. Quattro Pro 2.0 adds a few significant enhancements: a solver capability (like the Solver in Lotus 1-2-3/G) and better printer support. In fact, Borland provides in Quattro Pro a group of features not found in any single version of the market leader 1-2-3.



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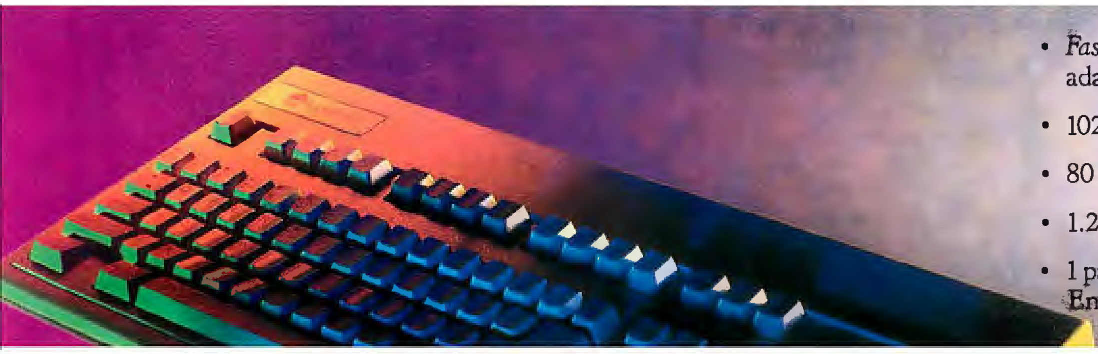

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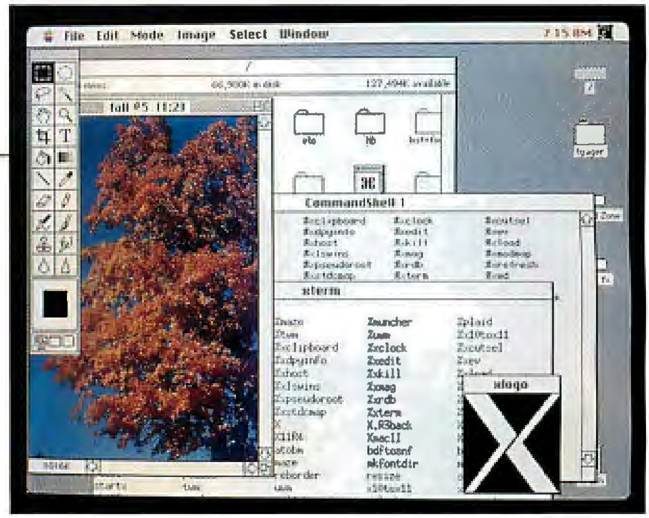
1990 BYTE AWARD EXCELLENCE

A/UX 2.0, *Apple Computer*



By executing one of the most impressive ports of Unix we've seen, Apple managed to create an operating system that represents a merging of Unix System V, BSD Unix, *and* the Mac OS. The operating system installs easily in a matter of minutes from a CD-ROM (and other media) and presents users with a familiar Mac interface. Combined with an Ethernet board and X Window System 11 for A/UX (both optional), A/UX brings the benefits of workstation power and connectivity to Mac users, without forcing them to give up their library of Mac applications. This is the perfect way to bring Unix to the desktop, and with A/UX's ability to run on the inexpensive Mac SE/30 and the new Mac IIsi systems, Apple could make a name for itself as a provider of low-cost Unix solutions.

LaserJet IIP, *Hewlett-Packard*

The first laser printer to break the $1000 street price barrier, the LaserJet IIP immediately became the price/performance benchmark for the new class of personal laser printers introduced in 1990. The IIP and its competitors not only made personal laser printers affordable, they also helped pull down the prices of more sophisticated PostScript laser printers and helped make dot-matrix printers more of a niche market.

In its standard configuration, the 4-page-per-minute printer offers 512K bytes of memory and a solid 10-MHz 68000 processor. With memory upgrades and font cartridges, the IIP helped bring PostScript to general-business applications with a price tag that's under $3000. Compared to its larger cousins, the IIP sacrificed some speed and duty volume, but it lost nothing in output quality and economy. For many users, this justified the cost of placing a laser printer on their desktops or beefing up their overall printing resources.

LaserJet III, *Hewlett-Packard*

For the last few years, Hewlett-Packard has effectively defined business printing by defining the laser printer market. As a result, the LaserJet II was the dominant force in laser printing and was priced below many other laser printers. So what did HP do? It redesigned its already excellent LaserJet II by adding more fonts, as well as scalable fonts, more standard memory, and Resolution Enhancement to smooth out the edges of images. And then HP dropped the price a little. By taking the unusual step of improving on excellence and then offering the customer a better deal, HP has defined the market once again.

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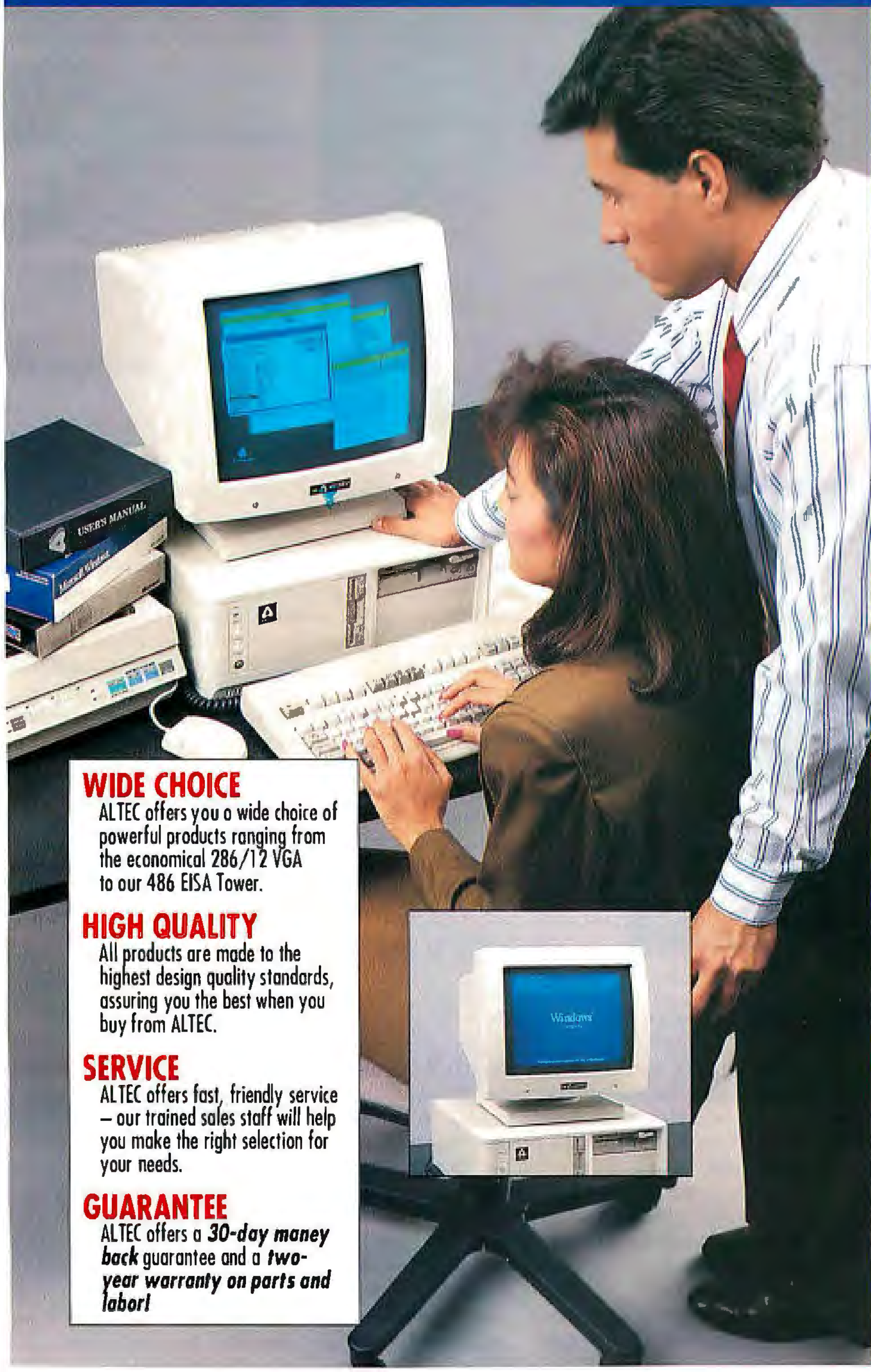

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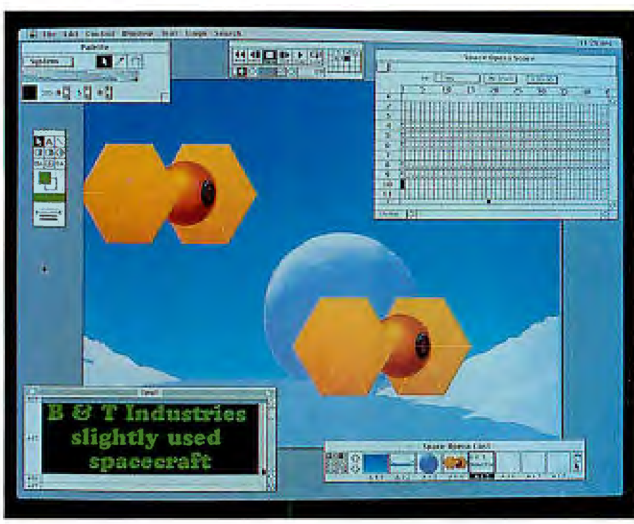
1990 BYTE AWARD EXCELLENCE

RISC System 6000, *IBM*

IBM has come out swinging in its effort to get back into the workstation market, and at the same time has made a strong commitment to the commercial Unix market as well. The RS/6000 is unmatched in performance and remains competitive in price/performance six months after its introduction. The America CPU chip set includes some amazing technology, including parallelism, superscalability, and pipelining.

IBM has made a great effort to get third-party support for the RS/6000, and it seems to have paid off. Many popular workstation-based software packages in the areas of desktop publishing, CAD, and scientific applications are now running on the RS/6000 under AIX.



Director 2.0, *MacroMind*

An excellent program for developing real multimedia content on the Mac, Director is fairly easy to use, it's decently priced ($695), and it doesn't require trading in your car for some exotic hardware. The program shines at helping you put together sounds, scanned images, computer-generated artwork, and text in precisely controlled sequences. Besides a nice, intuitive interface, Director 2.0 has its own HyperTalk-like scripting language for building interactive controls (e.g., menus and buttons). For users lacking the talent of a Disney artist, the program has an easy-to-use animation generator.

Unlike some other programs for working with graphics and sound from multiple sources, Director is designed so well that it won't stymie nonartist types and won't limit artistic types. "Movies" created with Director will be playing soon under Windows, thereby extending the reach of this program. This is an ideal piece of software: It takes the drudgery out of work and turns the computer into an effective tool.

Am286ZX/LX, *Advanced Micro Devices*

This diminutive chunk of silicon and circuitry isn't quite the "complete AT on a chip" that we had hoped it would be, but it's definitely the closest thing yet to a complete AT motherchip. This highly integrated device, incorporating AMD's version of the 286, combines the processor functions and accompanying components that are required to turn that processor into a working computer. Manufacturers using the Am286ZX/LX will be able to construct an AT around this single module by adding just the DRAM chips, keyboard controller, and system bus. This device can eliminate motherboards crowded with 50 to 150 chips.

The LX model, intended for very small portable computers, implements some power management features, like a CPU shutdown mode, so computer vendors won't have to build them separately. A designer could put together a notebook computer with VGA display, serial and parallel ports, and a slot or two using the LX and four or five other devices, plus a DRAM chip. This amazing piece of engineering could result in smaller, less-expensive 286-based machines.

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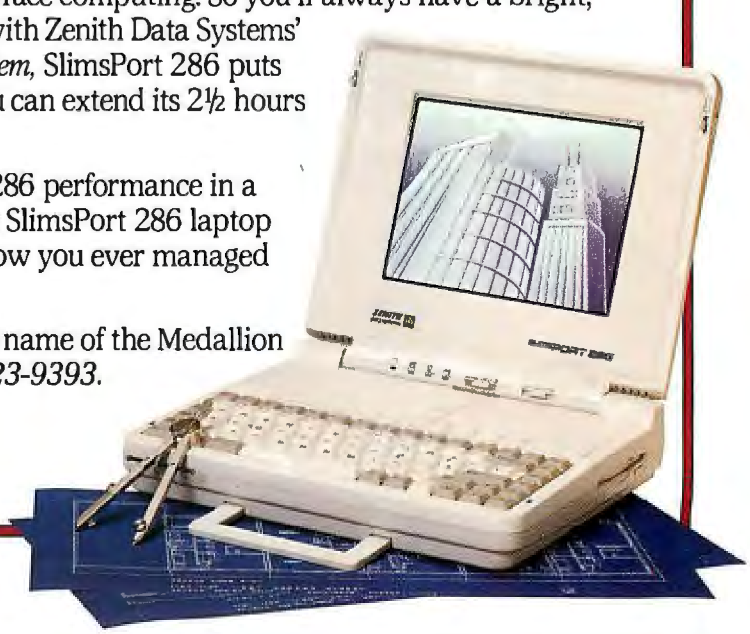

*Source: 1990 Dataquest estimate for U.S. battery-powered laptops. Graphics simulate Microsoft® *Windows™ version 3.0,* a product of Microsoft Corporation. *Intelligent Power Management* is a trademark of Zenith Data Systems Corporation.

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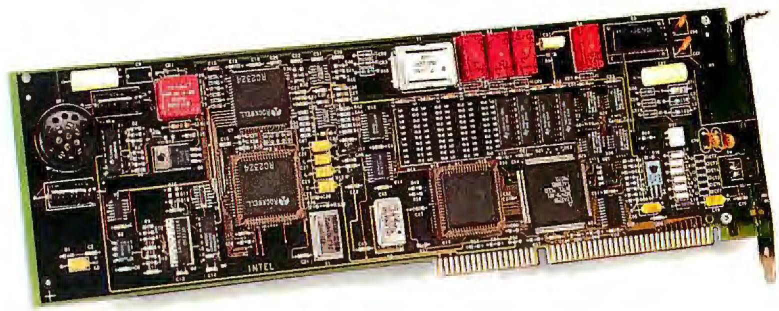
1990 BYTE AWARD OF EXCELLENCE



DOS Protected Mode Interface, *Microsoft*

DOS Protected Mode Interface will be a key component of future applications to allow them to peacefully coexist in protected mode, whether under the auspices of Windows or a DOS extender. However, Microsoft is apparently dragging its feet on letting other members of the DPMI group gain access to the Windows specifications. But DPMI will definitely supersede VCPI (Virtual Control Program Interface).

SatisFAXtion, *Intel*

At under $500 with a modem, fax management, a port for a scanner, and a coprocessor for communications, this add-in board is terrific. SatisFAXtion's best feature is its ease of use. You just install it and then set it up to act like an Epson-compatible printer. Once this is done, all you have to do is have your application print output to an Epson-compatible printer, and SatisFAXtion intercepts it, converts it to Group 3 fax format, and sends it.

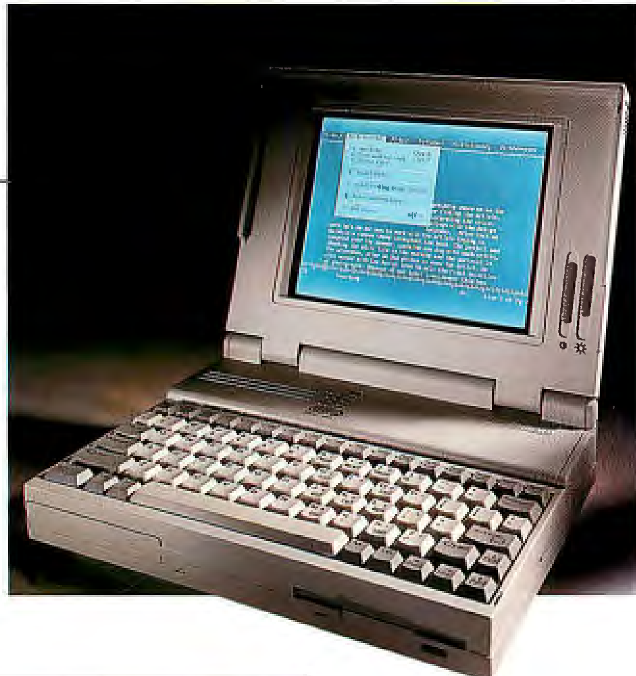
The final fax looks as good as if it were printed from an Epson printer. Software is included and can manage telephone books of users, receiving faxes, and even receiving and immediately printing faxes. Because you can attach a hand-held scanner, SatisFAXtion truly allows a PC/fax-board combo to replace a stand-alone fax machine by letting you scan and send any document.

RadiusTV, *Radius*

Radius was one of the last Mac display vendors to offer a video display and capture board. However, being the last entrant into this market didn't hurt, because RadiusTV does it best. An analog box conditions the video signal before digitizing it at a rate of 30 frames per second and placing the image in a resizable window on a Mac's screen. But RadiusTV not only digitizes the video signal, it also digitizes the audio component, piping the sound out of the Mac's speaker. Finally, RadiusTV can grab any close-captioned text present in the video signal and save it to a file for an immediate electronic transcript of a TV broadcast. The synergy of all these features makes RadiusTV a crucial engine in any multimedia work.

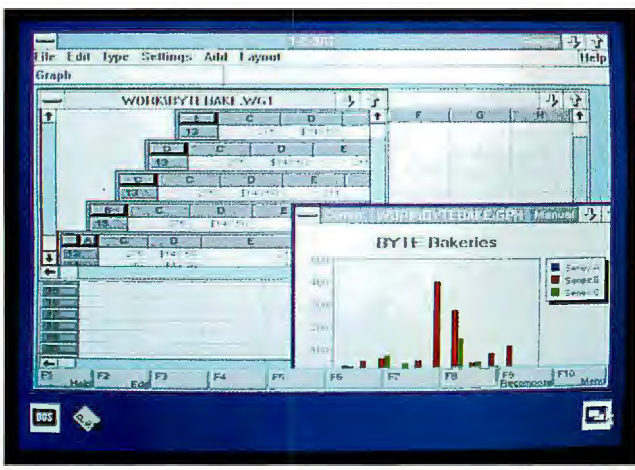
1990 BYTE AWARD DISTINCTION

LTE 386s/20, *Compaq*



The LTE 386s/20 is a great improvement over Compaq's best-selling LTE 286. Compaq answered users' calls for a VGA screen, souped up the CPU to impressive levels, and sacrificed minimally on size, weight, and battery power consumption. The use of aerospace technology in producing the unit's motherboard shows Compaq's commitment as a leading-edge innovator.

Although powerful and technologically innovative, the 386s/20's most important feature is its ability to double as a desktop system. With notebook computers getting more and more capable, there soon won't be much point in buying two systems; many users will just plug their portables into an expansion chassis while they're at the office. Compaq, by virtue of the LTE 386s/20's size and performance, is now leading that trend.



Lotus 1-2-3/G, *Lotus Development*

This is a state-of-the-art OS/2 Presentation Manager spreadsheet, with powerful multithreaded architecture, good graphics support, and the Solver goal-seeking utility. Especially praiseworthy is the WYSBYGI (what you see before you get it) preview mode for type and colors. By expanding the definition of Common User Access, Lotus managed to preserve keystroke and macro compatibility with earlier versions of 1-2-3.

Continuous Edge Graphics (CEG) Chip, *Edsun Labs*

This D/A converter chip, which plugs into a standard VGA board, brings sharper, more colorful graphics to regular PCs without jacking prices out of line. The device uses interpolation techniques to smooth dreaded jagged lines and blend colors on the screen, resulting in crisper images and a bigger palette. With its color-mixing engine, the chip can blend VGA's selection of 256 colors into more than 700,000 shades. Boards using the CEG chip will give standard IBM compatibles the power to generate photo-realistic graphics on VGA-type displays.

In OEM quantities, the chip is cheap at $15 a pop; it will raise board prices by $200 to $300, a good price to pay for smoother, more vibrant images. Whether this chip finds a significant place in the market will be decided by companies making graphics boards and drivers. But the developers deserve recognition for their work in improving the look of VGA and bringing workstation-style graphics to low-cost PCs.

NetModem V.32, *Shiva*

Thanks to its built-in LocalTalk connector, this 9600-bps V.32 modem can be shared by every Mac on an AppleTalk network or can act as a router between networks. Mac users can easily transfer files, send E-mail, or access printers anywhere on either network, whether the LANs are next door or thousands of miles apart. Also, this modem gives traveling employees full dial-in access to the company's Macs and peripherals. At $2000 each, it makes this wide-area-networking technology affordable for small businesses.

1990 BYTE AWARD DISTINCTION

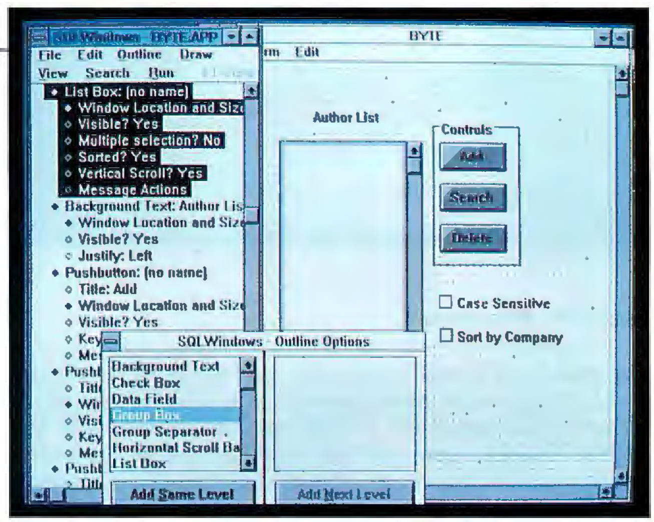
Nextstation and Nextdimension, *Next*

Steve Jobs has finally delivered on the original promise of the Next computer. These machines are fast and very inexpensive for what they do. Also, the applications coming out for them are, as promised, very hot. The Nextdimension, with its powerful graphics board incorporating an i860 and a C-Cube CL550, will set a new standard for video and graphics performance. The Interface Builder remains the most enticing aspect of these machines.

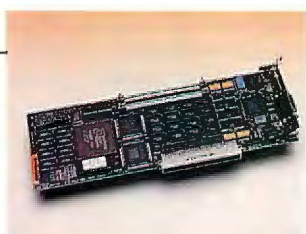
These new systems point the way for advanced use of color display PostScript. Next has taken a leading role in the migration of expensive, powerful workstation technology to cheaper, desktop platforms. The integration of sound and real video is another area in which Next is in the forefront.

SQLWindows, *Gupta Technologies*

Until now, Structured Query Language has always been a standard that was difficult to use and not very accessible. To use SQL, either you had to be a programmer or you had to know one. SQLWindows is the first product that's completely capable of supporting a major SQL application while at the same time offering an interface that even a beginner can use. To make SQLWindows even more useful, the Windows 3.0–based package supports various SQL databases on personal computers, database servers, minicomputers, and mainframes. Users can access several of these databases at the same time, and the process is transparent.



8•24 GC, *Apple Computer*



With the advent of 32-Bit QuickDraw, Macs can display and manipulate graphics with thousands (16-bit pixels) or millions (24-bit pixels) of colors. However, such graphics constitute a lot of data to muscle around—so much data that even screen updates on a Mac IIfx's 640- by 480-pixel monitor can be sluggish. Apple fixes this with its 8•24 GC, a 24-bit color board that uses an AMD 29000 RISC processor and on-board display buffers to accelerate Mac graphics. The 29000 processor offloads certain QuickDraw graphics primitives from the Mac's CPU. The board's buffers store and manipulate bit-mapped images without the penalty of moving chunks of data from main memory to the display board. Both are a potent combination that allows high-end Macs to be versatile graphics workstations for scientific, engineering, and photo-imaging work.

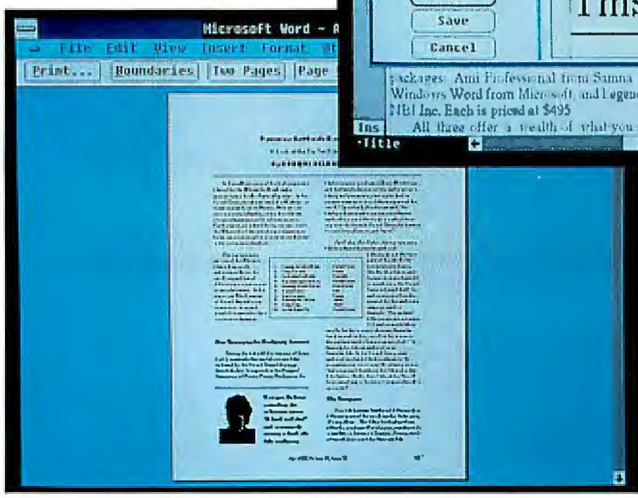
Desqview/X, *Quarterdeck Office Systems*

An enormous technical achievement, Desqview/X lets you run a DOS-based PC with a multitasking windowing shell that supports X Window System sessions. Other products may let you hot-key into X Window, but only as a view into sessions running on a remote client. Desqview/X could become the software glue that brings Unix to the DOS desktop.

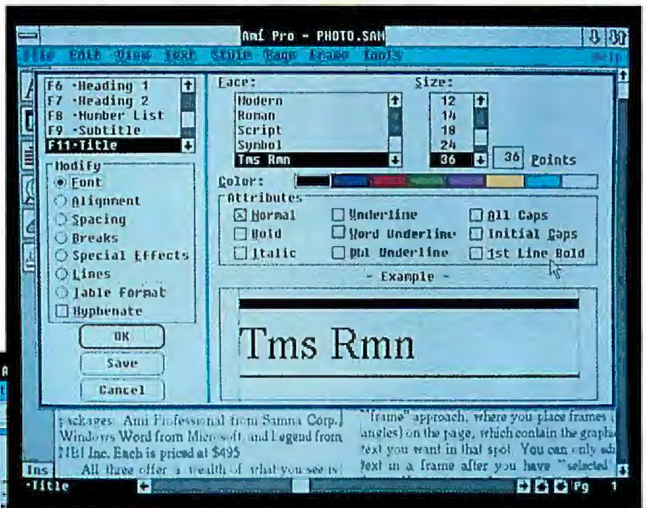
What is significant here is that Desqview/X will allow X-based Unix systems to coexist naturally with DOS systems on a network, widening the options available to users. This means that your MS-DOS machine suddenly becomes part of the corporate X environment and is transparent to operating systems, just as the multitasking in DOS is transparent.

1990 BYTE AWARD DISTINCTION

Ami Professional, *Samna*
Word for Windows, *Microsoft*



Word for Windows



Ami Professional

Word for Windows and Samna's Ami Professional make serious word processing a reality in Windows. In doing so, Microsoft and Samna have raised PC applications to a new level—one where applications don't have to be overly simple or unacceptably slow. Because of the technical success of these two word processors, the most often used application of BYTE readers on a PC need not be held back by a text-only environment. Their success also leads the way for scores of other products in Windows.

FaceLift, *Bitstream*

The masters of digital typography have developed a software package that gives Windows users smooth, scalable fonts on the screen and on paper. But it's not just laser-printer users who benefit. FaceLift generates nice-looking text on dot-matrix printers and lets you control the saturation of dots to produce characters that are sharp, not muddy. FaceLift works with existing bit-map fonts if available; otherwise, it scales the characters to the size you specify. Not only does FaceLift generate nice type, it comes with 13 Bitstream fonts. The only thing wrong with this program is that it works only with Windows.

DR DOS 5.0, *Digital Research*

PC users, particularly those whose PCs are tied to a network, are tired of running out of memory for applications in MS-DOS. Although several utilities have tried to take advantage of extended and upper memory by loading memory-resident programs and device drivers there, they often meet with mixed success. As one BYTE editor commented, everything above 640K bytes is a swamp. But DR DOS fixes that. It lets you move network device drivers and memory-resident programs out of the 640K-byte work space. It even relocates its own kernel in high memory, giving you the maximum amount of work space below 640K bytes for your applications. At least one company isn't willing to give the whole MS-DOS playing field to Microsoft.

WordScan, *Calera Recognition Systems*

Probably the best implementation of optical character recognition today, WordScan runs under Windows and makes use of its Dynamic Data Exchange capabilities. Therefore, it will make a natural partner for all kinds of imaging and word processing/desktop publishing applications under Windows. Its other capabilities, including a pop-up verification window, are typically found in high-end systems.

Looking Glass, *Visix Software*

This software comes closer than any to providing a Mac-like environment for Unix systems. Files, directories, and programs are all represented by unique (and changeable) icons, and a simple scripting language allows the program's behavior to be modified. Looking Glass is a boon for those administering large networks of systems, since administrators can develop custom scripts that give users easy point-and-click access to applications and services. This product, and others like it, will go far toward bringing Unix and X Window System to the general computing market.

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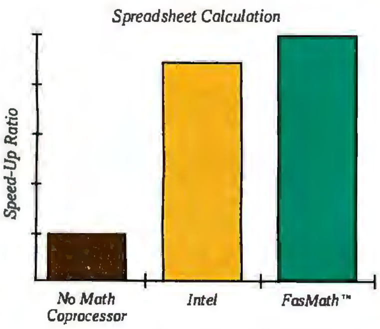

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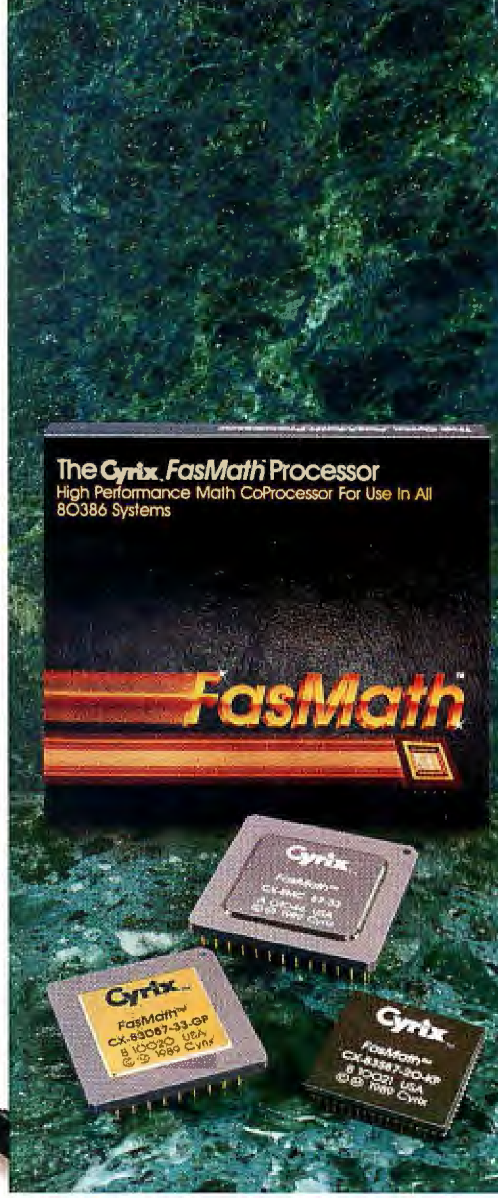

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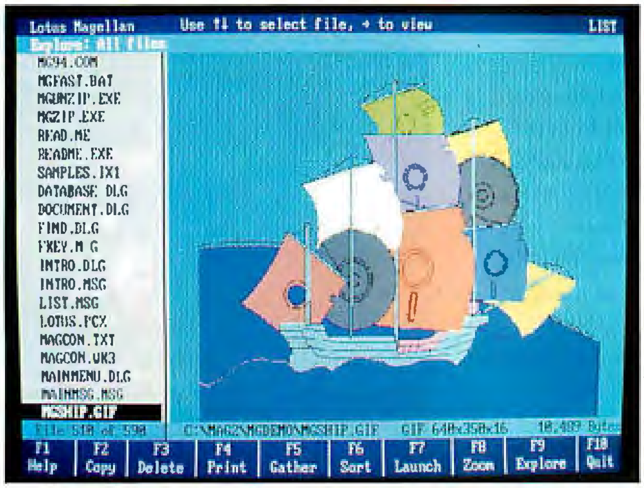
1990 BYTE AWARD DISTINCTION

X Window System release 1.2, *Interactive Systems*

With this release, Interactive Systems has created the fastest, most capable X implementation for PC Unix. It works with a wide range of graphics cards, supporting resolutions of up to 1280 by 1024 pixels in 256 colors. Interactive has also added support for 256-color VGA and 8514/A, making it possible to build color-rich Unix workstations at a lower cost than before. Interactive's unique hardware-independent server architecture paves the way for support of new graphics technologies as they become available. Looking Glass, which also won a BYTE Award of Distinction, is included.

Magellan 2.0, *Lotus Development*



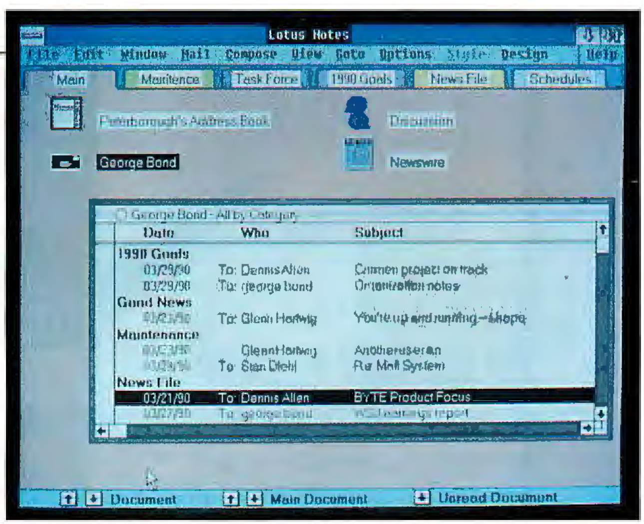
The strength of Magellan is its joining of two unrelated software technologies: industrial-strength data compression plus extremely powerful indexing. PKZIP gives you the same data compression (effectively doubling your hard disk capacity), but finding what's in a ZIP file is a pain; other programs have powerful indexing but can't tell you what's inside a ZIP file. Magellan lets you PKZIP any or all files, yet it retains a complete index of every word in the ZIPped (and unZIPped, for that matter) files. You can locate, browse, copy, and print text from inside the ZIPped files without having to unarchive them to disk.

Apollo 2500, *Hewlett-Packard/Apollo*

At its introduction, the Apollo 2500 was the most inexpensive Unix workstation on the market, and its arrival forced other vendors to follow with low-end systems of their own. For under $5000, the 2500 offered high-resolution monochrome graphics, 8 megabytes of memory, and a network adapter. Running Domain/OS, users could have the best of both Unix System V and BSD Unix, as well as full support for both X Window System and Apollo's Display Manager graphical interfaces. The low-end workstation market is now thriving, with Sun, DEC, and Hewlett-Packard all participating, but it was the Apollo 2500 that kicked it all off.

Notes, *Lotus Development*

An ambitious project, to say the least, Lotus Notes is the first major product to bring together all workgroup activities for PC-based networks in a nonrestrictive way. Its support of LAN and wide-area-network activities with self-replicating file servers (so that branch offices are working with up-to-date data), as well as its text filters and manager, puts Notes in a class all by itself. Notes automatically sifts through mail and electronic conferencing messages in a way that's tailored for each user on the network.



Gram·mat·ik™ IV

Grammatik IV, *Reference Software*

Considered by many to be the best proofreading package for the PC, Grammatik IV works with most major word processing programs. It allows on-the-fly style and grammar changes, and it adapts to the style of writing it is evaluating.

1990 BYTE AWARD OF MERIT

Adobe PostScript Level 2, ***Adobe Systems***
Major upgrade of the industry-standard page-description language.

HyperCard 2.0, ***Apple Computer***
Significant revision of the hypertext development software for the Mac.

Macintosh IIfx, ***Apple Computer***
High-performance 40-MHz 68040-based system.

FileMaker Pro, ***Claris***
Flat-file database manager.

Color MacCheese, ***Delta Tao***
Low-cost 32-bit color paint program for the Mac.

Dragon Dictate, ***Dragon Systems***
Voice-recognition system for the PC.

Hercules Graphics Station, ***Hercules Computer Technology***
Low-cost, high-resolution graphics card for the PC.

American Heritage Dictionary, ***Houghton Mifflin Software***
On-line dictionary and thesaurus reference.

M-Motion Video Adapter/A, ***IBM***
NTSC video board for the PC.

ScanMan Model 32, ***Logitech***
Hand-held scanner with innovative software.

MediaMaker, ***MacroMind***
Macintosh-based presentation-creation program for novices.

R:base 3.1, ***Microrim***
Relational database manager for the PC.

LAN Manager 2.0, ***Microsoft***
Network operating system for the PC.

OS/2 2.0, ***Microsoft***
Multitasking operating system for the PC.

Works 2.0, ***Microsoft***
Low-cost integrated software package for the Mac and PC.

RMD-5100-S Rewritable Optical Disk Drive, ***Mass Optical Storage Technologies (MOST)***
The first rewritable 3½-inch optical drive.

WaveLAN, ***NCR***
A wireless LAN for PCs.

Personal Mainframe/8000, ***Opus Systems***
A set of 88000-based ISA bus cards that turn PCs into workstations.

Nisus 3.01, ***Paragon Concepts***
Upgraded version of a popular Mac word processor.

Stor/Mor, ***Q/Cor***
The first-to-ship ultra-high-capacity (20 MB) floppy disk drive for PCs.

QMS-PS 410, ***QMS***
Innovative, low-cost PostScript laser printer.

Desqview 386/QEMM-386, ***Quarterdeck Office Systems***
New version of the popular multitasking software for PCs.

Sparcstation IPC, ***Sun Microsystems***
Small, fast, and inexpensive RISC workstation.

TravelMate 3000, ***Texas Instruments***
Powerful 20-MHz 386SX-based notebook PC.

Paradise 8514/A Plus Card, ***Western Digital***
A fast, inexpensive display adapter with VGA pass-through.

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Photoshop
PostScript Level 2
Adobe Type Manager 2.0
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Mountain View, CA 94039
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Inquiry 1138.

Advanced Micro Devices (AMD)
Am286ZX/LX
5204 East Ben White Blvd.
Austin, TX 78741
(512) 385-8542
Inquiry 1139.

Apple Computer, Inc.
8•24 GC Accelerator Card
A/UX 2.0
HyperCard 2.0
Mac IIfx
Mac Classic
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 1140.

Bitstream, Inc.
FaceLift
215 First St.
Cambridge, MA 02142
(617) 497-6222
Inquiry 1141.

Borland International
Quattro Pro 2.0
Turbo C++
1800 Green Hills Rd.
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 1142.

Calera Recognition Systems, Inc.
WordScan
2500 Augustine Dr.
Santa Clara, CA 95054
(800) 544-7051
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Inquiry 1144.

C-Cube Microsystems
Compression Master CL550
399-A West Trimble Rd.
San Jose, CA 95131
(408) 944-6300
Inquiry 1143.

Claris Corp.
FileMaker Pro
5201 Patrick Henry Dr.
Santa Clara, CA 95052
(408) 987-7000
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Compaq Computer Corp.
LTE 386s/20
P.O. Box 692000
20555 FM 149
Houston, TX 77269
(713) 370-0670
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12303 Technology Blvd.
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Sunnyvale, CA 94087
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DR DOS 5.0
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Monterey, CA 93942
(408) 649-3896
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Cupertino, CA 95014
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American Heritage Dictionary
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Cambridge, MA 02142
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Inquiry 1020.

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SatisFAXtion
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Hillsboro, OR 97124
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Inquiry 1021.

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Logitech, Inc.
ScanMan Model 32
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
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Lotus Development Corp.
Lotus 1-2-3/G
Magellan 2.0
Notes
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
Inquiry 1024.

MacroMind, Inc.
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MediaMaker
410 Townsend St., Suite 408
San Francisco, CA 94107
(415) 442-0200
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Mass Optical Storage Technologies, Inc. (MOST)
RMD-5100-S
Rewritable Optical Disk Drive
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Cypress, CA 90630
(714) 898-9400
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3925 159th Ave. NE
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Inquiry 1027.

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WaveLAN
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Dayton, OH 45479
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Inquiry 1029.

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Inquiry 1030.

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Nextdimension
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Inquiry 1031.

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Building 400
Cupertino, CA 95014
(408) 446-2110
Inquiry 1032.

Paragon Concepts, Inc.
Nisus 3.01
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Solana Beach, CA 92075
(800) 922-2993
(619) 481-1477
Inquiry 1033.

Perceptive Solutions, Inc.
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(214) 954-1774
Inquiry 1034.

Q/Cor
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(404) 923-6666
Inquiry 1035.

QMS, Inc.
QMS-PS 410
P.O. Box 81250
Mobile, AL 36689
(205) 633-4300
Inquiry 1036.

Quarterdeck Office Systems
Desqview 386/QEMM-386
Desqview/X
150 Pico Blvd.
Santa Monica, CA 90405
(213) 392-9851
Inquiry 1037.

Radius, Inc.
RadiusTV
1710 Fortune Dr.
San Jose, CA 95131
(408) 434-1010
Inquiry 1038.

Reference Software
Grammatik IV
330 Townsend,
Suite 123
San Francisco, CA
94107
(415) 541-0222
Inquiry 1039.

Samna Corp.
Ami Professional
5600 Glenridge Dr.
Atlanta, GA 30342
(404) 851-0007
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Sharp Electronics Corp.
Sharp PC-6220
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9500
Inquiry 1041.

Shiva Corp.
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155 Second St.
Cambridge, MA 02141
(617) 864-8500
Inquiry 1042.

Sun Microsystems
Sparcstation IPC
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
Inquiry 1043.

Texas Instruments
TravelMate 2000
TravelMate 3000
P.O. Box 202230
Austin, TX 78720
(800) 527-3500
Inquiry 1044.

Visix Software, Inc.
Looking Glass
11440 Commerce Park Dr.
Reston, VA 22091
(703) 758-8230
Inquiry 1045.

Western Digital Corp.
Paradise 8514/A Plus Card
2300 Main St.
Irvine, CA 92714
(415) 960-3353
Inquiry 1046.

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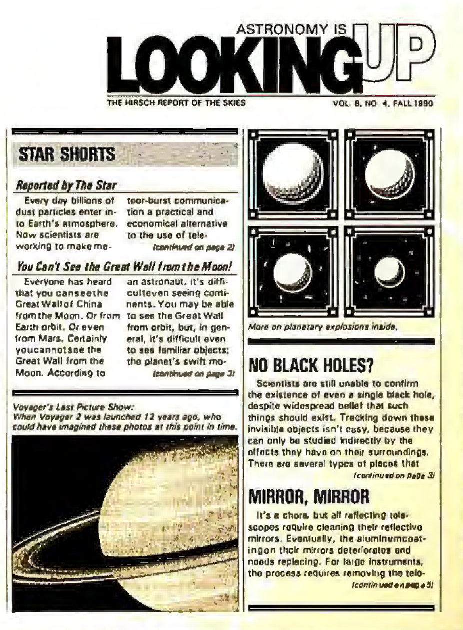

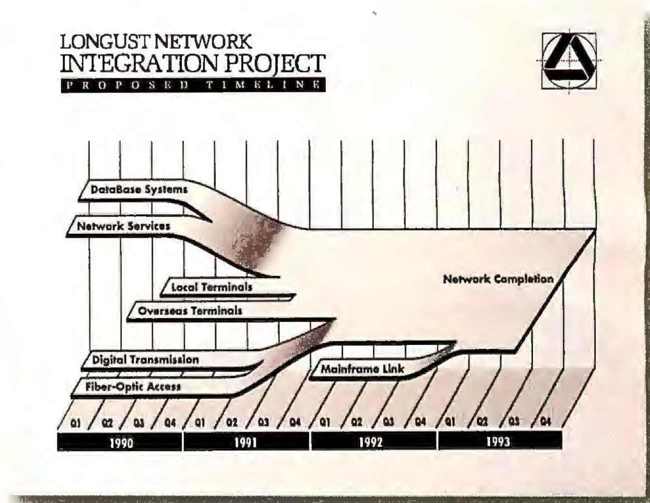

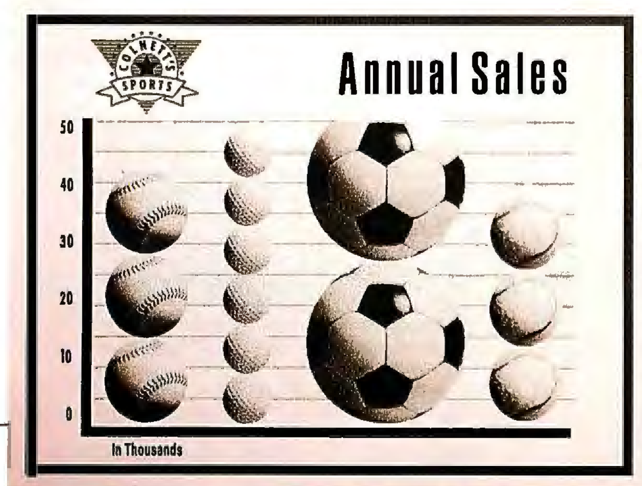

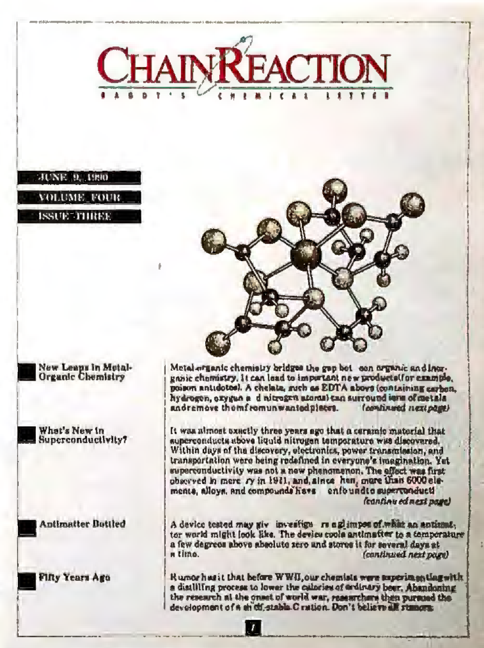

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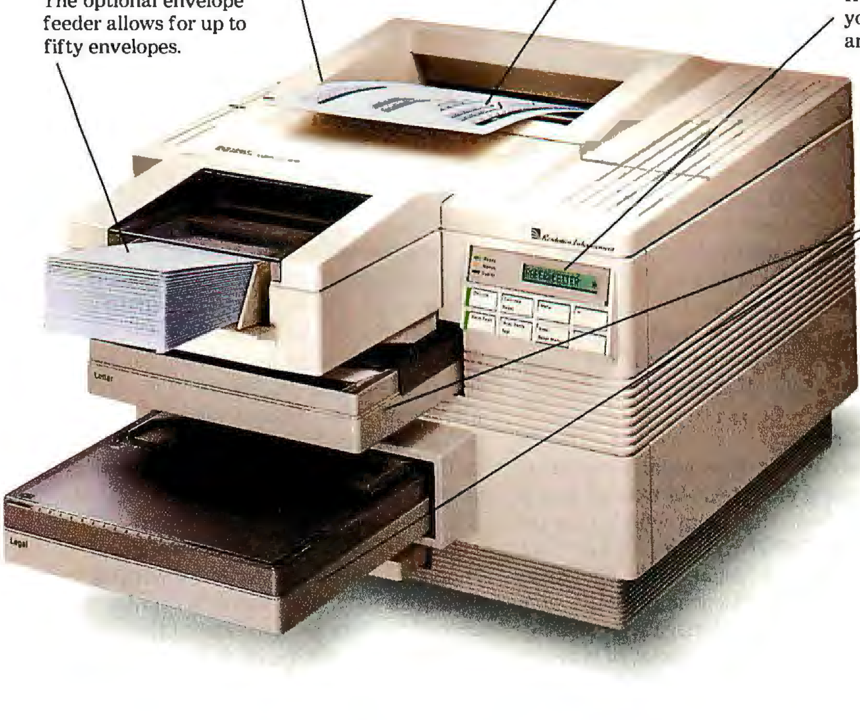

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HEWLETT PACKARD

Caching Cards Speed Data Access

The BYTE Lab tests eight caching controller cards that help relieve hard disk drive bottlenecks

Steve Apiki and Rick Grehan

If you spend your days doing hard disk drive-intensive chores, you know all too well how a slow disk subsystem cripples an otherwise speedy computer. Even today's faster hard disk drives put only a dent in data bottlenecks. A drive's 12-millisecond access time may sound impressive, but that hardly keeps up with a 33-MHz CPU's voracious demand for data.

For many people, the solution to hard disk drive gridlock lies in caching controllers. This technology borrows from a decades-old idea: sandwich fast (primary) storage between the processor and the slow (secondary) storage. In this context, primary storage is the high-speed RAM that is sequestered to the controller, and secondary storage is the hard disk drive.

But caching controller manufacturers don't stop there. Semiconductor intelligence rides herd on all the RAM, and this intelligence ranges from 8032 microcontrollers all the way up to 68000s. The result: These boards aren't just fast, they're smart, too.

This month, the BYTE Lab evaluates eight of the fastest caching boards available for ATs (two other products, a Unix-based caching controller from Consensys and an ESDI controller from Ultrastor, did not arrive in time for testing). We chose ESDI and SCSI controllers because we believe that these interfaces will remain the mainstays for high-performance hard disk drives in the future.

To test these controllers, we wrote a pair of benchmarks that reflect activities that depend heavily on hard disk drive system performance. The tests are portable across operating systems, specifically DOS (see figure 1), Novell's NetWare 386 (see figure 2), and The Santa Cruz Operation's SCO Unix (see figure 3), so we could gauge controller performance in each environment. For benchmark details, see the text box "How We Tested Controllers Across Three Operating Systems" on page 172. To help you decide which card is right for you, see the text box "Choosing the Right Caching Controller" on page 180.

Disk Caching

Hardware disk caches usually consist of 1 or 2 megabytes of RAM with an access time of about 100 nanoseconds (see the text box "Buffering: The Lower-Cash Alternative" on page 176). The disks that these products cache typically consist of a few hundred megabytes of magnetic media with access times of between 15 and 25 ms. Caches are pragmatic solutions to an economic, not a technical, problem. They dramatically improve the performance of slower, cheaper media (hard disks) with just a small amount of fast and expensive media (RAM).

The cache holds a copy of some data from the disk. When the system requests data from the caching controller, the controller first looks in the cache to determine if the cache contains the requested data. If it does, the controller processes the request almost immediately; if not, the controller gets the data from the disk at normal disk-access speeds. In general, the larger the cache, the better the performance, although there is a point of diminishing returns.

While the concept is simple, its implementation encounters some rather difficult technical problems. Using proprietary algorithms, the caching controller decides which sectors of the disk should be copied to the cache in anticipation of the system's next request. The controller then must organize the cache for efficient processing.

When the cache is full, the controller must decide which sectors can be discarded. The dedicated microprocessor, which may be as powerful as a 68000 or Z280 chip, helps solve these complex problems.

Each manufacturer jealously guards its caching algorithm because that's one of the main determinants in deciding a controller's performance. However, controllers share some techniques for solving performance problems. For example, when your system asks to read a sector that has not been cached, the controller copies that sector into the cache as well as fulfilling the request from the disk.

On a disk write, the controller may choose to buffer the write by writing to the cache only. The controller writes the cached sectors to disk later, after some period of inactivity or if the modified sector must be replaced in the cache. While buffered writes improve performance, there is a small chance that data will be lost in a power failure or other disaster.

Read-ahead is a method for improving read performance. On a read request, the controller reads more sectors than requested (sometimes a full track) and sends them into the cache. Because the system tends to read sectors in contiguous blocks, this optimization can save access time, although there is some overhead due to the additional information being read.

Organizing the Data

Cache data is usually organized in a *set-associative* fashion. This means that each cache location can contain data only from a fixed set of disk locations. In a two-way set-associative cache, two cache

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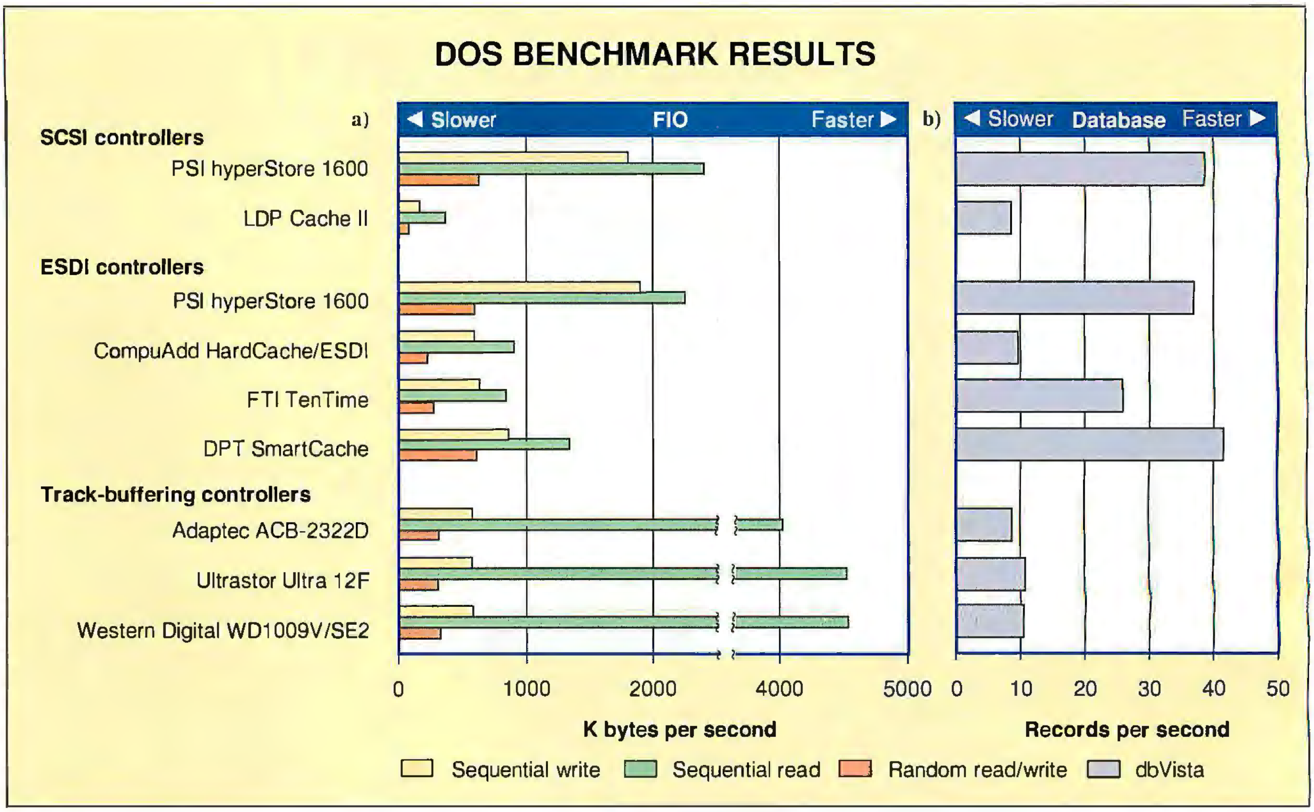


Figure 1: *DOS benchmark performance. PSI's hyperStore 1600 clearly demonstrated superiority on sequential operations* **(a)**, *while DPT's SmartCache edged it out on our random tests.* **(b)** *In our dbVista benchmark, the performance of CompuAdd's HardCache/ESDI suffered because of its write-through design.*

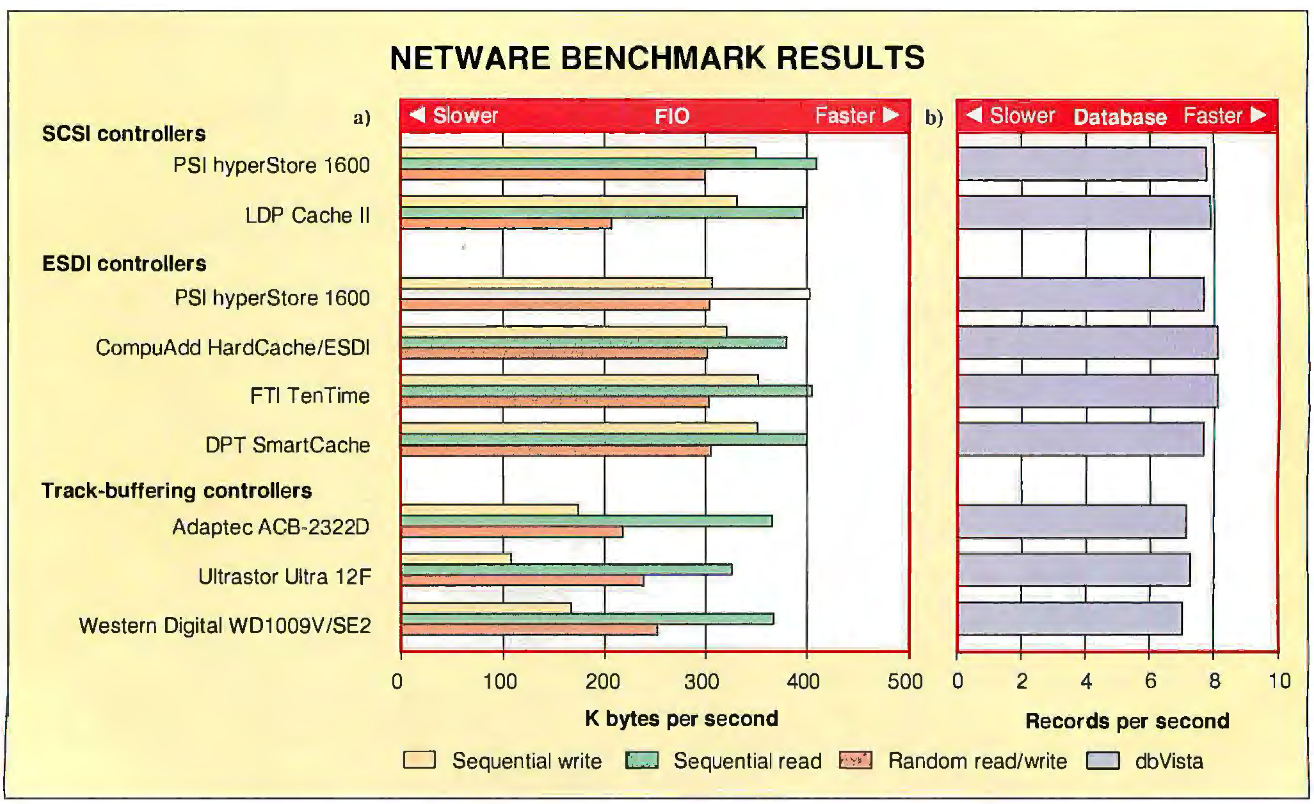


Figure 2: *Performance under NetWare 386 version 3.10. Performance of all the boards was similar on all tests* **(a,b)**. *Our four-user LAN simulation apparently did not push NetWare past its own cache; in small networks, even heavy random disk access may not show a measurable benefit from a caching controller.*

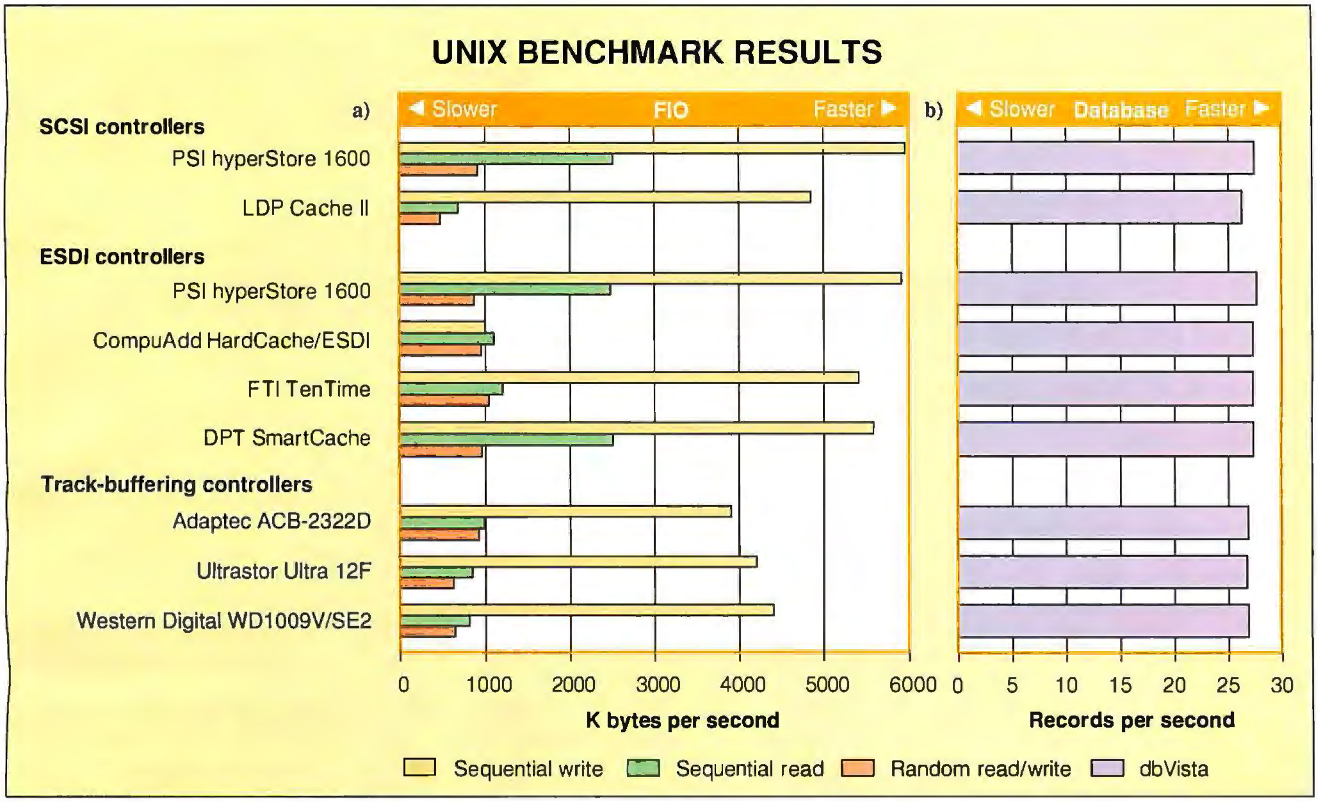


Figure 3: *Results of our benchmarks under SCO Unix.* **(a)** *Notice that the hyperStore 1600 continues to perform well. Also note that Unix's write-buffering scheme favors write operations over read operations.*
(b) *SCO Unix's own buffers were able to handle most of the dbVista throughput (even the track-buffering controllers did well), so the results are tightly grouped. The hyperStore 1600 barely edges past the competition.*

locations cache the same set of disk sectors. The controllers we evaluated offer up to eight-way set-associative caching. Fewer numbers of sets mean that more disk area can be held in the cache at one time, but the trade-off is that the cache locations must then be replaced more often.

In a multiple-set-associative cache, the controller must decide which cache location to discard when the cache becomes full. The most common strategy, known as *least recently used*, discards the location that has gone the longest time between accesses.

When these caching algorithms work and requested data is in the cache, the controller can return the data almost instantaneously. However, the access time is still limited by the I/O bus, which usually runs at 8 MHz. Most manufacturers test these boards at higher bus speeds, up to 16 MHz, and you may want to consider running them at speeds higher than 8 MHz.

The Interface

Internally, caching controllers have little in common with the Western Digital WD-1003 controller, which set the interface standard for IBM ATs and clones. However, to maintain compatibility with PC operating systems, all the caching controllers that we tested mask their internal technology with a WD-1003 register-level interface.

Thanks to this interface, the caching controller looks like a WD-1003 to your PC. This means that any operating system that supports a WD-1003 (as virtually all do) can run these cards without device drivers.

Most of these cards also supply a built-in BIOS ROM, which handles INT 13 hexadecimal calls. Usually, BIOS calls use the controller in "native" mode, which is more efficient than going through the WD-1003 interface. Fast Technology, Inc., and Perceptive Solutions, Inc., supply operating system drivers that access the board's full capabilities and avoid the standard interface (PSI currently supplies drivers for Unix, NetWare, and DOS; FTI offers DOS drivers and says it is exploring Unix drivers).

DOS supports a maximum of 1024 cylinders for each of its drives. Some software expects that there will be only 17 sectors per track, in keeping with the usual MFM format. Because ESDI drive controllers often format their drives with many more sectors, and large drives can have more than 1024 cylinders, some translation is needed to ensure compatibility.

All the controllers we evaluated can map the physical geometry of the disk to some combination of heads, cylinders, and sectors that has fewer than 1024 cylinders. The controllers can also map to 17 sectors per track. If your BIOS table does not support the full capacity of your drive, these controllers can provide a drive type that will.

The ultimate limitation under DOS is 1024 cylinders, 16 heads, and 63 sectors per track, or 512 MB. Several caching controllers let you split a drive into multiple logical units to overcome this limitation on large drives and provide better organization.

Other Considerations

Two features of caching controllers—field upgradability and mirroring—don't enhance speed or compatibility, but they may help you decide whether or not to

How We Tested Controllers Across Three Operating Systems

We ran DOS and NetWare tests on a Club American AT 386/33 with 4 megabytes of memory. The AT 386/33 runs its I/O bus at 8 MHz. To complete our small test network, we used two Compaq 286Ns hooked to the AT 386/33 through an Ethernet connection. Our test ESDI disk drive was a Maxtor XT-8380E, and our test SCSI drive was a Micropolis 1684.

For Unix tests, we used an Everex Step 33-MHz 386 with 8 MB of memory. The same disk drives that served as test units for DOS and NetWare also served time on Unix.

Our test suite consisted of two benchmarks: `fio`, which exercises rudimentary file operations, and a database benchmark that put the test systems through more complex calisthenics. The `fio` benchmark is one we have revived and revised from past system and disk drive reviews. The test simulates both random and sequential disk activity typical of applications in which one system may be called upon to perform several different types of tasks.

The `fio` test reports three results: throughput rates for sequential reads, sequential writes, and random I/O. The `fio` benchmark conducts sequential I/O with random block lengths to avoid favoring any single drive geometry or controller mapping. The only constraint is that the lengths of each access must be in whole sectors. This avoids unrealistic delays, since most disk transfers are sector oriented, and non-sector-aligned transfers incur additional overhead. For these tests, the access lengths ranged from 512 bytes to 32K bytes.

The `fio` random tests are designed to represent the actions of one or more users using a random-access application—a database, for example. For our DOS tests, we set `fio` to simulate one user, using two files of 1 MB each. Files are accessed as sets of records, and the records vary in length from 512 bytes to 4K bytes. Under Unix and NetWare 386, we used two instances of `fio` to simulate four users, each with two 128K-byte files. Read-to-write ratios for the random tests were fixed at 3 to 1.

We wrote the database simulation benchmark using Raima's dbVista III database package. The dbVista system is actually a library of C routines that implement a combined relational- and network-model database system. We chose dbVista because it gave us control over the source code we wanted to generate and because DOS, LAN, and Unix versions of dbVista are available.

The database we constructed consisted of two data files and two index files. The first data file contained sales records composed of a sales representative's ID number, name, phone number, and department code. We indexed this file by the sales rep ID. The second data file contained customer records consisting of associated sales rep ID, customer ID, customer name, address, phone number, and payment balance. We indexed this file using a compound key of sales rep ID plus customer ID.

The test reads two raw ASCII files, building the database as it goes. The first ASCII file holds the sales rep data that is simply loaded into the database. The second ASCII file carries customer data. As the program reads each line of customer information, it first searches the sales rep key file to verify that the customer's associated sales rep already exists in the sales file. If the program finds a match, it inserts the customer information into the database.

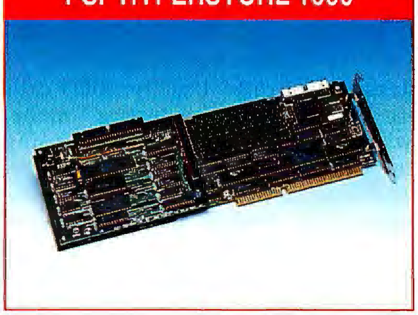
We ran the LAN version of the benchmark on two client stations; each updated a central database stored on the server. One of the client stations ran the lock manager—a TSR program that coordinates multiuser access. Client tasks communicate with the lock manager via NetBIOS. (Extensive testing revealed that running the lock manager on a client station had no effect on the performance of that station.)

The test simply reports one number, an index indicating the number of records processed per second. Note that this figure combines sales rep and customer records for all clients operating simultaneously. (Our NetWare tests were apparently unable to stretch any controller to the point where differences become apparent. NetWare's built-in disk optimizations made each controller perform at the same level.)

use a caching controller. All but one of the cards reviewed can be field-upgraded using off-the-shelf memory parts. Cache capacities range beyond what most users will need—up to 16 MB—so you can start off with a minimal amount of memory and increase it as your disk requirements grow.

Finally, some of these boards support *disk mirroring* as a standard feature or as an option. Disk mirroring allows you to connect the controller to two drives, address them as a single drive, and have the contents of one duplicated exactly on the other. NetWare handles mirroring on its own, but hardware mirroring will give you enhanced reliability with any operating system.

PSI HYPERSTORE 1600



Our performance crown belongs to PSI's hyperStore 1600, a solidly built controller that displayed impressive speed on all our tests. In addition to performance, the hyperStore offers expansion hooks for controlling an impressive amount of storage. The controller is not a bargain-basement item, but it combines an excellent price and performance balance in our tested configuration ($1700). (The price—like that of FTI's TenTime controller—is approximate. PSI sells the board without RAM, so you add your own. The tested-configuration price is based on $100 per MB for RAM; adjust it up or down according to the latest quotes from your favorite RAM vendor.)

Caching controller vendors usually tout their products as vehicles to boost random-access disk speed. On our random `fio` test, the SmartCache from Distributed Processing Technology (DPT)

ISA CACHING DISK CONTROLLERS

Both true caching controllers and track-buffering controllers are represented in this table. Although many of the basic features are similar, we found that all boards do not perform equally well (●=yes; ○=no).

	Full caching controllers					Track-buffering controllers		
	CompuAdd	Distributed Processing Technology	Fast Technology	Lomas Data Products	Perceptive Solutions	Adaptec	Ultrastor	Western Digital
Model	HardCache/ESDI	SmartCache	TenTime	LDP Cache II	hyperStore 1600	ACB-2322D	Ultra 12F	WD1009V/SE2
Price[1]	$895	$2025	$1990[2]	$1170	ESDI:$1700[2] SCSI:$1700[2]	$163	$195	$292.50
System interface	WD-1003, INT 13h	WD-1003	WD-1003, INT 13h	WD-1003, INT 13h	WD-1003, INT 13h	WD-1003, INT 13h	WD-1003, INT 13h	WD-1003, INT 13h
Disk interface	ESDI	ESDI	ESDI	SCSI	SCSI, ESDI, ST506, IDE	ESDI	ESDI	ESDI
Number of hard disk drives supported[3]	2	4	4	7	7 SCSI[4] 2 ESDI or ST506 2 or 4 IDE	2	2	2
Number of floppy disk drives supported	2	2	2	2	2	3	3	3
Standard RAM	256K	512K	2 MB	1 MB	0 MB	64K	32K	64K
RAM configuration (as tested)	4 MB	4.5 MB	4 MB	4 MB	4 MB	64K	32K	64K
Maximum RAM	4 MB	4.5 MB[5]	10 MB	16 MB	4 MB[6]	64K	32K	64K
Memory type	256K-byte SIMM, 1-MB SIMM	2-MB modules	1-MB SIMM	1-MB ZIP, 4-MB ZIP	256K-byte SIMM, 1-MB SIMM	DIP	DIP	DIP
Memory speed (ns)	80	100	100	100	100	70	100	70
Bus speed compatibility	12.5 MHz	16 MHz	16 MHz	16 MHz	12.5 MHz	11 MHz	16 MHz	11.5 MHz
Processor	80188	MC68000	SCC68070	80C188	Z280	8032B	Proprietary	80C196
Disk mirroring	○	Optional	Optional	●	Optional	○	○	○

[1] As tested; price includes RAM (see RAM configuration, below) and daughtercards, if required.
[2] Price based on $100 per MB for RAM; company does not have a list price that includes 4 MB of RAM.
[3] Addressable disks; if disk mirroring is supported, additional drives may be required.
[4] Numbers are given per daughtercard; up to four daughtercards can be attached.
[5] Additional 12 MB available with additional bus card.
[6] Additional 16 MB available with additional bus card.

clipped the hyperStore, but just barely (see figure 1a). Both the hyperStore and the SmartCache drives easily beat the CompuAdd Hard Cache/ESDI and FTI TenTime cards on random file I/O.

On sequential tests, where caching controllers do not usually fare much better than noncaching controllers, the hyperStore stood out (see figure 1a). Under DOS, both sequential read and sequential write times were far and away the best of any controller.

According to PSI, the hyperStore can detect access patterns and determine whether they are generally sequential or generally random. If the controller detects sequential accesses, it organizes the cache with a granularity greater than a single sector. This means that on large sequential reads and writes (as in our sequential benchmarks), the controller can cache strings of sectors or even an entire track. Obviously, the technique results in excellent sequential performance. CAD and image-file applications can probably get a big boost from PSI's design.

The hyperStore's Z280 runs its own disk-based multitasking operating system. When you first configure the controller, it copies the operating system from a floppy disk and writes it to a reserved area on the hard disk it controls. At boot time, the controller reads the operating system from the hard disk. Operating-system upgrades are trivial; you just download them from a floppy disk.

In addition to WD-1003 emulation, the hyperStore offers two native modes of operation, based on either block- or sector-based data transfers. While both are faster than WD-1003 emulation, the block-based mode of SSP (standard storage protocol), which we tested, provides a significant performance advantage over the other modes. It transfers data in blocks larger than a single sector. SSP-block mode is available to DOS users through the built-in INT 13h BIOS; PSI provides SSP drivers for NetWare 2.15 and for popular versions of Unix.

The hyperStore in its base configuration has no disk interface. Instead, the controller accepts daughtercards with either ESDI, SCSI, IDE, or ST506 interfaces. Up to four daughtercards can be mixed and matched on a single controller. Each daughtercard has its own 32K- or 64K-byte track buffer for additional speed.

Since the controller runs a multitasking operating system, it can access multiple daughtercards simultaneously. In a large setup with multiple daughtercards, you could expect to see good performance because of this parallelism.

While the daughtercard scheme makes for a wide controller (it will prevent you from using several adjacent slots), it also provides access to a staggering amount of mass storage. PSI claims that the hyperStore's total storage capacity is 50.4 gigabytes.

In addition, the controller can address single disk drives as multiple logical units. With optional software, the hyperStore can be used to mirror one logical unit to another.

The card is complex: The setup software and preliminary documentation that we saw were downright confusing.

continued

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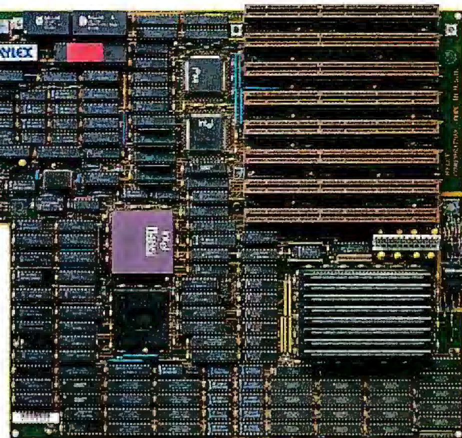

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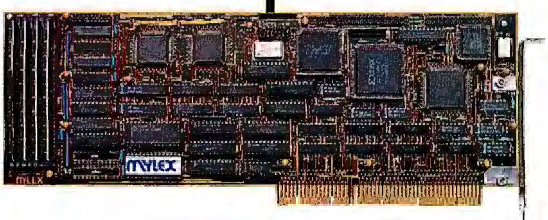
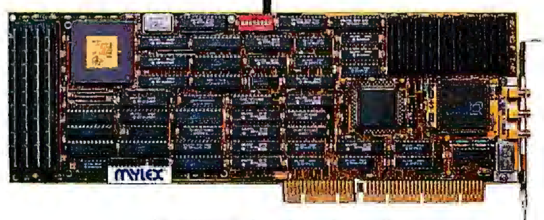
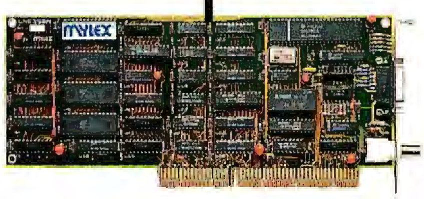


SCSI Caching Host Adapter



TI 34020™ Graphics Controller



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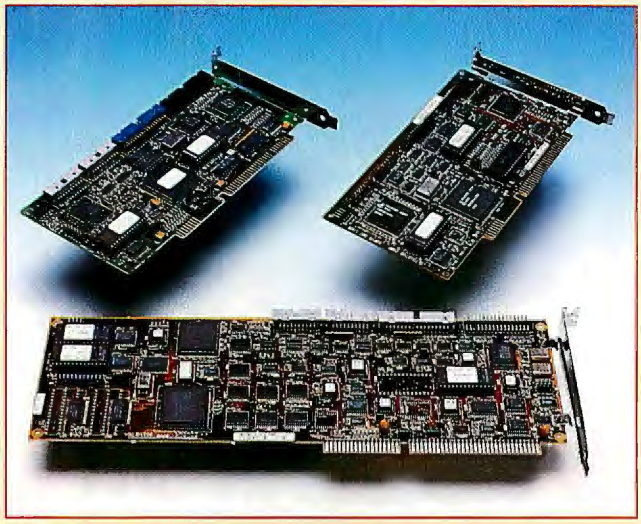
Buffering: The Lower-Cash Alternative

While we progressed through this Product Focus, we unearthed some alternative caching philosophies. A number of manufacturers of track-buffering controllers, which typically hold 32K or 64K bytes of RAM, showered us with some persuasive arguments. Specifically, don't put the cache memory on the controller board; keep it in the host. The reason: Once it's on the controller board, all memory can ever do for you is cache disk data. When it's in the host, you can control how much the operating system uses for disk buffers and how much is used for program code and data.

If you're going to spend money on memory, the argument continues, spend it on memory that can do double duty. Besides, there's plenty of good, inexpensive disk-caching software available. Examples often cited were PC-Kwik from Multisoft, Flash from Software Matters, and Fast from Future Computer Systems. And there's the SMARTDRV.SYS driver that Micrososft now includes with DOS 4.x.

Two track-buffering controllers, from Adaptec and Ultrastor, are short cards (the Western Digital controller is a full-length card). The differences between these boards and the "heavyweight" caching controllers are not merely physical. Because the buffering controllers aren't weighted down with complex cache-management algorithms, installation code can live comfortably on a single EPROM. The result is that to perform a low-level format on your hard disk, you must use DEBUG as a way into the EPROM's initialization code. Fortunately, that's a once-only job, and all the boards we tested had sophisticated initialization programs that kept complexity to a minimum.



Three track-buffering controllers (clockwise from top left): the ACB-2320D, Ultra 12F, and WD1009V/SE2.

ACB-2322D

Adaptec offers a pair of controllers: The ACB-2320D supports only an ESDI hard disk drive, while the ACB-2322D (our test controller) also carries an onboard floppy disk drive controller.

The ACB-2322D's on-board 64K-byte track buffer allows the controller to perform track read-ahead operations. So, when a read request comes in for a single sector, the ACB-2322D anticipates sequential operations by reading the four upcoming tracks.

Other interesting features of the ACB-2322D include *power sequencing*, which reduces current draw on the host power supply by spinning up the hard disks one at a time. *Sector sparing* lets you set aside one sector per track as a spare. If, during low-level formatting, a sector on the track is found to be defective, the spare will be used. *Drive splitting* lets you convert one large physical drive into two smaller logical drives. This allows DOS to handle a single drive of up to 1 gigabyte.

The ACB-2322D's manual is well designed and has plenty of diagrams and jumper location maps. We were happy to see a list of supported operating systems in an appendix—right down to the revision level.

Ultra 12F

Ultrastor's Ultra 12 ships with only 8K bytes of cache memory (expandable to 32K bytes by replacing a single static RAM chip). We tested the 32K-byte 12F version.

The Ultra 12F's on-board configuration program allows sector and track mapping. *Sector mapping* enables DOS to accept drives that have more than 1024 cylinders; *track mapping* overcomes the 528-megabyte limit that the Adaptec 2322D handles via drive splitting. Finally, NetWare users will be pleased to discover that the Ultra 12F's manual outlines a technique whereby you can shorten the lengthy COMPSURF procedure to a matter of minutes.

WD1009V/SE2

The WD1009V/SE2 from Western Digital is a well-designed board. It's so easy to install that the instructions take up only three paragraphs in the manual. And because the controller comes from the developer of the WD-1003 interface, compatibility is not a concern.

Western Digital describes its on-board 64K-byte cache as "adaptive." The controller's on-board microcontroller constantly monitors incoming data, looking for patterns in how the data is retrieved. On the fly, the microcontroller optimizes the cache to the current pattern. Western Digital boasts a 50 percent boost in throughput, thanks to the cache optimizing.

Operating Cache-Free

The track-buffering controller cards fared surprisingly well in our benchmark tests, especially when you consider that they cost hundreds of dollars less than even the least-expensive caching controllers. In particular, note that the performance of the small caching controllers in the Unix leg of the db-Vista benchmark was so close to that of the large caching controllers that the difference is virtually negligible. This is an example of an application that runs well within the caching provided by the operating system.

On the DOS benchmarks, we ran the small caching controllers through the tests using SMARTDRV.SYS with 4 MB of cache enabled. We should therefore point out that the figures shown owe their values more to SMARTDRV.SYS and less to the operations of the boards. However, we consider this to be a good indication of small-caching-controller throughput.

Should you go the track-buffering controller route? The answer depends on the specifics of your application. Our tests indicate that the better-performing large caching controllers outperform the small caching controllers by at least a modest margin. You have to decide how critical that performance margin is and whether it will justify the cost. But when you compare $163 to prices over $1000, you may be willing to overlook a few seconds' delay here and there.

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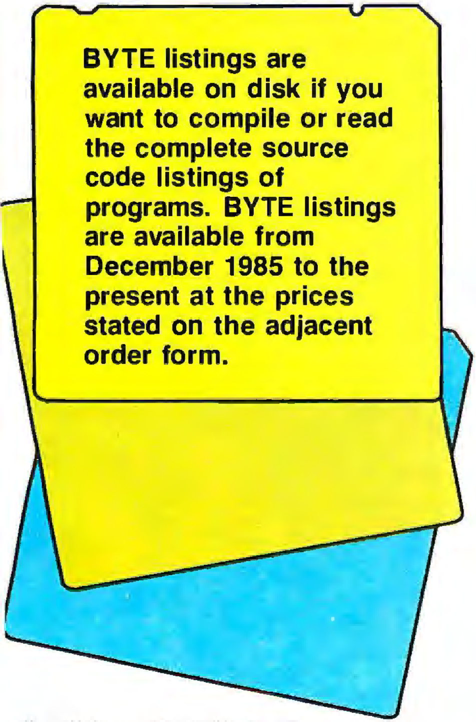

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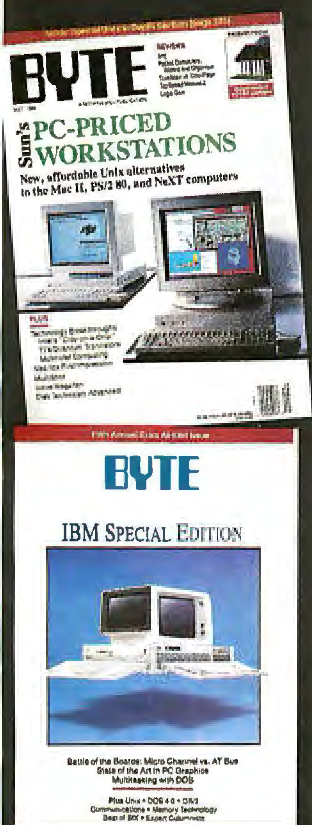

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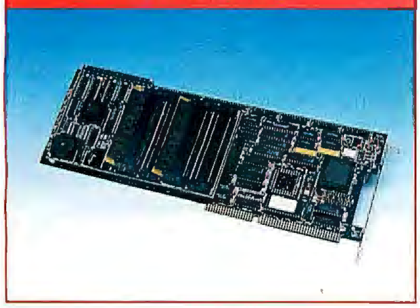
But after you choose your options and get the card running, its performance and addressing capability are more than adequate rewards for your trouble.

FTI TENTIME



Like many other caching controllers, TenTime from FTI acts less like a controller and more like a dedicated coprocessor board. It has a 68070 CPU that executes a proprietary real-time, multithreaded operating system. The operating system supports error correction and intelligent cache management (the details of which the people at FTI were understandably reluctant to reveal).

The result is a sophisticated combination of hardware and software. For example, if the TenTime acts up and you can't determine the problem, you can attach a special cable to an on-board diagnostic port, hook the cable to a modem, and FTI's technical-support people can call your board for an over-the-phone house call.

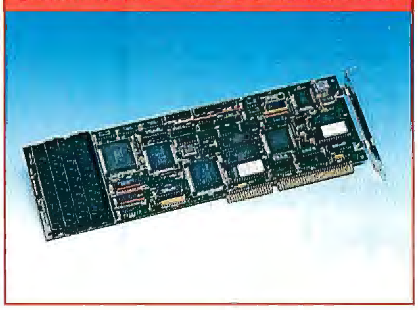
The basic TenTime board comes with 2 MB of RAM, which can be expanded to 10 MB via daughterboards. If you're worried about data integrity, you can choose an optional battery-backed static RAM "write safeguard." This circuit holds data that is on its way out to the disk, so if a power failure takes your system down during a write operation, the TenTime will complete the write when the power returns again.

The TenTime operates in WD-1003-emulation mode. As of this writing, FTI was in the final stages of preparing a driver to bypass emulation mode under DOS. Drivers for NetWare and Unix may be on the way as well.

The TenTime's documentation was adequate for the comparatively easy controller installation. FTI provides an installation and diagnostic floppy disk drive with a simple menu-driven install procedure. There is also a utility for tweaking various parameters controlling the board's software. For example, you can disable caching when you're installing Unix, so the Unix installation's surface scan can talk directly to the disk and identify questionable tracks.

Performance scores for the TenTime ranged in the middle of the pack. However, the controller's price stood near the top for the configuration we tested. This makes us hesitate before suggesting the TenTime over less expensive boards that performed as well or better. However, the TenTime's write-safeguard feature makes the product attractive in situations where data is critical, power is questionable, and an uninterruptible power supply is unavailable.

COMPUADD HARDCACHE/ESDI



Based on its price alone, CompuAdd's HardCache/ESDI is instantly attractive. At $895 in its tested 4-MB configuration, the HardCache costs less than half the price of comparable ESDI controllers. Although its performance lagged behind the others in this select group, the HardCache significantly improved performance over that of a standard controller.

The card's DOS utility lets you run a low-level format or a surface scan on the drive, and you can configure the physical parameters. You then use the DOS commands FDISK and FORMAT as usual. While this is standard procedure with other cards, too, the HardCache's utility was the easiest to use, and the drive worked on the first try.

You can fine-tune read-ahead parameters using another utility. CompuAdd's HardCache/ESDI utility (HCU) program lets you configure read-ahead using a read-ahead factor and a read-ahead cap. Each time the system makes a request, the number of sectors requested, multiplied by the read-ahead factor, determines how many sectors the HardCache will actually read. If the number is greater than the read-ahead cap, the controller uses the read-ahead cap value instead. While we didn't do any tuning for our tests, HCU should increase performance by tailoring reads to your application.

continued

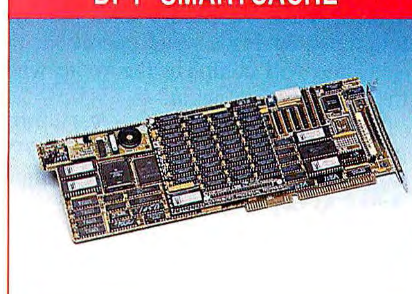
The HardCache uses a set-associative organization that ranges from two to eight sets. The number of sets is automatically determined by the amount of memory that's on-board.

While most of the controllers that we tested buffer writes as well as reads, CompuAdd takes a fail-safe approach in implementing a *write-through cache.* Write-through caching means that the controller always writes to the disk as well as the on-board cache. There is no increase in write performance over a standard controller, but if a power loss occurs, you'll have all the data you've written safely stowed on the disk.

This design hampered the HardCache on several of our benchmarks—most notably, on the dbVista benchmark under DOS, where the HardCache was easily outrun by its three competitors. The dbVista benchmark does a lot of writing, and it rarely reads back what it has written. This is a worst-case situation for the HardCache; it should perform better in most real-world applications.

The HardCache also performed near the bottom on the sequential-write portion of the `fio` benchmarks under Unix. Other DOS benchmarks put it well below the top-performing hyperStore and SmartCache boards but close to the TenTime. Under NetWare 386, however, any write performance differences evaporated. NetWare itself operates a delayed-write cache within the operating system, and the operating-system cache was enough to overcome any differences between controllers. Overall, the HardCache is an adequate performer at an excellent price. If affordability is one of your top criteria, the HardCache may well be the controller for you.

DPT SMARTCACHE



DPT's SmartCache is a caching controller pioneer. Although old by PC industry standards, the SmartCache is well designed and managed to outperform most of the other boards we tested.

We should note that DPT is planning to

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Memory type	Std. SIMMS	Custom	Custom
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Custom drivers	Optional	No	Optional
Drive types supported	IDE,SCSI,RLL ESDI, MFM	ESDI, MFM,RLL	ESDI
Networks, UNIX and multiuser systems	All	Most	Most
Boot drive	Any	"C" only	"C" only
1-to-1 interleave	Yes	No	No
Auto bad track repair	Yes	No	No
Parity check RAM	Yes	NO	Yes
I/O bus speed	12.5	10.0	10.0(12.5 opt)
Data look ahead	Track	Sector	Sector

CACHE IN

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Choosing the Right Caching Controller

First, the obvious: Users whose applications are disk intensive will benefit the most from a caching controller. An installation that makes heavy use of databases is the most obvious target for a caching controller. Many tasks are CPU-bound: For example, a caching controller won't help an AutoCAD application draw any faster.

Tasks that might benefit from a caching controller include desktop publishing applications that allow you to spool printer output to disk. A caching controller that buffered write operations would allow the DTP application to complete the print job rapidly; you'd be back editing your document quicker.

Price should certainly be a factor, particularly given the wide range present between the caching controllers and the track-buffering controllers. Our tests indicate that a Unix system of modest proportions will perform acceptably with the track-buffering controllers. Ditto for NetWare. Consequently, the operating system you use will surely affect the outcome of any buying decision.

Analyze the daily load on your disk system. If you have a friend willing to lend you a memory card for a week or so, try using that. See if caching in the host will give you the throughput you need. If it does, simply adding to your system memory will certainly be a less expensive route to higher performance.

If you've decided that you *must* have a caching controller, don't focus solely on the performance. Think about flexibility and expandability. Most ESDI controllers that we looked at will handle at most two hard disk drives (some can handle four). SCSI controllers can accept up to seven; this capability may be important if the target machine is the server of an infant network. As the network grows and the disk requirements grow, the SCSI bus will go a greater distance.

release a new version of the SmartCache, with major revisions, by the time you read this. In addition to having bundled, native support for popular versions of Unix, DPT promises that the new board will be faster than the current model.

Not that the model we tested was any slouch. Its excellent performance was partly due to read-ahead buffering. However, rather than reading a whole track into a buffer for each read, as some other boards do, the SmartCache hands back the requested data before continuing with the read-ahead. While the main system CPU reads the data, the DPT's on-board 68000 continues to read a fixed number of sectors into the cache.

The SmartCache also buffers all disk writes. It installs data written by the host system into the cache and immediately acknowledges the data. During idle periods, or when a fixed percentage of the cache locations become dirty, the SmartCache dumps the data out to the disk. When dumping the data, the controller writes sectors according to disk geometry, minimizing seeks wherever possible. You can interrupt this disk write, and the read-ahead mentioned above, if the host system requires data that is not in the cache.

Under DOS, these performance features really show. The hyperStore 1600 blasted the SmartCache on sequential benchmarks, but on the random and dbVista benchmarks, the SmartCache held a slight edge. The hyperStore's sequential optimizations helped in sequential operations, while the SmartCache's sector-oriented organization served it well on benchmarks with a more random access pattern. (When comparing benchmark results, remember that the SmartCache had 4.5 MB of RAM, while the other cards had only 4 MB. We couldn't avoid this discrepancy because the SmartCache doesn't support 4 MB and the other boards don't support 4.5 MB. However, we believe that the difference in size did not give the SmartCache a significant edge on these tests.)

Installation and setup were straightforward. We had trouble with a buggy new version of the firmware but resolved the problem after calling DPT technical support. In addition to excellent phone support, DPT offers a full BBS service. The documentation was the best among the boards we reviewed.

The first thing you'll notice if you test the board with the computer's cover off is a 10-position bar-graph LED, which constantly reports the drive's status. You can watch the controller go through its POST RAM tests, and if there's an error, you can determine the cause immediately.

DPT's format utility, which is appropriately called DPTFMT, lets you prepare the drive. When the low-level format is complete, the utility asks what operating system you intend to use with the controller. The software uses your answer to look up the best match available in the BIOS table. The board we tested had an optional BIOS expander ROM installed, which supplements the choices available through the BIOS.

The SmartCache has two drawbacks, however, and both involve money. At $2025, the SmartCache is the most expensive board we tested. It's more than $300 costlier than the hyperStore, which closely paralleled its performance. The board's second weak spot will become apparent only if you need to upgrade your controller. DPT, unlike the other manufacturers, provides additional RAM on proprietary modules that must be purchased from the company. With off-the-shelf memory prices continuing to drop, upgrading the SmartCache could be significantly more expensive than upgrading the other boards.

LDP CACHE II

Lomas Data Products may not be a well-known name among disk drive controller vendors, but it builds a good product that's available at a good price. Although the LDP Cache II's benchmark performance was generally disappointing, it offers built-in disk mirroring and the prospect of enhancing slower disk drives at about two-thirds the price of the other SCSI entry, PSI's hyperStore.

The hyperStore 1600 beat the LDP Cache II handily on all the benchmarks. Although the LDP Cache II buffers

writes, it obviously does not do it as well as its competitor. But the results may be skewed by the speed of our test SCSI drive, a Micropolis 1684. The Micropolis has a cache of its own, which attempts to buffer directories as much as possible. LDP pointed out that the controller's caching overhead may have offset any performance gains the card could have provided to the relatively fast drive.

On a slower drive, the LDP Cache II achieved better relative results. It clearly outperformed a standard SCSI controller on the test that is most representative of cachable applications, the random I/O benchmark. Nevertheless, its performance doesn't compare with that of the hyperStore 1600.

Installation and setup were easy, helped by LDP's utilities. Like the other controllers, the LDP Cache II provides the operating system with an appropriate number of heads, cylinders, and sectors based on the number of SCSI blocks it reads from the drive. Most controllers look up the geometry in a table in ROM and provide whatever table entry comes closest. LDP's strategy is to generate a table based on drive size and store it in EEPROM, so full utilization of a large disk drive is virtually certain.

LDP offers disk mirroring as a standard feature. The card's setup program lets you configure the controller to mirror one SCSI device to another. The utility can also format the drive and duplicate data from one drive to another.

When an error occurs, the controller attempts to correct it. If the error cannot be corrected, the controller notes that the disk is bad in its internal EEPROM, and the disk is not used. The next time the system boots, the LDP Cache II's BIOS notifies you that one of the disks has failed and is no longer in use. Surprisingly, the controller board does not provide an audible alarm on drive failure.

We can't recommend the LDP Cache II strictly on performance, but only if high reliability is your primary goal and you don't already have a fast disk drive.

Memorable Results

We learned two important lessons from this Product Focus: first, that no two controllers are created equal (which is not as obvious as it sounds in this plug-and-play world); and second, that no two operating systems are created equal (which is much more obvious). During our testing, we discovered that those two facts wrapped themselves around one another. The result: Benchmark results for a controller running on one operating system won't adequately predict its performance while running on another operating system.

Unix and NetWare users will have a slightly more difficult decision to make than DOS users. That's because Unix and NetWare provide buffering and caching features built in. This raises two questions: Should you buy a controller with lots of RAM and hope the controller guesses right about buffer management? Or should you buy a less expensive (and theoretically less capable) controller and put the difference into host RAM, where the operating system can use it and, in theory, make more informed guesses? We suspect that cost-conscious people will choose the latter route; the small (track-buffering) caching controllers can provide you with more than acceptable performance at unbeatable prices (see "Buffering: The Lower-Cash Alternative" on page 176). Throughput-conscious souls will likely choose the former route—if you've got to squeeze every byte per second you can out of that disk system, a 4-MB caching controller might be just what you need.

For overall price and performance, we prefer PSI's hyperStore. Its multiple-personality design is unique, allowing you to run any of the popular hard disk drive interfaces from a single controller board. Its performance is a winner, too. Its scores ranked at or near the top for all the tests across all operating systems. If you run a large installation that consists of LANs, Unix workstations, and DOS machines, the hyperStore 1600 should do well on them all. Flexibility like that is hard to find. ■

Steve Apiki is a BYTE Lab testing editor/engineer. Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. You can reach them on BIX as "apiki" and "rick_g," respectively.

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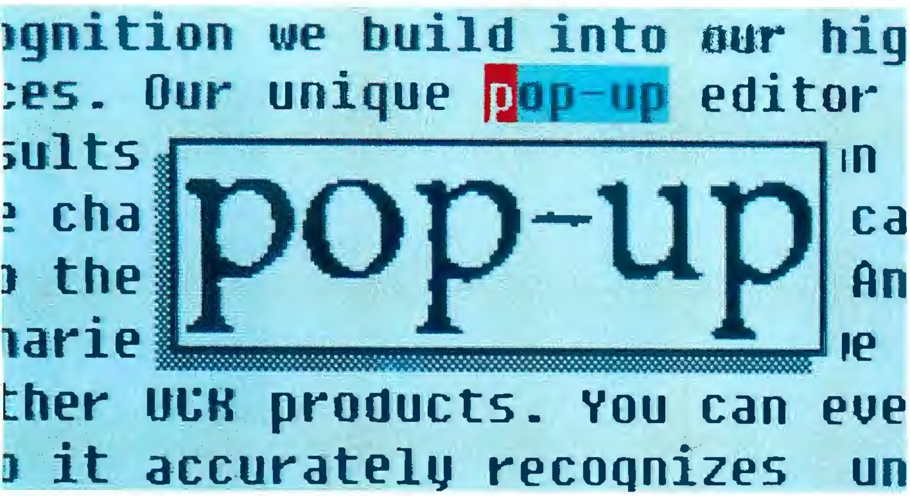

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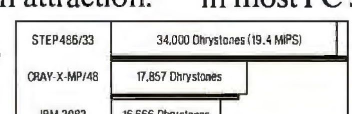

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SOFTWARE

Robert Mitchell

REVIEW

LAN Remote-Control Software: Better Than Being There

Remote-control programs have come a long way. The first programs worked exclusively with modems, but now remote users can exchange keystrokes and screen information with any other workstation on a LAN. These packages are handy tools for network administrators, technical-support personnel, or any user who wants to gain temporary access to another node's resources.

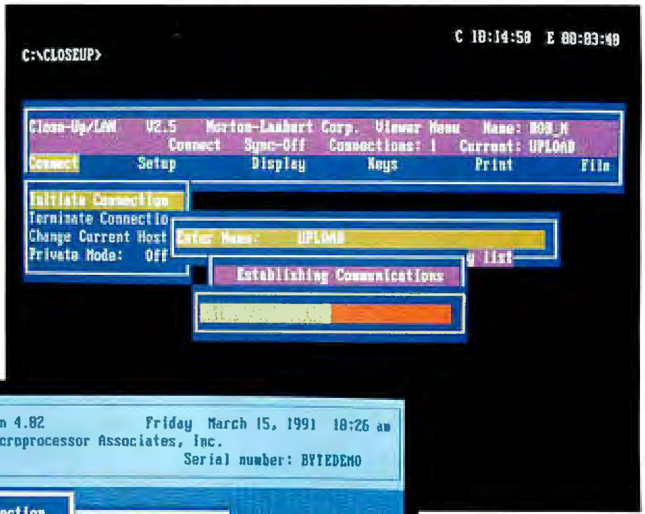
Some LAN remote-control packages support one-to-one connections exclusively; others let you simultaneously access many hosts and toggle between sessions. Still others let many remote users simultaneously control a single host machine. These one-to-many and many-to-one sessions are designed for training situations where a teacher wants to monitor each student's progress or wants all students to view the instructor's screen.

I reviewed six LAN remote-control programs that run on NetWare or NetBIOS PC LANs: Close-Up/LAN, Netremote+, The Network Eye, pcAnywhere IV/LAN, R2LAN, and Screen Monitor. In addition, senior editor at large Tom Thompson tested two products for Macs on AppleTalk Phase II LANs: Carbon Copy Mac 1.0 and Timbuktu 3.1 (see the text box "The Macintosh Takes Control" on page 190). Each program has its own terminology that describes the controlling and controlled machines; for clarity, I'll refer to them as the remote and host machines, respectively. Table 1 lists important features for each PC LAN product.

In the PC's increasingly graphical world, remote support would be incomplete without the ability to view host applications running in VGA mode. Surprisingly, many packages offer limited or no graphics support. All run in the background on the host machine, with memory requirements ranging from 2K bytes to 100K bytes, depending on the configuration. Other key features include host and remote security, session logs, chat windows, and performance-tuning options. At press time, no program supported a remote mouse on the PC, and sound support was limited to beeps generated through the BIOS.

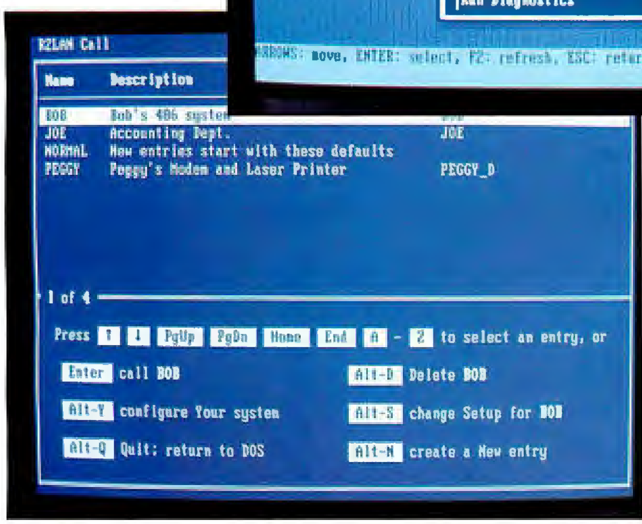
My PC LAN test-bed consisted of a NetWare 2.15 LAN that was running

Close-Up/LAN's simple pull-down menus make remote control easy.



System administrators can configure pcAnywhere IV/LAN host lists and tailor remote access rights for each user.

Netremote+ reads NetWare bindery files and presents remote users with a wealth of configuration and diagnostic information for any workstation on the LAN.



Once set up, the R2LAN dialing directory makes establishing connections a snap.

over a twisted-pair Ethernet. Test systems included a Club American 386SX, Gateway 386SX and 386/20 machines, and several Hyundai 286 systems.

I tested each package for compatibility with Quattro Pro 1.0, XyWrite 3.55, FoxPro LAN 1.1, Procomm Plus 1.1, and Windows 3.0. Windows posed the biggest challenge; the programs that ran it successfully required a special keyboard handler and supported Windows in real mode only.

To test host performance degradation I ran the BYTE low-level CPU benchmarks, first without the host software loaded and then with the software running and one remote connection active. At the remote machine, I measured screen response when running the applications suite; each package received a grade of pass or fail. Some programs update the remote screen at timed intervals; others perform updates only when the host screen changes. Dynamic updates create less network traffic and produce much faster screen response.

I judged each program by its ability to reproduce host graphics screens at the remote machine, performance, memory requirements, ease of use, security, pricing, and other features.

Close-Up/LAN

Norton-Lambert's Close-Up/LAN 2.5 is one of the most flexible and easy-to-use packages I tested. It has many advanced features, but you won't find them cluttering up the program menus; most run from the command line. Close-Up/LAN only supports text or CGA screens, and the $795 eight-user license fee makes this package the most expensive of the group.

Close-Up/LAN's Viewer lets you control workstations running the Host software. Both programs reside in memory. Viewer consumed 80K bytes of RAM on my test machine. Host occupied 54K bytes, but a menuless version fits into just 10K bytes.

Using Viewer's pull-down menus, you start up to 16 simultaneous sessions. You then toggle between sessions or go back to viewing your local screen while other applications continue to run on the host machines. Hosts can accept up to 16 remote sessions. Viewers can set up exclusive connections and disable the host keyboard and screen for privacy. You can even set up a host to alert remote users when a process completes on the host.

Close-Up/LAN automatically uses NetWare user names when you run Viewer or Host. It lists how many LANs and Close-Up users are available, but it doesn't tell you who those users are; you must know the host user name. The program doesn't support file transfers, but you can hot-key to your local screen and then copy files to the shared area of the file server, where the host machine can access them.

The Host menu lets you establish a master password and a Viewer password for each host machine. You can restrict remote users to viewing only, or you can restrict access by user name. As a host, you can also alert a viewer when you want to begin a session.

You can increase the number of host connections beyond 16 by daisy chaining—connecting to a host and then running Viewer on the intermediate machine to connect to a second host. This works as long as you reconfigure the Host and Viewer on each machine so that each has unique hot keys.

Close-Up/LAN doesn't support asynchronous sessions; for that you need Norton-Lambert's Support/ACS remote program ($245) and Customer/Terminal host program ($195). By running Customer/Terminal and Viewer on the host machine, remote users can call into one network node and control any other host.

Close-Up/LAN successfully worked with all host applications. On the remote side, Viewer was unable to run under Windows 3.0's V86 mode. Close-Up/LAN performed well overall. With one remote connection, host CPU performance didn't degrade significantly. Screen response at the remote machine was somewhat jerky at the command line, but all applications ran smoothly. Adjusting the scan interval settings on the host side improves the response somewhat.

Close-Up/LAN is ideally suited for teaching and other environments that require one-to-many or many-to-one sessions and don't need VGA graphics support. Its simplicity also makes it a good choice for the average user who wants to remotely take over an idle computer's modem or printer.

Netremote+

Brightwork Development's LAN remote-control package is a must for NetWare administrators, and its simplicity makes it ideal for other users as well. Netremote+ 4.1 supports one-to-one

PC LAN REMOTE-CONTROL SOFTWARE

Table 1: *LAN remote-control packages fall into two camps: those that support one-to-one connections exclusively, and those that support many simultaneous sessions per host or remote machine. The more advanced packages let remote workstations view host VGA-mode applications. All LAN remote-control packages run as TSR programs on the host machine, but memory requirements vary considerably. Once you've configured the host, Close-Up/LAN and pcAnywhere IV/LAN let you run small versions of the host software to save memory (●=yes; ○=no).*

	Close-Up/ LAN 2.5	Netremote+ 4.1	The Network Eye 1.23	pcAnywhere IV/LAN 4.02	R2LAN 2.0	Screen Monitor 5.1
Networks supported						
NetWare SPX/IPX	●	●	○	●	●	●
NetBIOS	●	●	●	●	●	●
Memory requirements (observed) (K bytes)						
Host TSR	10/54	15	2	20/62-80[1]	68-100[2]	18
Remote TSR	67-80	7	24	N/A	N/A	54
TSRs unload from memory	●	●	○	●	●	○
Graphics modes supported	CGA	VGA[3]	Text mode	VGA	VGA	EGA
Remote screen updates	Dynamic	Dynamic	Timed	Dynamic	Dynamic	Timed
Adjust screen update rate	●	●	○	●	○	○
Maximum concurrent sessions						
Per host	16	1	99	1	1	1[4]
Per remote	16	1	32	1	1	1[4]
Daisy chain sessions	●	●	●	●	○	○
Broadcast host screen	○	○	●	○	○	●
Host security						
Password access	●	●	●	●	●	○
Notify when connection made	●	●	●	●	●	●
Reject connection request	●	○	○	●	●	○
Terminate session	●	●	○	●	●	○
Restrict remote to view only	●	●	●	●	○	○
Allow/disallow host reboot	●	●	Always allowed	●	○	Always allowed
Set to reboot after each session	●	●	○	●	●	○
Remote security						
Disable host keyboard	●	●	○	●	●	○
Disable host display	●	○	○	●	●	○
Exclusive session	●	N/A	●	N/A	N/A	N/A
Asynchronous connections	Option	●	○	●	Option[5]	○
Chat window	●	○	○	●	●	○
File transfers	○	○	○	●	●	○
Redirect printing from host to remote	●	○	○	●	●	○
View list of available hosts	○	●	○	●	○	○
Host can initiate session	●	○	○	○[6]	●	○
Remote diagnostics	○	●	○	●	○	○
Session log	○	●	○	●	○	○
Price	$795 for 8 users	$350 per server	$295 per LAN	$495 for 2 users; $25 each additional user	$795 per LAN	$295 per server

[1] Small host requires 20K bytes. Standard host uses 62K bytes; file transfer capability requires an additional 18K bytes of RAM.
[2] Host requires 68K bytes; Chat feature and Guard security require an extra 21K bytes and 10K bytes of RAM, respectively.
[3] NetBIOS version supports CGA mode only.
[4] Supports one controlling machine on the network at one time but can broadcast screens to an unlimited number of workstations.
[5] Requires Remote 2, IBM Asynchronous Communications Server, or other protocol-compliant communications server.
[6] Host can initiate asynchronous sessions only.
N/A=Not applicable.

connections only, but it offers an easy-to-use interface for end users, as well as powerful remote diagnostics that will save network managers countless trips around the office. Netremote+ requires little memory, supports applications running in VGA mode, and includes Triton's remote-control dial-up software, Co/Session—all for $350 per server. It's also the fastest product I tested.

The Netremote+ host module requires just 15K bytes of RAM. The remote module runs from the command line or as a 7K-byte TSR program.

There's no host menu; command-line switches let you set the host password, break a connection, or unload the host program from memory. The remote menu lists all network nodes and station numbers, and it highlights those running as hosts. You can search for hosts by user ID, network address, or internetwork address.

When you select a computer, Netremote+ displays configuration information that includes the node's SPX/IPX version, network interface card type and settings, and network address. If the machine is operating as a host, Netremote+ attempts to determine the host system's CPU type, DOS version, video adapter type, current video mode, and memory configuration. You can then control the host PC, view additional configuration information, or run diagnostic tests.

Once you connect to the host, a pop-up menu lets you hang up or change your control options. Additional system information includes a memory map of the host system that lists programs running, the amount of memory used, and interrupts used. Server and network information is equally detailed. Diagnostics exercise server connections, analyze the network traffic at the host, and display LAN adapter and IPX statistics.

Using Netremote+ didn't affect the host performance significantly. Remote screen performance was noticeably faster than with R2LAN or pcAnywhere IV/LAN when running graphical applications. Tuning options determine how much host processor time Netremote+ gets and how often remote screen updates occur. Netremote+ ran all the application tests without problems, although Windows 3.0 required special tuning.

Netremote+ doesn't offer all the bells and whistles of R2LAN or pcAnywhere IV/LAN. But it's fast on graphics, and it provides invaluable information for system administrators. Unfortunately, the NetBIOS-compatible version of Netremote+ isn't as exciting. It only supports CGA graphics and doesn't offer any remote diagnostics capabilities.

The Network Eye

The Network Eye 1.23 is the only other product besides Close-Up/LAN that lets you control more than one workstation at a time. Artisoft's $295-per-LAN licensing fee is the lowest in the group, and the program requires just 2K bytes of RAM on the host. The program supports text mode only and works only with NetBIOS LANs (I used Novell's NetBIOS emulation program during testing).

The Network Eye is the only product besides Close-Up/LAN that lets you control more than one workstation at a time.

The Network Eye doesn't have menus. To initiate a session you press the insert key, which brings up a window, and enter the name of the workstation that you want to control. By repeating this process, you can have a "master" system control up to 32 "workstations" simultaneously. Conversely, a workstation can have up to 99 masters and can restrict access to viewing only. Masters can move or resize windows and can toggle between them. The Clipboard window lets you capture host screen information and transfer it between hosts, but it doesn't work with the local screen.

You won't find many advanced features in The Network Eye. There's no chat window or session log, for example, and you can't remove the software without rebooting. The manual is short and not well organized.

Performance was fair. On a controlled workstation with one master connected, CPU performance declined about 15 percent. At the controlling workstation, screen response time was good.

The Network Eye ran all applications satisfactorily except for Windows 3.0, which requires graphics support. The program also doesn't like `himem.sys` and `smartdrv.sys`. For text-mode applications, The Network Eye works fine. But with so many applications now requiring graphics screens, chances are that at least one user on your LAN will find this package inadequate.

pcAnywhere IV/LAN

This new product from Dynamic Microprocessor Associates (DMA) integrates both node-to-node and remote dial-up connections in one package. Its gateway function enables off-LAN users to dial in through a gateway machine to control any host machine. Alternately, you can share the gateway machine's modem with all LAN users for outgoing calls. Operations take place in the background, freeing the gateway system for other tasks. pcAnywhere IV/LAN 4.02 also supports remote connections to NASI/NCSI-compliant asynchronous communications servers, such as Novell's ACS.

pcAnywhere IV/LAN translates between graphics modes so that a remote monochrome, EGA, or CGA system can view applications running in VGA mode on the host machine. The program supports one active host session at a time, but you can "suspend" sessions and switch between them fairly quickly.

LAN administrators create a shared set of configuration files that define host machines, gateway machines, and access privileges for each remote user. Alternately, users can maintain their own configuration files locally. Hosts can set passwords and session time limits, log calls, allow background file transfers, and even record sessions and play them back to see what remote users did. Remote users can also maintain session logs.

One menu system controls gateway, host, and remote operations. You start by entering a three-character user ID, naming your machine, and then selecting host, gateway, or remote operation. Remote users can select from a predefined list of host and gateway machine names, and they can list currently available host machines.

pcAnywhere IV/LAN's diagnostics utility generates basic system configuration information and tests the communications ports, video subsystem, and keyboard for your local machine. It doesn't give you the same level of detail as Netremote+, however, and you can't run the diagnostics tests remotely.

All test applications ran without incident. Establishing a session didn't affect host performance significantly, but remote screen response could have been better in VGA modes. pcAnywhere IV/LAN reproduced the host VGA mode screens at about the same rate as R2LAN

The Macintosh Takes Control

Tom Thompson

The Mac LAN remote-control software market has two products: Farallon's Timbuktu 3.1 and Microcom's Carbon Copy Mac 1.0 (see table A). They function through various AppleTalk network implementations such as LocalTalk, EtherTalk, and TokenTalk. Both are TOPS-compatible. In the parlance of these products, the *host* is the Mac that is viewed or controlled, while the *guest* is the Mac that views or controls the host computer. Both host and guest use a single INIT and a desk accessory to provide remote-control services. The INIT installs critical drivers at start-up that manage the network connection, screen imaging, and mouse/keyboard control. The DA lets you set access rights and control file transfers. You also use this DA to select the host from a list of network names.

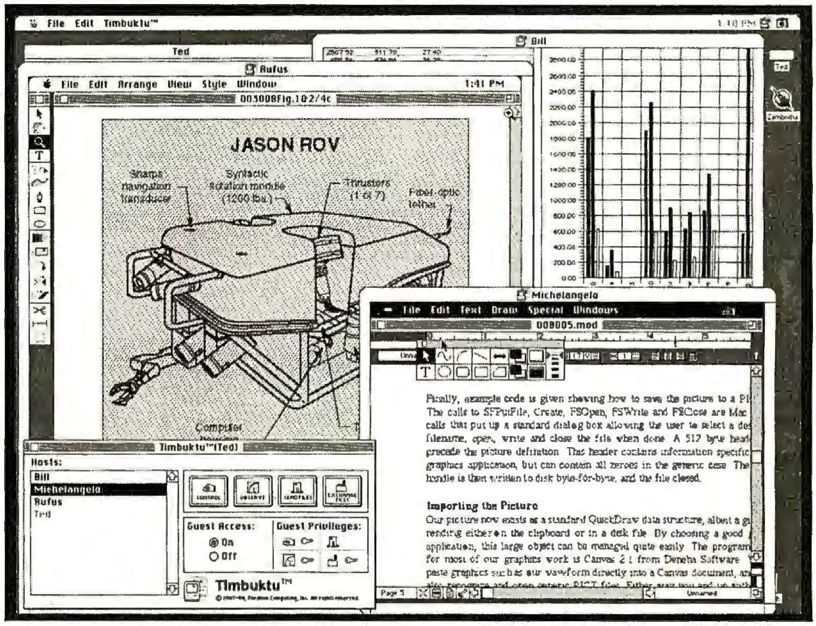
Timbuktu and Carbon Copy Mac let you passively view the host's screen or actively control the host using your own mouse and keystrokes. However, the host Mac always has the option of breaking the connection. Both provide peer-to-peer file transfer capabilities—that is, no server is required. Since a DA provides access control, you can connect and watch a host screen in a background window as you continue your work, even under the Finder. If the host has a larger screen than yours (e.g., if you're using a Mac SE to view a Mac II), the host screen is displayed in a draggable, scrolling window.

Only when the host screen changes does this software relay the changes to the guests. This lowers network traffic, but the overhead involved reduces the host's performance. On the Mac IIci, this performance penalty is scarcely perceptible; on a Mac SE, the system slows down noticeably when a guest connects.

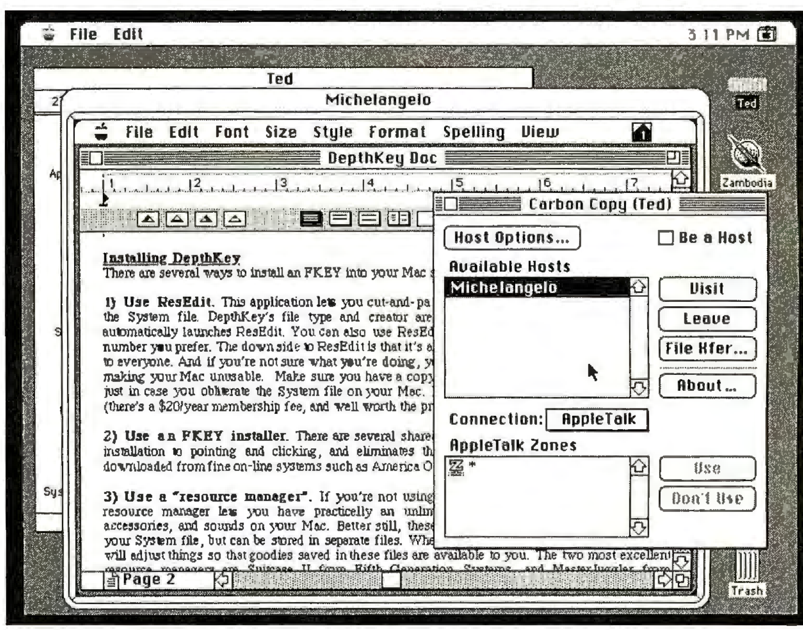
Both Timbuktu and Carbon Copy Mac relay only black-and-white screens to the guest, even if the host has a color display. This reduces the amount of data sent through the network, but it also makes remote work with color-imaging applications problematic. For the same reason, the host only relays beep signals to the guest; the actual beep sound is not reproduced on the guest Mac.

Timbuktu 3.1

Timbuktu ($298 for two users) lets you observe one or more host screens simul-



Timbuktu monitoring several sessions simultaneously. The Timbuktu DA window in the lower left is used to create connections to each host. Clicking on certain icons determines whether you control or view the host.



You can connect to a host via Carbon Copy Mac's DA window, seen at the right of the screen. You can monitor only one host at a time, in this case a Mac IIsi with a low-cost screen.

taneously. It provides a rich array of access controls for the network expert. A configurable password table lets you set varying levels of host access, as determined by the password that the guest uses to connect. Different passwords can provide combinations of control/view access and determine whether the guest can send, receive, or delete the host's files.

Timbuktu's menu-bar icon flashes when a guest connects to a host. This icon also provides a pull-down menu that supplies a guest log (i.e., who connected to the host); lets you modify the access rights (e.g., change a guest from a controller to a viewer); and disconnects a particular guest or all guests.

In a teaching environment, where dozens of Macs are guests to an instructor's computer, the host can "broadcast" its actions rather than maintain individual sessions with each guest. This reduces network traffic, but it can cause conflicts with routers or bridges that use the same broadcast socket (the network's logical address for broadcast data) to query the network for printers or other bridges. Timbuktu sidesteps this problem by allowing you to change the broadcast socket number.

Carbon Copy Mac 1.0

Carbon Copy Mac uses a minimalist interface that effectively spares the user from network details. It displays only a single host screen at a time. A two-user package costs $299.

A single password allows host access. The host configuration determines the guest's control privileges and file transfer capabilities. As a guest, you can select a specific network zone to search when looking for a host Mac.

You can set the host so that guests require the host's permission to connect. An alert box with the guest's name appears, and the host can approve or deny the connection. Unlike with Timbuktu, you can't be selective about disconnecting guests: Once you disable the hosting function, all attached guests are disconnected.

Carbon Copy Mac can also connect to a remote host via a serial connection. (Farallon offers a separate package, Timbuktu/Remote, to accomplish this.) A pop-up menu enables you to choose whether to use an AppleTalk or serial connection.

A Choice of Pathways

I used a Mac IIci, Mac SE, and Mac II for my networking tests. The only problem I encountered was a conflict between the Carbon Copy INIT and MasterJuggler 1.53 when booting the Mac IIci in the the host mode. My typical workday host of applications—MindWrite, MacWrite II, Photoshop, Illustrator, and White Knight 10.10—operated without problems.

While both products worked flawlessly, I found Timbuktu's refined networking controls more to my taste than Carbon Copy's minimal interface. My preferences are based on the fact that I maintain BYTE's AppleShare network; someone with less network experience might prefer Carbon Copy's setup to keep network matters simple.

Tom Thompson is a BYTE senior editor at large. You can reach him on BIX as "tom_thompson."

MAC LAN REMOTE-CONTROL SOFTWARE

Table A: *Both Carbon Copy Mac and Timbuktu support host graphics screens on the remote machine in black and white only. Timbuktu offers a broadcast mode that's handy in classroom situations. Carbon Copy Mac supports asynchronous dial-up connections as well as node-to-node sessions. Farallon supports asynchronous connections through its Timbuktu/Remote package.*

Product	Carbon Copy Mac 1.0	Timbuktu 3.1
Networks supported	LocalTalk, EtherTalk, TOPS, TokenTalk	LocalTalk, EtherTalk, TOPS, TokenTalk
Memory required		
Host and guest	250K bytes[1]	90K bytes[1]
Graphics support	Black-and-white viewing	Black-and-white viewing
QuickDraw/bit maps	Both	Both
Maximum concurrent sessions		
Per host	Limited by memory	Limited by memory
Per remote	1	Limited by memory
Daisy chain sessions	○	●
Broadcast host screens	○	●
Host security		
Password access	●	●
Notify when connection made	●	●
Reject connection request	●	○
Terminate session	●	●
Restrict remote to view only	●	●
Allow/disallow remote host reboot	●	●
Reboot after each session	○	○
Guest security		
Disable host keyboard	○	○
Disable host display	○	○
Exclusive session	●	●
Asynchronous connections	●	Option
File transfers	●	●
Host can initiate session	○	●
Session log	●	●
Price	$299 for 2 users; $199 each additional user; $999 for 15 users	$149 per user; $1995 for 30 users

[1] Additional memory usage determined by screen size and operating mode.
●=yes; ○=no.

REVIEW

did. Adjusting the screen update rate didn't help.

pcAnywhere IV/LAN's many unique features come at a price. An eight-user license costs $645. The program also takes its share of memory: It requires at least 62K bytes on a host—80K bytes with the background file transfer option. But once you've configured the host, you can run a small version of the software that uses just 20K bytes of RAM. And if you use a memory manager such as Quarterdeck's QEMM, you can configure pcAnywhere IV/LAN to automatically load into high memory on the host when the session begins. The remote software doesn't run as a TSR program. You can temporarily exit to DOS, but pcAnywhere occupies 465K bytes of RAM, leaving little room to run anything else.

pcAnywhere IV/LAN isn't as easy to use as Close-Up/LAN or Netremote+, but it's still one of the best programs I tested. Shared configuration files make administration a breeze, and its ability to support background gateway operations is a plus.

R2LAN

DCA's R2LAN 2.0 doesn't have fancy remote diagnostics capabilities, but it does support VGA screens and just about every feature you might want. It also has the most comprehensive security of any package I tested. R2LAN supports one-to-one connections only.

Setting up R2LAN takes some work up front. At each host you set up an account for each remote that includes a password and specific privileges. Only the host user or a remote user with system manager rights can work with these accounts.

At the remote machine, you set up a *dialing directory* that includes the host name, password, and a few caller options. A pop-up menu lets you end the session, transfer files, disable the host video and keyboard, redirect printing, and save text-mode host screens to disk.

For extra security, you can load a rights mask that restricts each remote user's access to specific host drives or directories, and curtails their access rights within those areas. Remote users can have read, write, create, delete, search, open, or modify rights.

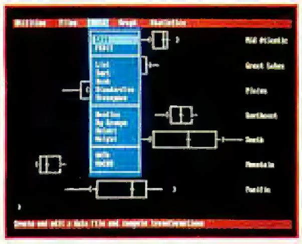
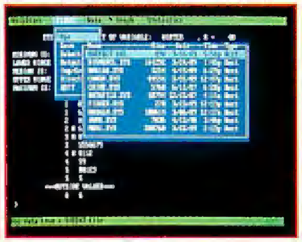
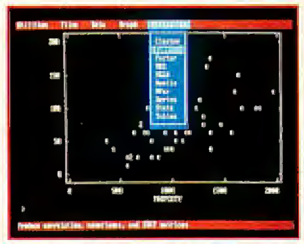
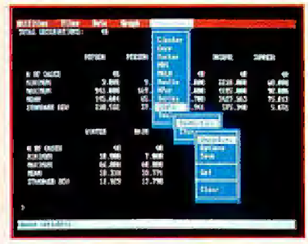
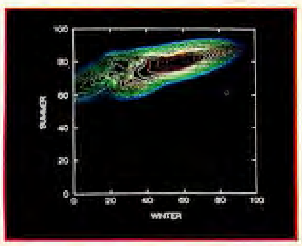
R2LAN ran the application test suite smoothly. Screen response at the calling machine was fast, except when running in VGA mode. R2LAN required about 20 seconds to draw a Quattro Pro pie chart that Netremote+ did in just 2 seconds. Establishing a remote connection

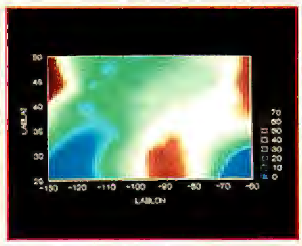
The best got better.

SYSTAT 5.0's new menus make the top-rated statistical program even easier to use.

V 4.1

SYSTAT is the *only* package to receive these three awards.




New Features Menus or commands – your choice • Rewritten documentation includes statistics tutorials • Fast, built-in drivers for SYGRAPH • Global mapping and many new plots • Multi way repeated measures • Means model for missing cells designs • Post-hoc tests • Interactive stepwise regression.

Statistics Basic statistics, frequencies, *t*-tests, post-hoc tests • Multi way crosstabs with log-linear modeling, association coefficients, PRE statistics, Mantel-Haenszel, asymptotic standard errors • Nonparametric statistics (sign, runs, Wilcoxon, Kruskal-Wallis, Friedman two-way ANOVA, Mann-Whitney U, Kolmogorov-Smirnov, Lilliefors, Kendall coefficient of concordance) • Pairwise/listwise deletion of missing values, Pearson correlation, SSCP, covariance, Spearman, Gamma, Kendall Tau, Euclidean distances, binary similarities • Linear, polynomial, multiple, stepwise, weighted regression with extended diagnostics • Multivariate general linear model includes multi way ANOVA, ANCOVA, MANOVA, repeated measures, canonical correlation • Principal components, factor analysis, rotations, components scores • Multidimensional scaling • Multiple and canonical discriminant analysis, Bayesian classification • Cluster analysis (hierarchical, single, average, complete, median, centroid linkage, k-means, cases, variables) • Time series (smoothers, exponential smoothing, seasonal and nonseasonal ARIMA, ACF, PACF, CCF, transformations, Fourier analysis) • Nonlinear estimation (nonlinear regression, maximum likelihood estimation, and more).

Graphics Overlay plots • Drivers for most graphics devices • *Two-dimensional:* Error bars • Scatterplots • Line and vector graphs • Vector, dot, bubble and quantile plots • Bar graphs (single, multiple, stacked, range) • Box plots (single and grouped) • Stem-and-leaf diagrams • Linear, quadratic, step, spline, polynomial, LOWESS, exponential smoothing • Confidence intervals and ellipses (any alpha value) • Smooth mathematical functions • Rectangular or polar coordinates • Log and power scales • ANOVA interaction plots • Histograms (regular, cumulative, fuzzy) • Stripe and jitter plots • Gaussian histogram smoothing • Scatterplot matrices • Voronoi tesselations • Minimum spanning tree • Maps with geographic projections (U.S. state boundary file included, county and world boundary files available) • Chernoff faces • Star plots • Fourier plots • Pie charts • Contour plots on regularly and irregularly spaced points • Control charts and limits • *Three-dimensional:* Data plots • Smooth function plots • Vector plots • Linear, quadratic, spline, least squares surface smoothing • Typefaces that print in perspective.

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Circle 310 on Reader Service Card (RESELLERS: 311)

didn't have a significant effect on host performance.

R2LAN supports remote dial-up connections on NetBIOS LANs that are running IBM Asynchronous Communications Server or compatible communications servers. Otherwise, you'll need Remote2 ($195) for off-LAN connections.

The R2LHOST program gobbles up 68K bytes of RAM. Adding a chat window (21K bytes) and Guard (10K bytes) increases the memory hit to almost 100K bytes. R2LCALL doesn't run as a TSR program. You can hot-key to DOS during a session, but you lose 155K bytes of RAM. Both programs can run under Desqview.

R2LAN is a good choice for LAN administrators who want to closely control access to host machines.

In smaller, more informal LANs, R2LAN's extended features and fancy configuration menus are probably overkill—especially when you consider the $795 per LAN price. But it's a good choice for LAN administrators who want to closely control access to host machines, and once set up, the package is easy to use. I liked R2LAN's well-organized and illustrated documentation and context-sensitive help screens. I'd like to see faster VGA screen updates and an option for callers to view a list of available host machines, but otherwise, the product is top-notch.

Screen Monitor

D-Link's Screen Monitor 5.1 does things a little bit differently. Here a "host" controls one "client" or views many client screens. The host can broadcast its screen to all clients, or capture any client screen and broadcast it to other clients on the LAN.

The host software requires 18K bytes of RAM. Only one host system can operate on the network at a time. A hot key brings up the menu. To control another workstation, you enter its name. The client screen then appears, and a "Remote Controlling [station name]" message flickers atop the screen in reverse video. I couldn't remove this message, which blocked part of the Quattro Pro menu.

You can monitor a client screen or create client groups that you want to monitor. Screen Monitor dutifully cycles through these screens, pausing for 3 seconds at each. You can stop cycling by holding down the F1 key, but there's no option to step through the screens or change the cycle time.

Screen Monitor doesn't have many other features. There's no chat window or file transfer capability. Clients can't restrict access by password or prevent a controlling user from rebooting their workstations. You can't hot-key to your local screen while controlling another workstation. The memory-resident host and client software won't unload without rebooting. Screen Monitor only supports graphics modes up to EGA. Documentation is also poor. But Screen Monitor's biggest weakness is its performance.

Controlling a client cut its performance in half. At the host machine, response time was unacceptably slow. Keystrokes took 1 to 2 seconds to echo back to the host system, and screen updates were jerky. Except for Windows 3.0, all the applications I tested ran fine. A conflict between `client.exe` and `smartdrv.sys` caused Procomm Plus to fail. Removing `smartdrv.sys` from the CONFIG.SYS file solved the problem.

As a remote-control tool, Screen Monitor doesn't cut it. Other programs offer more features, better performance, and the ability to have many remote workstations controlling hosts on the network simultaneously. This product is best suited to one-to-many teaching situations where rapid screen updates aren't an issue. For those users, the program's $295 per server price may make Screen Monitor worth considering.

Controlling Factors

For one-to-one connections over NetWare, Netremote+ offers the best combination of features and performance at a good price. It supports host VGA screens at the remote machine, executes fast remote screen updates without degrading host machine performance, provides asynchronous, off-LAN connections through bundled Co/Session software, uses little host memory, and, above all, is easy to use. The program's extensive remote diagnostics capabilities under NetWare are an invaluable tool for LAN administrators and support technicians. And at $350 per server, it's one of the

PC-MOS

The Multiuser DOS Platform For The '90s

The 386 and now the 486 microprocessors have focused a lot of attention on the multiuser, multitasking possibilities of advanced PCs. A myriad of software and hardware manufacturers are promising a new age of multiuser options in the '90s.

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The advantage to the PC-MOS shared processing solution is its ability to maximize the available memory on your PC, taking full advantage of extended memory and sharing it with up to 25 users on inexpensive terminals or monitors. You can share data with the same speed and integrity of a network solution without the expense of network cards and the waste of under-utilized PCs. And no additional investment is required to get the multitasking capabilities inherent in PC-MOS.

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Circle 326 on Reader Service Card (RESELLERS: 327)

COMPANY INFORMATION

Artisoft, Inc.
(The Network Eye 1.23)
575 East River Rd.
Tucson, AZ 85704
(602) 293-6363
Inquiry 1076.

Brightwork Development, Inc.
(Netremote+ 4.1)
766 Shrewsbury Ave.
Jerral Center W
Tinton Falls, NJ 07724
(800) 552-9876
(201) 530-0440
Inquiry 1077.

DCA
(R2LAN 2.0)
1000 Alderman Dr.
Alpharetta, GA 30201
(404) 442-4000
Inquiry 1078.

D-Link Systems, Inc.
(Screen Monitor 5.1)
5 Musick
Irvine, CA 92718
(714) 455-1688
Inquiry 1083.

Dynamic Microprocessor Associates
(pcAnywhere IV/LAN 4.02)
1776 East Jerico Tpk.
Huntington, NY 11743
(516) 462-0440
Inquiry 1079.

Farallon Computing, Inc.
(Timbuktu 3.1)
2000 Powell St., Suite 600
Emeryville, CA 94608
(415) 596-9100
Inquiry 1080.

Microcom Systems, Inc.
(Carbon Copy Mac 1.0)
500 River Ridge Dr.
Norwood, MA 02062
(617) 551-1999
Inquiry 1081.

Norton-Lambert Corp.
(Close-Up/LAN 2.5)
P.O. Box 4085
Santa Barbara, CA 93140
(805) 964-6767
Inquiry 1082.

Although not included in this review, the following companies also sell LAN remote-control software:

Fresh Technology Group
(LAN Assist Plus)
1478 North Tech Blvd., Suite 101
Gilbert, AZ 85234
(602) 497-4200
Inquiry 1084.

LAN Systems
(LANsight)
300 Park Ave. S
New York, NY 10010
(800) 458-5267
Inquiry 1085.

MicroNet, Inc.
(LANshare)
2356 Parkside Dr.
Boise, ID 83712
(208) 384-9137
Inquiry 1086.

Ultinet Development, Inc.
(Remote Access)
P.O. Box 34016
Los Angeles, CA 90034
(213) 204-0111
(remote control for OS/2 workstations)
Inquiry 1087.

least expensive programs I tested.

R2LAN and pcAnywhere IV/LAN are both better choices for NetBIOS LANs. They're more elaborate, more expensive, and not quite as fast or as easy to use as Netremote+. But each has unique capabilities that may make it a better choice for you. If host security is your primary concern, R2LAN should be at the top of your list. Otherwise, pcAnywhere IV/LAN gets my vote. It offers good security and has many unique features, including asynchronous gateway operation, that make the product worth DMA's asking price.

If you need to establish multiple simultaneous sessions, Close-Up/LAN is the clear winner. This easy-to-use program supports only CGA screens, but it requires little host memory and supports 16 sessions on each host and remote machine. ■

Robert Mitchell is a technical editor in the BYTE Lab. You can reach him on BIX as "rob_mitchell."

386 and 486 Windows users:

DOS Lives. Despite what you may have read.

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When Windows 3.0 says there's not enough room to run your DOS programs, it's just trying to tell you it needs QEMM 5.1.

Windows 3.0 may have been a big step forward for some programs.

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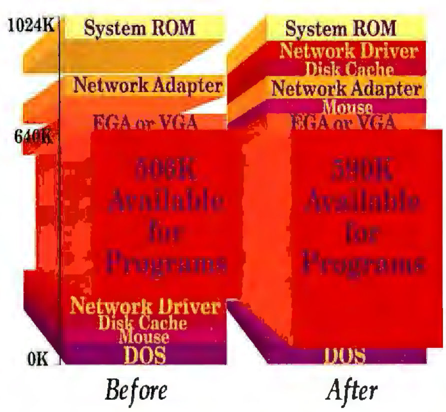
QEMM 5.1 works with the built-in capabilities of your 80386 or i486 processor to find and recover unused memory segments. As you can see in the chart, there are gaps in your PC's memory usage above 640K. QEMM 5.1 fills those gaps and provides more room for your DOS programs to run.

And of course, QEMM 5.1 still works with DOS when you're not running Windows. You get all the same benefits: up to 130K more memory to run the new generation of memory-hungry programs; space for larger spreadsheets and database files.



Unused memory is like hidden gold in your PC. QEMM finds it and makes it available.

Introducing DESQview 2.3 and DESQview 386 2.3 for users of Windows 3.0

They said it couldn't be done, but DESQview 2.3 can run Windows 3.0 programs. Not just in Windows "Real mode" but in "Standard" mode. That means programs can be up to 16MB.

And it can run DOS programs and DOS-extended programs i.e., 1-2-3 Release 3, side-by-side.

DESQview 386 2.3 does all that and more. It lets you run 386 DOS extended programs like AutoCAD 386 and IBM Interleaf side-by-side.

DOS, extended DOS; Windows—whatever standards you set, we will support. We're committed to helping you get the most out of your hardware and software today. And tomorrow.

QEMM-386 System Requirements: 80386-based PCs and PS/2s and PCs with 80386 add-in boards. Operating system: PC DOS 2.0-4.0, MS DOS 2.0-4.0, Windows 3.0. Conventional memory requirement 1.5K.

DESQview System Requirements: IBM Personal Computer and 100% compatibles (with 8086, 8088, 80286, 80386 or i486 processors) with monochrome or color display; IBM Personal System/2 • Memory: 640K recommended; for DESQview itself 0-155K • Expanded Memory (Optional): expanded memory ards compatible with the Intel AboveBoard; enhanced expanded memory boards compatible with the AST RAMpage; EMS 4.0 expanded memory ards • Disk: two diskette drives or one dis ette drive and a hard disk • Graphics Card (Optional): Hercules, IBM Color/Graphics (CGA), IBM Enhanced Graphics (EGA), IBM PS/2 Advanced Graphics (VGA) • Mouse (Optional): Mouse Systems, Microsoft and compatibles • Modem for Auto-Dialer (Optional): Hayes or compatible • Operating System: PC-DOS 2.0-4.0; MS-DOS 2.0-4.0 • Software: Most PC-DOS and MS-DOS programs; programs specific to Microsoft Windows 1.03-3.0, GEM 1.1-3.0, IBM TopView 1.1 • Media: DESQview is available on either 5-1/4" or 3-1/2" floppy diskette.

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	DESQview 386 2.3 (includes QEMM)			$219.95	
	DESQview 2.3			$129.95	
	Shipping & Handling $5 in USA/$10 outside USA				
	California Residents add 6.75%				
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Tom Badgett and Corey Sandler

REVIEW

"Ultra" VGA Debuts on the MicroPaq

Photo 2: *A MicroPaq board with an Edsun Labs graphics chip displayed this 35,000-color demo image on a VGA monitor. At press time, drivers weren't available to run commercial software.*

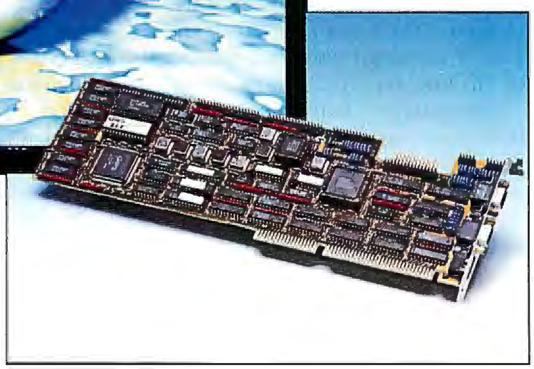


Photo 1: *Monolithic's MicroPaq 452 Ultra uses a custom graphics chip from Edsun Labs to simultaneously display 700,000 colors on a standard VGA monitor.*

On the surface, Monolithic Systems' MicroPaq 452 Ultra looks like a handy multifunction board that enables you to install hard and floppy disk drive controllers, parallel and serial ports, and a graphics adapter into a single expansion slot. But run it with a custom software driver on a standard VGA monitor, and you'll see its secret. An Edsun Labs Continuous Edge Graphics (CEG) chip on the board displays graphics images on a standard PC that rival those seen on some high-end engineering workstations.

The Edsun CEG chip eliminates jagged oblique lines (aliasing) while displaying over 700,000 colors; standard VGA displays support a maximum of 256 simultaneous colors. You can think of the chip design as the "TV approach" to computer display. Even though screen resolutions are only 525 lines, broadcast TV images don't suffer from the jaggies, thanks to the large number of colors used in TV broadcasts. Instead of trying to achieve higher and higher actual resolutions, the Edsun design relies on thousands of colors and the ability to combine two colors in a single pixel. This fills in the edges of lines that would appear jagged with conventional technologies.

The color approach to improving apparent resolution works because beyond resolutions of 400 lines or so, the human eye can't distinguish between actual resolution improvements and color enhancements that produce apparent improvements in resolutions. And because the images run on a standard fixed-frequency VGA display, there's no need to spend extra money on a high-resolution display.

CEG Explained

Monolithic Systems is one of the first vendors to ship the CEG chip in production versions of motherboards and multifunction cards (see photo 1). Monolithic markets the $765 MicroPaq 452 Ultra primarily for CAD, business graphics, and desktop publishing applications.

Edsun's CEG/DAC (D/A converter) is a pin-for-pin replacement for most of the popular RAM/DAC chips used in current VGA display adapters, including the Brooktree BT471/8 and Analog Devices ADV476 chips. Edsun supplies its chips in various packages to match different RAM/DAC configurations. The chip itself costs board manufacturers about $20 and requires little or no hardware redesign to reside on existing VGA boards, according to Edsun.

Although commercial versions of the hardware were shipping at press time, custom video drivers that support the CEG technology weren't available when we evaluated the board. Monolithic says it plans to be shipping drivers for Lotus 1-2-3, AutoCAD, and Windows 3.0 by the time you read this. Edsun is writing driver software for these environments and is releasing code to encourage developers to write for other applications. Edsun believes the technology could encourage software developers to combine graphics with databases, for example.

Software that takes advantage of the new chip does not store or "remember" every color to be used in an image. Rather, the application specifies some of the colors, and the chip calculates the rest. Separate red, green, and blue processors positioned between the color lookup table and the DAC output compute color points between known colors.

CEG images are generally conversions of existing files, such as TIFF or TARGA images. The CEG format reduces storage requirements yet retains image information down to $1/32$ pixel, according to Monolithic. For example, a 640-pixel by 480-line VGA image with 75,000 colors requires only 308K bytes of space. Higher-resolution images require more storage space, but the CEG format can still be more efficient than some other formats for graphics images.

Monolithic Achievement

Monolithic's implementation of the CEG chip is a good one. It turned our standard VGA monitor into a surprisingly capable graphics station. This full-size, 16-bit card includes dual serial ports, a parallel port, an Intelligent Drive Electronics

MicroPaq 452 Ultra

Company
Monolithic Systems Corp.
7050 South Tucson Way
Englewood, CO 80112
(800) 525-7661
(303) 790-7400

Hardware Needed
IBM AT or full-size compatible with a VGA monitor

Price
$765

Inquiry 1061.

PHOTO 2 IMAGE COURTESY OF THE UNIVERSITY OF CALIFORNIA—DAVIS © 1991

(IDE) hard disk drive interface, a dual-floppy disk drive controller, and the Edsun-based display adapter.

The IDE interface is designed for the industry's AT intelligent drives. We ran the hard disk drive controller with a Control Data Imprimis 143-megabyte hard disk drive with no compatibility problems. Likewise, we used the floppy disk drive controllers with a variety of drives without a snag.

The IDE interface is designed for the industry's AT intelligent drives.

We configured the serial ports as COM3 and COM4 so we could use them in conjunction with the existing motherboard-based COM1 and COM2 ports. You can set the serial and parallel ports to address all DOS-supported locations through on-board jumpers. Monolithic supplies the cables and connectors you'll need to hook up all the I/O ports, including the IDE drive. You can use jumpers or switch settings to disable each of the ports individually if you have these facilities on your motherboard.

We plugged the MicroPaq 452 Ultra into a low-profile CompuAdd 386SX, and although the full-size card was a tight fit, it worked fine. Without any special software, the display is sharp and crisp—just what you would expect from a high-quality VGA card. When we turned on the MicroPaq's mode drivers, it looked like no other VGA display we have seen (see photo 2). Demonstration images from Edsun, supplied as part of the Monolithic package, shows scanned photographs, computer-generated art, line drawings, and even moving graphics with 75,000 colors displayed simultaneously.

The display adapter uses the Chips & Technologies 82C452 video controller for high-performance VGA graphics in resolutions of 1024 pixels by 768 lines (this requires a multisync monitor designed to support this resolution). But even at the standard 640-pixel by 480-line VGA resolution, the results were striking. The extra color gives the illusion of very high resolution through subtle shading, hue, and intensities.

Interestingly, you don't need nearly this many colors for truly striking displays. Some images with "only" 3000 or 4000 colors look like engineering drawings that we've seen on $250,000 workstations. In addition, all these images were a relatively compact 308K bytes.

The Micropaq did indeed remove the jaggies. It achieves straight lines primarily by filling in the ragged edges with extra color. This makes some lines appear a bit fatter than their jagged counterparts, but the results are impressive.

A WYSIWYG Natural

Monolithic Systems is targeting the MicroPaq 452 Ultra for three basic applications. One is CAD, where jaggies exist even at 1024-pixel by 768-line resolutions. Second, image displays, such as image databases or scanned-image presentations, could use the board's multicolor capabilities for more realistic displays. Finally, Windows applications that make use of WYSIWYG and graphics may also benefit from the antialiasing features. For example, italics and small fonts displayed in Excel or Microsoft Word for Windows are difficult or impossible to read on conventional displays.

The biggest short-term problem with the MicroPaq is the lack of applications that take advantage of the board's capabilities. If third-party developers decide to support CEG technology, we could see some very significant and welcome changes in the looks of the applications we use.

At $765, the MicroPaq 452 Ultra is expensive if you only need the video display adapter. But Monolithic says it is working on a video-only version of the board. For users whose systems are already configured with disk drive controllers and I/O ports, it is probably better to wait for that version to come out. However, if you're using separate plug-in cards for disk drive controllers and I/O ports, the MicroPaq saves slot space and can display images on a VGA screen that you truly have to see to believe. ■

Tom Badgett and Corey Sandler review hardware and software products for Word Association, Inc., a consortium of high-tech authors. They can be contacted on BIX c/o "editors."

Greg Loveria

REVIEW

TARGA+ Lowers Cost of High-End Graphics

I produced this hypothetical Kennedy Memorial using the TARGA+ adapter's 32-bit and 16-bit modes with AT&T's Topas 3-D Modeler and Truevision's TIPS capture and paint software. The main structure was created as a DXF wire frame in AutoCAD (as shown in the lower left). This was converted to a Topas Model (MDL) file using AT&T's CAD translator. The model was then imported and rendered in the TARGA+ adapter's 32-bit mode using Topas. The still of the planned site was captured from videotape. The brass title plate, wood frame, and site still were reflection- and texture-mapped to 3-D objects created in Topas (original DXF file courtesy of Douglas Persson; file-image-to-slide conversion courtesy of Image Center).

Since the mid-1980s, Truevision's TARGA (Truevision Advanced Raster Graphics Adapter) raster-graphics boards have stood as a cornerstone for professional-quality graphics and image generation. Medical imagers and TV stations were among the first to employ TARGA boards for creating and capturing images at the NTSC-compatible resolutions of 512 pixels by 486 lines in varying bit-plane pixels (bpp) and color depths. In short, a TARGA image doesn't look computer-generated; it is more akin to TV output.

Until now, to get such high-quality graphics, you'd have to spend about $5000 to implement 32-bit color on TARGA 32 adapters, which can display over 16 million colors per image. TARGA adapters also required an NTSC composite or an RGB analog display monitor with a 15.5-kHz horizontal scanning frequency (the standard VGA frequency is 31.5 kHz at 640- by 480-pixel resolution). Total costs were out of reach for many enthusiastic, but budget-conscious, graphic artists or computer imagers.

Truevision's new TARGA+ series addresses all these issues and more. For example, the TARGA+ 64 board, with 2 megabytes of on-board memory, costs just $2495, 50 percent less than previous 32-bit TARGA boards. Other TARGA+ adapters, like the TARGA+ 16 and the TARGA+ 16/32, retail for $1795 and $1995, respectively. Both boards have 1 MB of DRAM. They differ only in the number of colors they can display.

With the TARGA+ series boards' lower prices, many users formerly priced out of the market can now afford raster imaging. This includes advertising agencies and corporate art departments that can use TARGA adapters for advertising campaigns and layouts. Professional printers also use raster imaging for prepress work, such as electronic color separation of photographs, which traditionally is done by hand.

Imaging Plus

The TARGA+ 64 adapter that I tested is a full-slot, 16-bit ISA board. A Macintosh model, called the NuVista+, is also available, as is a Micro Channel architecture version, the first TARGA to support Micro Channel machines. Two nine-pin D-shell connectors serve as the analog video I/O ports for the ISA board.

Two proprietary on-board application-specific integrated circuits represent the major revisions in the "plus" line. The first, a CTL (for Condensed TARGA Logic) chip, helps reduce board component circuitry to lower manufacturing costs and eliminate the daughterboard attachments found on earlier TARGAs. A second ASIC, the TVG-MIX-V2, provides software-controlled video mixing and special-effects functions. (Unlike a Texas Instruments Graphics Architecture graphics board, TARGA adapters have no on-board processor.)

The TVG-MIX-V2 chip supports a host of software-controlled video special effects that can simulate high-end video production techniques such as image fades, image reversal, graphics over live video, and chroma keying. In the latter, a foreground video object moves against a color-keyed background video image, as when a TV weather forecaster moves in front of a weather map. The chip also controls VGA pass-through. You can connect a TARGA+ adapter to a VGA card's feature bus to enable VGA text and graphics pass-through to the TARGA+ adapter's RGB output monitor.

For testing, I used an Associates Computer Supply 386/25 tower system running DOS 3.31 with 640K bytes of base memory and 8 MB of DRAM configured as expanded memory using QEMM software. A Relisys RE5120 monitor functioned as my primary VGA display. I also used a Relisys RE5155 multiscan monitor (operating at 15.5-kHz horizontal bandwidth) for RGB/TARGA output display and VGA text and graphics pass-through testing.

Plug-and-Play

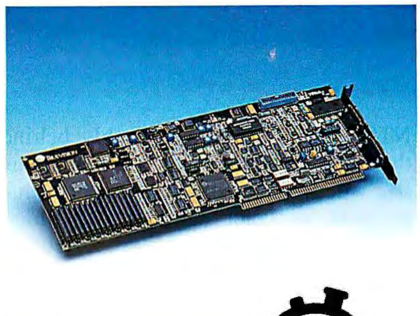
Two spiral-bound reference and installation manuals clearly explain the myriad settings for three on-board banks of DIP switches. The SW1 bank controls board I/O base address functions. I kept the default address setting at 0x220, although eight locations are possible. I left switch SW2 in the default down position to control horizontal/vertical sync output. In the up position, the board processes S-Video signals. S-Video (also known as S-VHS), which was originally developed for TV broadcasts, separates the signal luminance and color bandwidths, providing superior image quality—400 lines versus the 230-line VHS resolution. Bank switch SW3 controls interrupt requests; I left this in the shared interrupt default position, although five different IRQ settings are possible.

I currently use a TARGA 16 adapter for imaging and animation. After removing that board, I placed the TARGA+ 64 in the empty 16-bit slot. To enable VGA overlay and pass-through features, I connected one of the two ribbon cables shipped with the unit from the TARGA+ adapter's 26-pin male connector to my Trident VGA card's edge-card-type feature bus. The second ribbon cable ends in a 26-pin female connector. I used this cable to test Diamond Computer Systems' SpeedStar VGA card, which has a 26-pin male feature bus. Both cards functioned perfectly when connected to the TARGA+ 64.

The TARGA+ 64 adapter functions in two modes: standard TARGA board emulation and TARGA+ mode. At the DOS prompt, I typed in TPLUSINI.T16 (you can replace "16" with 8, 24, or 32 to specify the proper emulation). The TPLUSINI command places the TARGA+ into original TARGA mode. I then invoked my three-dimensional animation program, AT&T's Topas. I was extremely pleased to see the software function perfectly.

After exiting, I reinitialized the board to TARGA 32-bit emulation. When I reentered Topas, the TARGA+ was running as a 32-bit adapter. I then used a commercial version of Truevision's TIPS paint and capture software to capture video images, as shown in the photo (a demo version of TIPS also comes with the TARGA+ board).

Again, all the software and normal TARGA hardware features, such as zoom and image digitization, functioned perfectly. I didn't expect to see a difference in the final 32-bit images, but I was wrong. In the 32-bpp mode, rendered objects appeared more realistic and fluid than duplicate objects rendered in the 16-bpp mode.



TARGA+ 64

Company
Truevision, Inc.
7340 Shadeland Station
Indianapolis, IN 46256
(317) 841-0332

Hardware Needed
XT or AT with one free full-length 8- or 16-bit slot, VGA monitor, RGB multiscanning analog monitor, VGA card with feature bus I/O, and at least 640K bytes of RAM

Software Needed
TARGA applications software; applications software written specifically for TARGA+ required for TARGA+ mode

Price
$2495

Inquiry 1108.

TARGA+ Mode

To invoke TARGA+ operation, I put the command DEVICE=C:\DOS\TARGAP.SYS into my CONFIG.SYS file and rebooted. TARGA+ mode enables the VGA text and VGA graphics overlay and pass-through to the TARGA+ adapter's RGB monitor. This gives you a one-monitor solution, but only if you're using TARGA+ software specifically developed to run in TARGA+ mode. The TARGA+ will run all original TARGA software, such as TIPS and Topas, after you reinitialize the board with TPLUSINI, which disables VGA text and graphics pass-through.

At press time, Truevision offered two software packages that operate in the TARGA+ mode: the TIPS paint and capture program and TIPS TypeRight, a font-generation program for TARGA images. Panorama+, from AT&T-Graphics Software Labs; i.m.a.g.e., from New Image Industries; Inscriber, from Image North Technologies, and are third-party applications that support "plus" mode. According to Truevision, third-party manufacturers are developing or revamping original TARGA software to take advantage of the TARGA+ mode environment.

In the meantime, TDEMO.EXE is the program that really highlights the TARGA+ mode. I input an NTSC composite VHS video signal from my VCR into the TARGA+ video input connector. An extremely clean and smooth transitional fade between two TARGA Truevision logo images begins the demo. NTSC video fades in smoothly behind the logos. After the logos fade behind the live video, the moving images perform a reversal, or color negative. All video movement was clear and fluid; it actually looked better on the RGB monitor than on TV. A live video then fades into VGA text overlaid on a still-frame capture from the videotape.

Finally, the demo displays multiple single-frame captures of video in rapid sequence. Live-video movement displayed with this FX feature appeared animated. The program grabs and displays a video frame for about a half-second, causing objects to jerk from one position to the next, an effect similar to that of a strobe light on moving dancers. Video production equipment that performs this frame grab/hold/display technique alone can cost several thousand dollars. The technique is also used in music videos.

TMODE.EXE is an interactive program that sets TARGA+ resolution, pixel depth, and video format. There are 20 possible NTSC/VGA resolutions and 14 possible PAL display resolutions. To execute PAL resolutions, you must use the European version of the TARGA+ adapter.

After setting my board to NTSC (512 by 486 pixels by 32 bits, noninterlaced) using TMODE, I used a small TSR program, TPLUSTSR.EXE, to switch among TARGA+ output, VGA output, VGA overlay, and overlay color selection. By keying Ctrl-Shift-F2 and then Ctrl-Shift-F3, I passed VGA text and graphics to the RGB monitor. I used a shareware GIF file viewer, VPIC, to view 640- by 480-bit and 800- by 600-bit by 256-color GIF pictures rescaled to the 512- by 486-bit resolution on the RGB monitor. Both VGA graphics and text were extremely clear and readable.

TARGA Tally

At first, I was dismayed to find that the TARGA+ adapter's VGA pass-through/overlay modes and video-effects features don't function in the original TARGA software mode. However, this board creates very real possibilities for imaginative software developers. I would be thrilled to see software that incorporates the TARGA+ adapter's video mixing and graphics overlay capabilities into a videotape-editing software module. With a single-frame VTR controller board like DiaQuest's DQ-50P, you could emulate high-end mixing and editing consoles used in TV broadcast production via software-controlled insert-edit points.

Overall, I rate the TARGA+ a winner, not only because you can now do raster-graphics imaging in true 32-bit color at half the price, but also because I can't wait to see the new software that this board will inspire. ■

Greg Loveria has used TARGA boards for three years as a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be reached on BIX c/o "editors."

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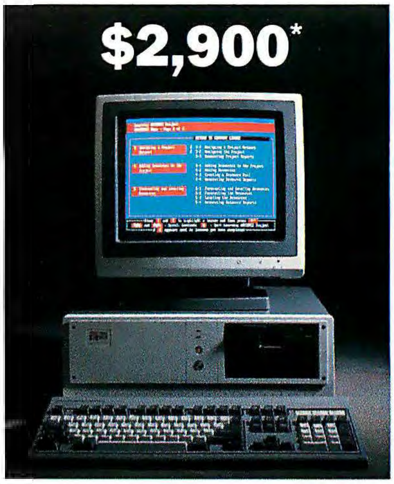

TEXAS MICROSYSTEM 4108
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- Choice of 80286, 80386, 80486 processors.
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- 8 full length ISA slots for industry standard cards.
- Up to 16MB of RAM on CPU, three half-height 5.25" bays for floppy/hard drives and one 3.5" hard drive.
- Super VGA graphics (1024 x 768 pixels) Also supports CGA, EGA.
- 1 parallel and 2 serial ports.
- 101-key enhanced keyboard with DIN connector on rear panel.
- 220 watt power supply.
- One year, on site warranty included.

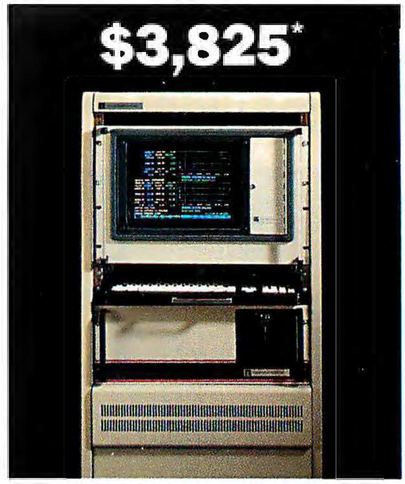
Specifications

- Dimensions: 6.5" x 17" x 16.5," 30 lbs.
- Power 220 Watt, 110 V.
- Operating environment.
  Temperature: 0°C to 55°C. (32°F to 131°F)
  Altitude: 15,000 feet equivalent

System Prices

Model	CPU/ MHz-RAM	Storage	Price
4216	286/16-1	40MB HD, 1.2 or 1.44MB floppy	$2,900
4320	386/20-1	40MB HD, 1.2 or 1.44MB floppy	$3,755
4325	386/25-1	104MB HD, 1.2 or 1.44MB floppy	$4,530
4333	386/33-2	104MB HD, 1.2 or 1.44MB floppy	$5,135
4425	486/25-4	104MB HD, 1.2 or 1.44MB floppy	$5,995

*From $2,900. Monitor not included.



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Features

- Choice of 80286, 80386, 80486 processors.
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- 14 full length ISA slots for industry standard cards.
- Boards bracketed and braced on all four edges.
- Two 110 CFM fans.
- Up to 16MB of RAM on CPU, and five half-height storage bays for hard drives, floppy and/or tape backup.
- Super VGA graphics (1024 x 768 pixels) Also supports CGA, EGA.
- 1 parallel and 2 serial ports.
- Built in speaker, door lock, power and CPU reset switch.
- 101-key enhanced keyboard with DIN connector on front panel.
- 225 watt power supply.
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- Dimensions: 19" x 22.18" x 6.96." Wt. 45 lbs.
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  Vibration: .25G, 5-100Hz operating
  5G, 5-100Hz non-operating
  Shock: 1.0G operating at 10 Msec duration

System Prices

Model	CPU/ MHz-RAM	Storage	Price
3216	286/16-1	40MB HD, 1.2 or 1.44MB floppy	$3,825
3320	386/20-1	40MB HD, 1.2 or 1.44MB floppy	$4,650
3325	386/25-1	104MB HD, 1.2 or 1.44MB floppy	$5,430
3333	386/33-2	104MB HD, 1.2 or 1.44MB floppy	$6,040
3425	486/25-4	104MB HD, 1.2 or 1.44MB floppy	$6,895

*From $3,825. Rackmount monitor not included.

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Robert Mitchell

REVIEW

The Compaq SLT: A Laptop Fit for the Desktop

Compaq's new SLT offers more power and expandability than any other laptop computer BYTE has tested.

SLT 386s/20

Company
Compaq Computer Corp.
20555 State Hwy. 249
P.O. Box 692000
Houston, TX 77070
(800) 231-0900
(713) 370-0670

Components (as reviewed)
Processor: 20-MHz 386SX CPU; 20-MHz 80387SX math coprocessor
Memory: 4 MB of system RAM; 4K bytes of processor cache SRAM
Mass storage: 120-MB Conner Peripherals hard disk drive; high-density 3½-inch floppy disk drive
Display: 10-inch VGA-compatible supertwist LCD with fluorescent backlighting
Keyboard: 82-key IBM Enhanced layout
I/O interfaces: Serial port; parallel port; external VGA monitor port; external floppy disk drive or tape drive port; expansion chassis port; external keypad port

Size
4⅛ × 8½ × 13½ inches; 14 pounds

Price
$9497

Inquiry 1112.

Compaq's SLT 386s/20 has blurred the line between laptop and desktop machines.

The original SLT's 12-MHz 286 CPU has given way to a 20-MHz 386SX processor that uses the same 4K-byte set-associative static RAM cache found in the Deskpro 386s/20. Compaq has increased the base configuration memory from 640K bytes to 2 megabytes, increased maximum RAM from 3.6 MB to 14 MB, and upped maximum hard disk drive storage to 240 MB—that's probably more than most users will ever need.

From the outside, the boxy-looking SLT, with its removable keyboard and fold-up VGA display, looks much the same. It still weighs in at 14 pounds, and the system's 4⅛-inch height (with the display folded down) makes it perhaps the tallest laptop on the market. It's also one of the most rugged.

Name Your Price

The entry-level Model 60 includes a 2½-inch 60-MB Connor Peripherals hard disk drive, a 3½-inch high-density floppy disk drive, and 2 MB of RAM for $6799. I tested the Model 120, which includes a 120-MB 19-millisecond Conner Peripherals hard disk drive and lists for $7499.

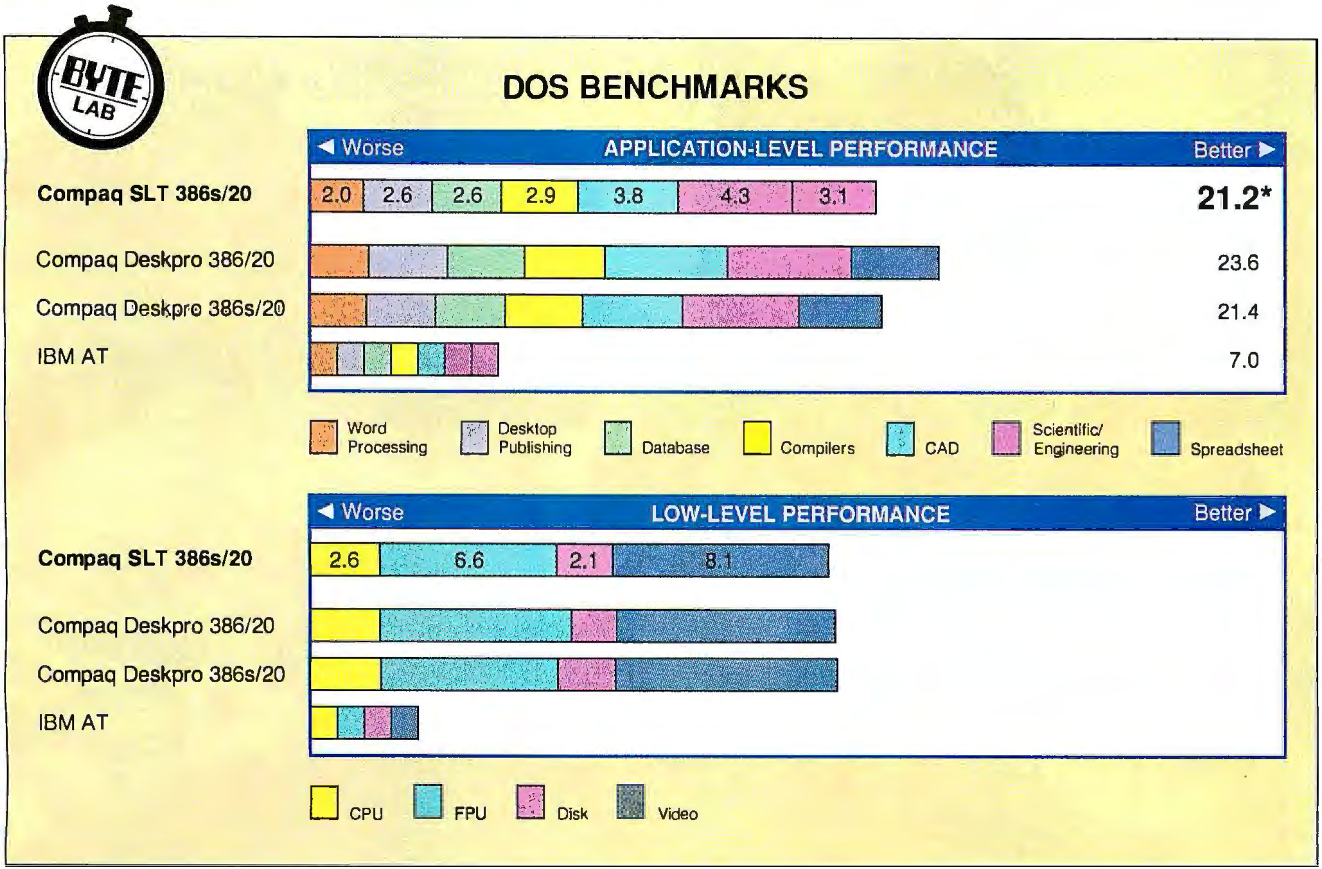
Compaq offers a variety of options for the SLT. You pay the price for Compaq's proprietary memory modules; my test machine included an extra 2 MB that adds $1299 to the list price. With the memory upgrade and a 20-MHz 80387 math coprocessor ($699), the total price came to an astounding $9497.

But don't pull out your checkbook just yet. The machine's confusing keyboard overlays make the external numeric keypad ($149) a must for spreadsheet users. If you opt for the internal 2400-bps modem ($599) you'll find that it cuts battery life to about 1½ hours, so you'll probably want an extra nickel-cadmium battery ($149). And since the machine won't fit in your briefcase, you'll probably want to buy the carrying case ($89).

Projecting Growth

The SLT has plenty of room to grow. If 120 MB of disk storage isn't enough, a second device bay can hold another 60- or 120-MB hard disk drive. The machine doesn't have any expansion slots; for that, you need the expansion base ($999), a rather large box that holds just two 8- or 16-bit add-in boards.

Compaq doesn't offer an internal network adapter, so if you need to access the office network, you may want the expansion chassis. But you can save space on the desktop by forgoing the expansion box, installing a Xircom or D-Link par-



CONVENTIONAL BENCHMARKS

	LINPACK (single) (MFLOPS)	Dhrystones (Dhry./sec.)
Compaq SLT 386s/20	0.15530	7934.6
Compaq 386/20	0.16970	8449.7
Compaq 386s/20	0.15560	7938.5
IBM AT	0.02105	2317.9

For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies performance differences between machines at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

The BYTE Lab introduced version 2.0 of the DOS benchmarks in the August 1990 issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

allel port network adapter, and hooking the office monitor and keyboard directly to the SLT.

On the Test Bench

The SLT's VGA supertwist LCD is fast, but it could stand improvement. Newer displays, such as the one in Texas Instruments' 286-based TravelMate 2000, are sharper and brighter, and they offer 16 gray scales to the SLT's eight. Also, the SLT cuts power to the LCD when you hook up an external monitor—an annoyance for users who want to run desktop presentations.

During continuous operation, the battery life averaged from 1½ to 2½ hours. You can extend the life of the battery by turning off power to the modem and specifying time-outs that shut down the display, the hard disk drive, or the entire system during periods of inactivity. Pressing the Stand By button on the front of the case also puts the machine into sleep mode. Pressing it a second time resumes operations where you left off.

The SLT 386s/20 is plenty fast; its low-level benchmark scores rival those of the Deskpro 386/20. But the identical CPU index scores don't tell the whole story. The Deskpro 386/20's true 32-bit CPU performed faster memory moves, but the 386s/20 made up for that with faster Sieve, Sort, and Integer Math results. The SLT also compares favorably with the 20-MHz 386SX desktop machines BYTE has tested (see "The SX Turns 20," October 1990). Compaq includes a disk-caching utility to squeeze out even better performance.

Weighted Decision

Traveling with the SLT isn't much different from taking your fully configured desktop machine on the road. It's well built and fast, although by today's size and weight standards, the SLT is a bit clunky.

I disliked the screen. Also, the placement of the Fn key on the lower left corner of the keyboard is awkward (see the photo). I found myself constantly hitting the Fn key with the palm of my hand, accidentally invoking unwanted control functions in my application programs.

If you're in the field for extended periods, the SLT's power and expandability can't be beat. Otherwise, I'd recommend that you get one of the new SX notebook computers and leave the rest of the hardware at the office. ■

Rob Mitchell is a BYTE Lab technical editor for system reviews. He can be reached on BIX as "rob_mitchell."

LANtastic's™ tiny RAM now has more cards to play with.

If the presence of Micro Channel machines has ever stood between you and the joy of running the award-winning LANtastic PC Network, this is your lucky day. Artisoft has just added three new Micro Channel adapters to its compliment of AE-2 Ethernet, 2Mbps and Voice adapters.

PC MAGAZINE EDITORS' CHOICE March 28, 1989 LANtastic

LANtastic AE-2 MC Ethernet for Micro Channel, a 16-bit adapter that can be used in either a 16-bit or a 32-bit slot, is in 100% compliance with IEEE 802.3 and Ethernet standards, and comes with on-board 16K RAM that is user expandable to 64K. Since AE-2 MC Ethernet is software compatible with Novell's NE/2000 hardware, you can run Novell "out of the box."

PC MAGAZINE EDITORS' CHOICE March 28, 1989 LANtastic

LANtastic 2Mbps MC adapters are the perfect way to economically network small or midsize businesses with Micro Channel computers. Each card includes a 10Mhz coprocessor and 32K of on-board dual-ported RAM, along with software-selectable IRQ and RAMBASE address settings. Artisoft's version of the NetBIOS standard can be loaded into and executed within the adapter. This plunges the NetBIOS draw on a PC's base RAM down to just 2K and off loads the network processing onto the adapter. The cards are easy to install and use inexpensive dual-twisted pair cable.

LANtastic Voice MC adapters let you save sound and speech onto disk for playback later on Micro Channel machines. Use them with LANtastic NOS 3.0 or above, and you can send voice messages across your LANtastic network. Just pick up the telephone handset provided with each Voice Adapter, bring up a handy on-screen menu, and talk. Use Voice Chat to carry on a real time conversation, or save the message for playback later in your own voice – either through the handset or through the Micro Channel machine's internal speaker.

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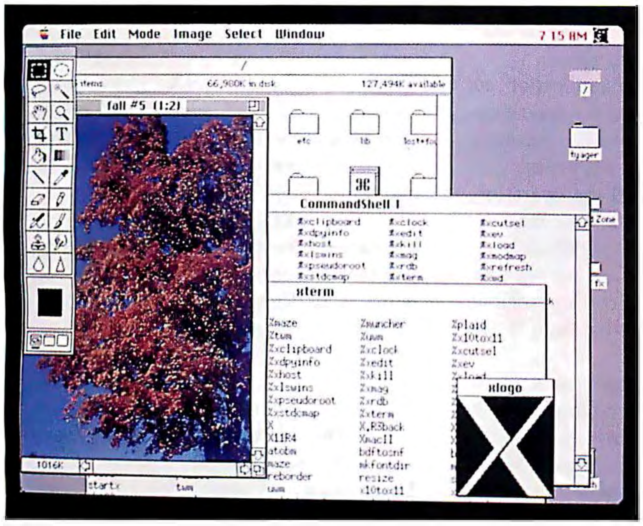
REVIEW

A Workstation in a Mac's Clothing



A/UX lets Mac, Unix, and X Window System applications run on one system and share the same display.

A/UX 2.0

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

Hardware Needed
Mac SE/30, II, IIx, IIcx, IIci, or IIfx (Mac IIsi requires A/UX 2.0.1) with 4 MB of memory and an 80-MB hard disk drive; Apple EtherTalk NB card (or compatible) required for TCP/IP networking

Price
On an 80-MB hard disk drive: $2395
On a CD-ROM disc: $795
On floppy disks: $995
On tape: $995
X Window System for A/UX: $350
MacX: $250

Inquiry 1075.

It might seem surprising that the ever-friendly Mac has taken on an operating system renowned for its unpleasant interface: Unix. A/UX, Apple's own Unix for the Macintosh, has been around for a while, but it was recently upgraded to include features that will turn some heads. It is now possible to have the best of both Mac *and* Unix in one box, running at the same time.

When Apple said it could run the Mac OS and Unix side-by-side, I was skeptical—but it works. There are some limitations and a bit of stumbling to go through yet, but Apple's solution is so elegant that it can raise a smile from even the most stubborn Mac basher.

Rather than one environment being subservient to the other, the two are truly equal. Mac applications execute under a special version of MultiFinder, while Unix applications run in their own address space under A/UX.

Experienced Mac users should have little trouble with the Mac OS side of A/UX (see the text box "The Mac Side of Unix" on page 214). Until you make it otherwise, the Unix is invisible. Once it is visible, however, windows containing Unix applications look just like normal Mac windows. They even show up on MultiFinder's list of active applications, and you can switch to them in the normal fashion. In fact, the default user interface for A/UX *is* the Mac Desktop and file manager. Unix files are represented and manipulated as though they were native Mac files.

But there's more to A/UX than that.

Taking a Bite

I took a Mac IIfx with 8 megabytes of memory and a RasterOps 364 display board, cabled up an external 300-MB LaCie SCSI hard disk drive, and got ready to install. My copy of A/UX came on a CD-ROM disc, so the Apple CD-ROM drive was connected to the SCSI chain as well.

Preparing the disk is not as straightforward as it could be. You must create separate partitions (LaCie's software takes care of this) for each of the Unix and Mac file systems. The partitions are oddly named ("Eschatology"? Gimme a break), and changing sizes outside of the defaults is far from intuitive. Some of this may be an artifact of LaCie's partitioning software, but I had to set aside another drive because it lacked this software completely; LaCie's was better than nothing.

I cannot fault LaCie—its drive performed magnificently. Apple's partitioning software should work with drives other than its own.

After you finish partitioning the drive, the A/UX installation procedure begins. You need to know the SCSI ID of the drive you're loading, but it's downhill from there. After a fashion, A/UX installs itself. I hope I live long enough to see the end of massive floppy disk–based operating-system distributions on other Unix systems. The whole of A/UX fit on one CD-ROM disc—the perfect backup medium for crucial system files.

Once you've installed the software, you use the Control Panel to select the freshly loaded drive as the boot device, and then reboot. Total time: about an hour, most of which I spent doing other things.

Getting Past the Main Gate

When A/UX comes up, after some initialization, it displays a dialog box for logging in. Giving A/UX a user name and password gets you into not only Unix but the Mac side as well. MultiFinder mavens will notice, however, that a Command Window process appears on the applications list. Selecting that from the Apple menu brings the Unix Command window to the foreground, and Unix users will breathe a sigh of relief—they'll feel that they're back in familiar territory.

Perched atop the Command Window is the regular Mac title bar. Command Windows are special-purpose Unix terminal emulators that share the Mac Desktop with ordinary Mac windows. They are manipulated in exactly the same way; there's even a menu bar associated with them. Under ordinary circumstances, Command Windows and the Unix console are the only means of communicating with Unix (the console is typically reserved for displaying the error log).

A Feel for It

A/UX is an unusual collection of Unix software. The base, according to the uname utility, is AT&T System V release 2. Unix followers know that release 4 is almost out the chute; Apple doesn't win

The Mac Side of Unix

Tom Thompson

A/UX 2.0 is a dramatic improvement over its predecessors. Earlier versions of A/UX were little more than a command-line-oriented Unix running on a Macintosh. With this new version, once you get past the log-in window that prompts you for a name and password, a Mac Desktop appears, complete with menu, windows, and icons. You launch your applications by double-clicking on them, print to a LaserWriter via LocalTalk, and select AppleShare file servers or other networked devices via the Chooser desk accessory. If you use a direct-color display board such as the RasterOps 364, you can work with 24-bit colors using either A/UX or Mac applications.

A clever sleight of hand is occurring here: A/UX is running a special version of MultiFinder (6.9) that supports the Mac environment. While other Unix processes (including MultiFinder) are preemptively shared (i.e., the CPU services each process for a certain time interval), the MultiFinder environment only supports cooperative multitasking (i.e., each application is supposed to yield control to MultiFinder at determined intervals). Thus, a poorly written Mac application could hog all of MultiFinder's processing time.

When you launch an application, an alert—"The application <Application-Name> is not 32-bit clean; opening it may result in a crash"—appears, with buttons to OK or cancel the operation. This warning reminds you that the A/UX environment uses 32-bit addressing, and any Mac application that assumes a different addressing scheme (hence the moniker "32-bit clean") will die a horrible death.

How does A/UX know if an application is 32-bit clean? Through a bit set in the application's `SIZE ID = -1` resource. This same resource also informs MultiFinder of the application's event-handling capabilities and memory requirements. Most Mac applications usually work. (In fact, some developers use A/UX to proof the 32-bit addressing capabilities of their application for another up-and-coming 32-bit operating system, System 7.0.)

Amazingly, some INITs, cdevs, and FKEYs work with A/UX 2.0. Installing the INITs and cdevs is simply a matter of dragging them to the /mac/sys/System Folder on the Unix volume. If you log out and then back into A/UX, the INITs install. You use ResEdit 2.0b2 to copy and paste FKEY resources into the System file in this folder. How well these extenders work depends primarily on how well they cope with the Unix file system. For example, After Dark 1.1c and SuperClock 3.9 functioned properly, while Adobe Type Manager could not locate resources stored in other files and failed to install. Boomerang 2.0.2, which tries to navigate among deeply nested folders, functioned erratically.

Given these potential problems, the Mac environment still runs well. Many applications, such as Aldus PageMaker 4.0, Adobe Photoshop 1.0, a beta version of Adobe Illustrator 3.0, and Data Translation's VideoQuill 1.0.1, ran smoothly. Printing documents with the LaserWriter 6.0.1 driver was flawless: the PrintMonitor spooled the pages to an original LaserWriter, and the output looked as good as anything printed from a typical Mac. A/UX 2.0 lets Mac users have their cake and eat it, too. They have their familiar Mac environment, while access to a powerful Unix operating system is only a window away.

Tom Thompson is a BYTE senior editor at large and Mac expert. You can reach him on BIX as "tom_thompson."

any points for keeping current on Unix developments. Grafted on top are some utilities, some libraries, and a file-system structure borrowed from BSD Unix. Again, the file system and other BSD-isms are reportedly taken from version 4.2, which considerably predates Berkeley's latest efforts.

Underpinnings aside, the implementation is nearly complete. I missed only a few things. The UUCP implementation is based on older (release 2) software that isn't as secure or as easy to manage as later implementations. The System V networking calls (i.e., the Transport Layer Interface) are missing, as are the functions for the Extended Terminal Interface (an enhanced full-screen function library). It might seem as if I'm knocking holes in A/UX; not at all. In fact, some may prefer Apple's approach. A/UX just feels more like BSD than System V.

The TCP/IP utilities and job control in A/UX have been done elsewhere, but Apple also threw in a host of Berkeley-specific utilities. Most notable are `lpd`, a network printer-sharing daemon; `sendmail`, a standard E-mail delivery mechanism; and `nroff` and `troff` text-formatting and typesetting languages.

One definite contribution from System V to A/UX is the Korn shell. Developed at AT&T, this follow-on to the ubiquitous Bourne shell is likeable almost to the point of being addictive. Job control is implemented in these and the C shell, so users can choose their favorite without losing features.

If you'd rather not deal with shells at all, A/UX's Commando facility comes in handy. Augmenting the on-line manual pages, Commando is a command completion program. If you enter a program name (or click on its icon in the file manager), Commando will open up a dialog box that represents the key options graphically. Click in the right places, and Commando builds and executes a command that gives you what you want. Nice.

For performance, my Mac IIfx was neither a barnburner nor a lumbering cow. I'd place it about even with a fast (33 MHz) 386-based Unix system, faster in some measures and slower in others. For similar cost, a 486 Unix system could run circles around it. If performance is your main consideration, don't bother with A/UX.

TCP/IP with X Window on the Side

Getting the system running on the BYTE Unix Lab's TCP/IP network was a bit of a challenge. The Apple Ethernet board I had was too old (revision C) to run with A/UX on a Mac IIfx, so Apple had to ship me a new one (revision K). Once the new board was in, however, the system came right up. A/UX works through MacTCP (which runs on the Mac OS side), and the system's network address and other particulars are set through a Control Panel dialog box.

A/UX comes standard with TCP/IP, Network File System, and Yellow Pages network services. Most of what I tested worked fine, but some of BYTE's other

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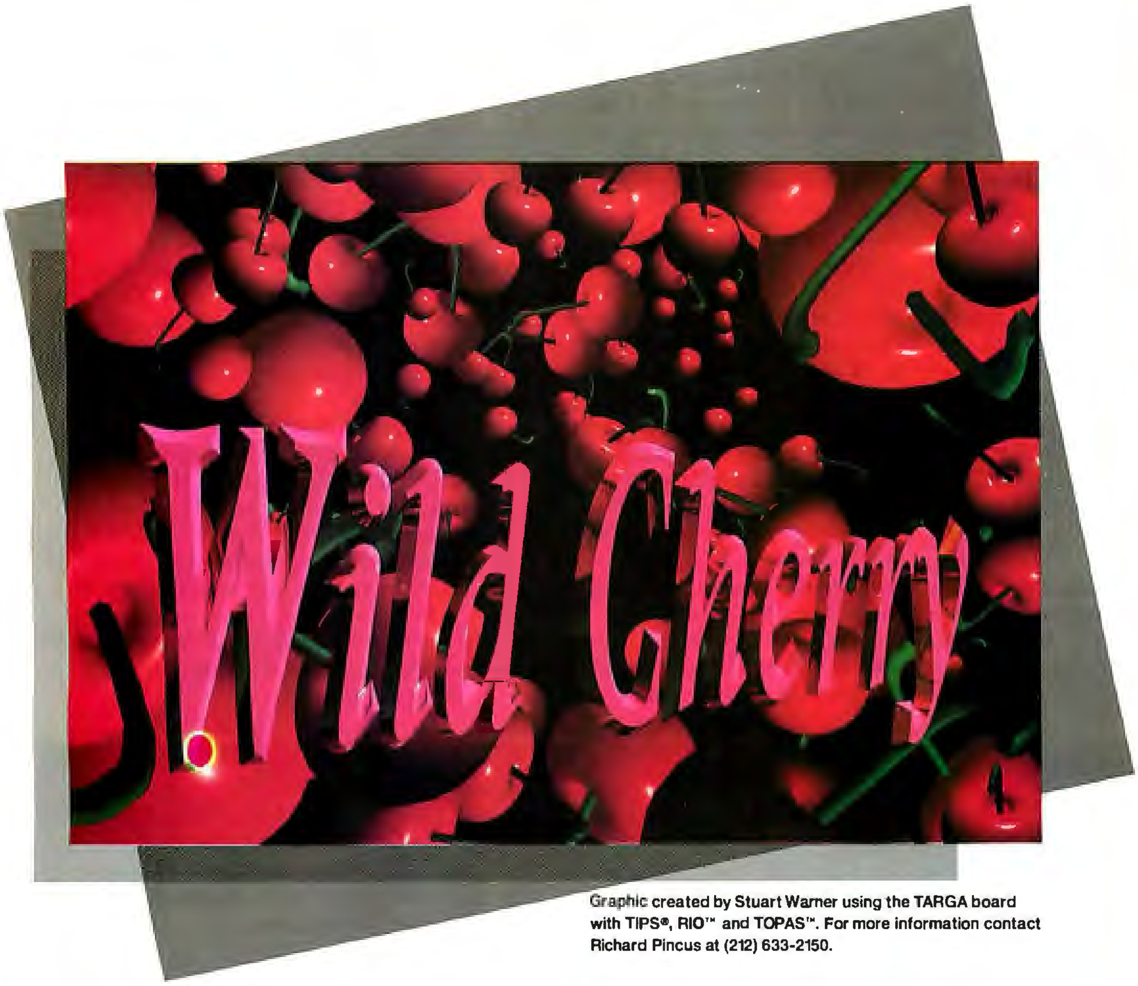

Graphic created by Stuart Warner using the TARGA board with TIPS®, RIO™ and TOPAS™. For more information contact Richard Pincus at (212) 633-2150.

Richard Pincus
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 Circle 339 on Reader Service Card (RESELLERS: 340)

systems didn't want to run full-screen applications on Apple's weird terminal emulator. That could have been fixed by working up a `terminfo` entry, something I didn't take the time to do.

I also had two versions of X Window System for the Mac: The X Window System for A/UX, and MacX. The former runs under A/UX and replaces the Mac Desktop with a full-screen X root window. The latter runs on the MultiFinder side and allows monochrome X clients to run on the Mac Desktop.

X Window System for A/UX ran as I expected it to. Both color and monochrome X clients connected without difficulty across the network. Display performance was unacceptable until I used the Control Panel to set the display bit depth to 8 (256 colors instead of 16 million). Even then, performance was not up to workstation standards, but that could have been owing to the RasterOps card's lack of a graphics coprocessor. Nothing against RasterOps there: The 364 is not cut out for high-speed windowing system operations, but it performs well in Mac imaging applications.

Even if a video card has 24-bit capability, both versions of Apple X Window are limited to a maximum of 8 bits. MacX has some additional limitations that combined to leave me feeling very uncertain about the product's stability. Its features are amazing in that it can support monochrome X clients on the Mac Desktop, and both monochrome and color clients in special scrollable windows. However, MacX's flaws became obvious from the first.

I asked our Opus 88000-based system to ship an `xgif` (a utility that displays GIF graphics images) window to a color MacX session. The `xgif` window came up blank and didn't paint until I selected it. When I overlapped the `xgif` window with something else, the GIF picture was displayed in a rectangle around the foreground window; it was repainted to black again when the overlapping window was removed. It was also painfully slow, taking several seconds to redraw a Motif window border. In general, MacX running in its own root window seemed flaky; I wouldn't use it in a commercial environment. Its most basic capability—putting up monochrome X windows on the Mac Desktop—worked very well, however, and for that I can safely recommend it.

It's a Wrap

I can't remember when I've seen something as appealing as A/UX 2.0. With the exception of MacX, Apple's integration of Mac and Unix is seamless and powerful. Clever developers should start putting out programs soon that take advantage of this blend, because it is truly not available anywhere else.

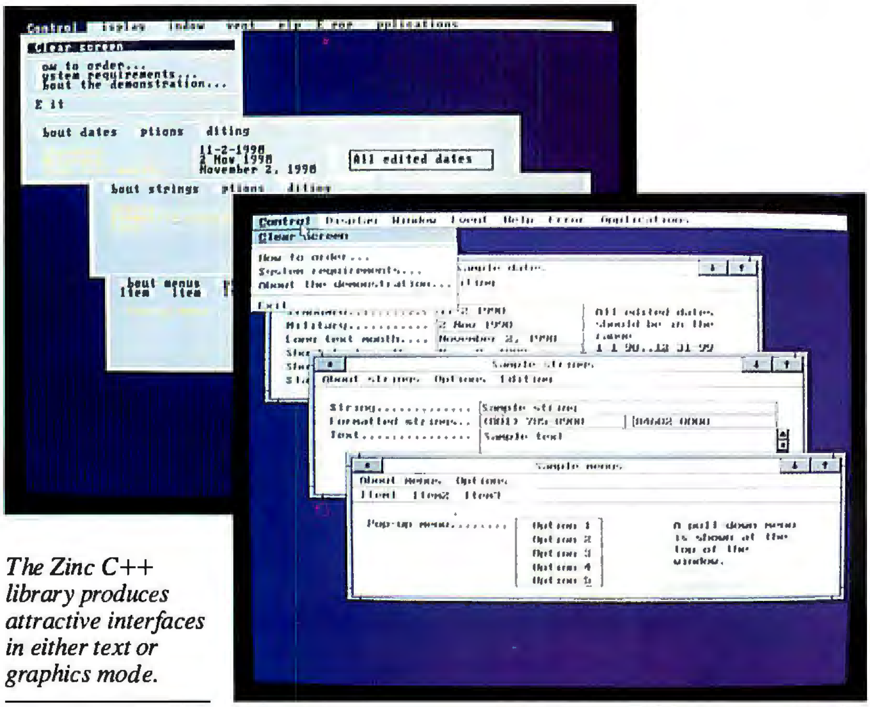
Before Apple can start gunning for workstations, however, it needs to pay more attention to two things: price and graphics performance. If you don't care about the ability to run Mac programs, A/UX would be a waste. Low-end workstations are more attractively priced and offer better graphics performance than even the fastest Mac. But if you need to run Unix without sacrificing your library of pet Mac programs, A/UX is the answer. It is a thoughtful, well-crafted mix of two good operating systems. ■

Tom Yager is a BYTE Lab technical editor and Unix expert. You can reach him on BIX as "tyager."

Steven Kearns

REVIEW

User Interfaces, C++ Style



The Zinc C++ library produces attractive interfaces in either text or graphics mode.

Are you embarrassed by the command-line interface to your PC program? Have you been looking enviously at the latest applications for Windows 3.0? Have you experienced the torture of programming a user interface in C? If so, the Zinc interface library may ease your suffering.

Zinc Interface Library

Company
Zinc Software, Inc.
405 South 100 East, Suite 201
Pleasant Grove, UT 84062
(800) 638-8665

Hardware Needed
IBM PC compatible with 640K bytes of RAM and a hard disk drive; Microsoft-compatible mouse recommended

Software Needed
Borland Turbo C++; DOS 2.1 or higher (3.1 or higher recommended)

Price
$199.95
Source code: $200

Inquiry 1223.

Zinc is a class library that uses the sophisticated features of C++, as well as the Borland graphical interface routines that come with Turbo C++, to minimize the notorious difficulty of user-interface programming. Zinc helps create user-friendly DOS programs, with either text or graphical interfaces. Currently, it works only with Turbo C++ on the IBM PC and compatibles.

The Bird's-Eye View

Zinc includes a wide variety of C++ classes, 46 of them, that you can mix, match, and modify to create an application. (The source code for the package can be bought separately for $200.) There are classes for using windows, title bars, pop-up and pull-down menus, fully editable text that supports cut/copy/paste, and selectable icons and bit maps. Zinc also includes classes designed to make it easy to input and validate numbers, dates, and times; for each, a wide variety of formats are handled automatically. Furthermore, if you have a novel type of input field—for instance, a field for inputting palindromes—it is easy to modify an existing input class to get what you want.

Two notable classes in Zinc are `help_system` and `error_system`. Your application can easily have context-sensitive help screens using the `help_system` class. The help system is less impressive than that in Windows 3.0; the latter has a hypertext appearance, while Zinc's is more a scrollable text display. But the Zinc system should be adequate for most programs. The `error_system` class provides a consistent, simple way of reporting and responding to errors throughout your program.

Getting the Picture

Zinc provides rudimentary support for graphics: Two-color bit maps, rectangles, lines, and text can be drawn on the screen. Unfortunately, Zinc does *not* make it easy to restrict drawing to a window, a fundamental service in most user interfaces. Also missing is a dialog editor, a graphical tool for designing screen layouts that can make user-interface design faster.

An important feature of Zinc is its ability to display on a wide variety of graphics boards, including various text modes, Hercules, CGA, EGA, and VGA, all from the same source code. In fact, Zinc includes a demonstration that switches display modes while the program is running. Zinc also provides an interface to the keyboard, cursor, and mouse that can be easily extended as new devices appear. C++ makes it easy to give different systems the same programming interface, and Zinc uses this capability extensively.

When running Zinc in graphics mode, you see a screen reminiscent of Windows 3.0 or Presentation Manager, including three-dimensional buttons and borders. The built-in editing commands were designed to be Systems Application Architecture compliant.

However, I found the font that is used throughout the user interface to be ugly and hard to read, and there is no documentation that explains how to change it. In addition, the toolkit does not enforce user-interface consistency to the same degree as Motif or Windows 3.0. For example, sometimes the "system button" in the upper left corner of a window will close a window, and sometimes it will bring down a menu of choices. These choices, of course, are under programmer control, so they can be fixed in your application.

Putting It to the Test

An important criterion for judging a set of classes is how cohesive they are. Specifically, after learning to use one class, it should be easier for you to learn another. Zinc is exceptional in this regard.

REVIEW

For example, to add a title bar, resizable border, and close box to a window, you just have to write

```
myWindow + new UIW_TITLE(...)
  + new UIW_BORDER
  + new UIW_SYSTEM_BUTTON;
```

Similarly, you can add a window to the window manager with `windowManager + myWindow`.

Documentation is a crucial part of any toolkit, and the lack of adequate documentation is Zinc's greatest failing. The Zinc package includes two attractive manuals, an overview/tutorial, and a reference. While this documentation is well laid out and informative, there is just not enough of it.

If you are content to use the 46 classes that Zinc provides, then the Zinc tutorial and reference manual are adequate. On the other hand, trying to subclass a built-in class reveals glaring deficiencies in the documentation. For example, there is no explanation of the coordinate system used to locate items in a window or on the screen. Also, the `UIW_WINDOW_OBJECT` class—the most important base class—has 16 public and protected member functions declared in the header file, yet the documentation lists and explains only two of them.

The event messages, through which windows communicate with each other and the window manager, are never described. There are many other examples, but the bottom line is that Zinc provides insufficient documentation for you to customize the classes.

Fortunately, Zinc Software is aware of the problem and promises supplementary documentation by the time you read this. The company's technical support is responsive, friendly, and knowledgeable—definitely above average.

Assuming that the documentation improves, Zinc seems to be most appropriate for Turbo C++ programmers who want to create modern-looking, easy-to-use DOS applications. It is especially suited for business applications requiring the user to enter and examine numeric, string, or date information. On the other hand, Zinc is much less useful for someone writing a graphical application, such as a draw program or graphics simulation. ■

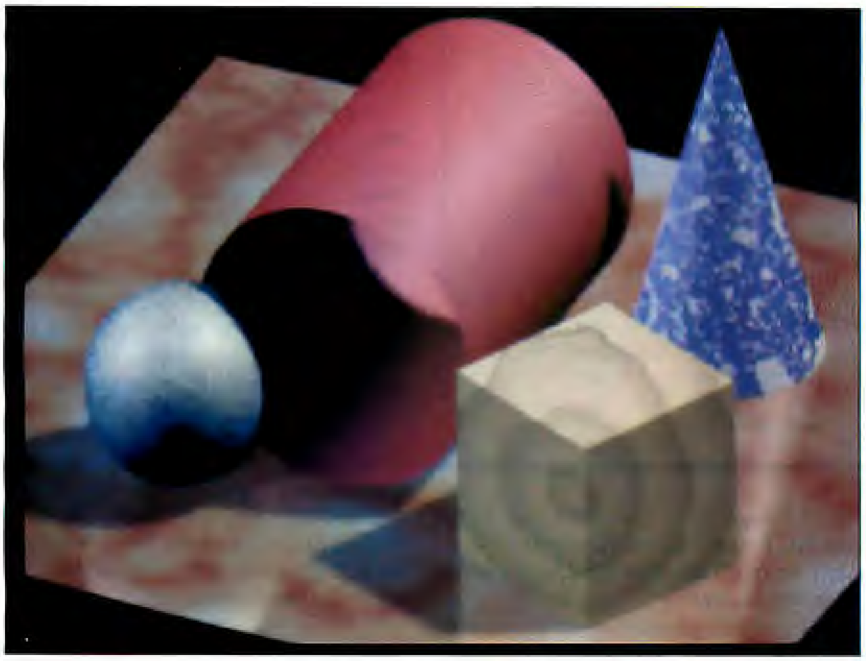
Steven Kearns received his Ph.D. in computer science from Columbia University. He is the president of Software Truth, developing a next-generation programming environment. He can be reached on BIX c/o "editors."

 Circle 91 on Reader Service Card (RESELLERS: 92)

Bill Calabrese

REVIEW

Photo-Realism for Those with Time (and RAM) to Spare



This image was created from the PhotoRealistic RenderMan component of MacRenderMan. Note the variety of surface textures and shadows used to create near-photographic-quality effects.

MacRenderMan

Company
Pixar
1001 West Cutting
Richmond, CA 94804
(415) 236-4000

Hardware Needed
Mac II, IIx, IIcx, IIci, or IIfx with at least 5 MB of RAM (8 MB recommended) and 5 MB of hard disk space

Software Needed
System Tools 6.0.3 or higher, MultiFinder, 32-Bit QuickDraw, and a modeling application program that outputs RenderMan Interface Bytestream scene-description data; a 24-bit color system is strongly recommended

Price
$795

Inquiry 1060.

Photo-realism has come to the Macintosh with Pixar's MacRenderMan. Derived from RenderMan, Pixar's DOS-only rendering program, MacRenderMan is designed for serious Mac users who need extremely realistic three-dimensional renderings and have hardware powerful enough to fully exploit the program's capabilities.

MacRenderMan generates images of extraordinary quality by creating surfaces as realistic to the eye as those in a photograph. But achieving this quality is both a time- and RAM-intensive task: Although my system has 8 megabytes of RAM, I often ran out of memory when I rendered some relatively simple objects for this review. And although I used a 50-MHz accelerator, these small renderings took about 20 minutes. If you're running at a more typical 25 MHz, expect the time to be about 30 percent longer.

These drawbacks limit the current version of MacRenderMan to use by product designers, interior designers (e.g., for modeling a corner of a room), advertising designers, and others who usually work with small-scale objects. Architects and those who render larger, more detailed models without benefit of a mainframe will probably find MacRenderMan too time-consuming and cost-prohibitive.

Almost a Photograph

MacRenderMan lets you create a wide variety of surface textures, plus motion blur and other effects. Most important, the software lets you manipulate light—a key ingredient in photography—to portray exactly the right mix of multiple light sources, amounts and angles of reflections, artificial and natural effects, and shadow gradations.

To create finished renderings, MacRenderMan uses a translation file called RIB (RenderMan Interface Bytestream), which in the future you'll be able to create with the Save As selection in third-party modeling programs. The RIB file contains not only a geometric description of the objects in the scene, but also the material properties necessary to fully describe the objects. These include material characteristics, shadows, texture maps, shading parameters, and the viewing perspective.

Subtle changes in the contents of the RIB file can make dramatic differences in the final image. You can use your text editor to change the RIB files created by your modeler to further define the qualities you would like displayed in your final rendering. You can also read the files as text and manipulate them in the text format.

Listing 1 shows a short section of a RIB file describing rendering setup information, positioning data, scene definitions (e.g., light sources), and the geometric form of objects. Sound simple? Not really. This is my main objection to the program: To change the attributes of a model using the RIB file format, you have to revert from the Mac's graphical user interface to an almost-DOS environment. Most of us Mac users bought our Macs to avoid doing just that. Also, there are additional commands that you will need if you want to modify shading and texturing.

Five Components

The MacRenderMan package comes with five applications, plus some sample libraries and tutorial demos. One of the applications, called RenderMonitor, is similar to the Print Monitor Desktop application available under MultiFinder.

continued

Listing 1: *A sample RIB file. Although it is versatile, changing code in the RIB file format requires Mac users to work in a DOS-like environment.*

```
Display "New Slide" "framebuffer"
   "rgba"
Format 128 96 1
ShadingRate 10
PixelSamples 1 1

Projection "perspective" "fov" 30
Translate 0 0 25
Rotate -10 1 0 0
Translate 0 -5 0

WorldBegin

LightSource "ambientlight" 1
   "intensity" [.9]

AttributeBegin
Attribute "identifier" "name"
   "wallfloor"
Translate 0 0 2.5
Patch "bilinear" "P" [-20 -20 0
   20 -20 0   -20 20 0   20 20 0]
Patch "bilinear" "P" [-20 0 -10
   20 0 -10   -20 0 0   20 0 0]
AttributeEnd

AttributeBegin
Attribute "identifier" "name"
   "middlegroup"
Rotate -90 1 0 0
Translate 0 0 5
Sphere 1 -1 1 360
Disk -1 1.7 360
Cylinder 1.7 -1.4 -1 360
Cylinder 1 -5 -1.4 360
AttributeEnd

WorldEnd
```

After you install RenderMonitor into the System folder, the application allows you to render images in the background so that you can continue with other work in the foreground. This is a great idea, but for the majority of the renderings I did for this review, the program asked me to quit out of all foreground applications to save system memory.

One of the program's renderers, the picture-making application, is called PhotoRealistic Renderman. It accepts modeling data through the RenderMan interface specification format to generate rendered 3-D images. This application is a cdev, and as such, you install it in the System folder. PhotoRealistic Renderman gives you options for choosing rendering size and quality.

The second renderer is Vector RenderMan, which generates wire-frame images for quick evaluations of your model. This System-folder-residing cdev offers the same options as PhotoRealistic Renderman.

RenderApp is a Desktop application that lets you display rendered images on a color Macintosh monitor. You can also use it to display and save image files in the PICT format. The renderer can then use these files to generate texture maps.

ShaderApp is a Desktop application for compiling shaders written in the RenderMan Shading Language (`.sl` file) in the Shading Language Object file (`.slo` file). The source must be a text file. ShaderApp generates a shader with the name specified in the source file and the `.slo` suffix.

Easy Installation

Installing the program was a straightforward procedure; I just dragged the items noted as System documents into the System folder, and the rest into a file on my Desktop. You must be in MultiFinder for MacRenderMan to do background rendering, so I selected MultiFinder and restarted my Mac, and the program was ready to go. For this review, I used a Mac IIx with System 6.0.5, 8 MB of RAM, a DayStar 50-MHz accelerator, and 1 gigabyte of ROM. My monitor was a Radius 19-inch color display.

Unlike with most Mac programs, you will probably need to read the MacRenderMan manual to use the software effectively. But the program is fairly simple to operate as long as you don't want to make changes to the RIB files and your modeling program supports the RIB format. There weren't many applications that did support RIB files as this went to press, but third-party representatives that I talked to said that they expected to within the next few months. According to Pixar, vendors are currently working to incorporate RIB file support in such programs as Vidi's 3-D Modeler, Dynaware's Dynaperspective, Intergraph's MicroStation Mac, MacroMind Three-D, Byte by Byte's Sculpt 3D, Strata's StrataVision 3D, Paracomp's Swivel 3D Professional, and Abvent's Zoom.

The actual rendering of a model from a RIB file is also straightforward. I first went to the Chooser to select a renderer (I used PhotoRealistic RenderMan for the image shown in the photo). I then configured the renderer by selecting the quality of the drawing (Quality or Preview) and the amount of RAM I wanted to assign to the renderer (4 MB in this case).

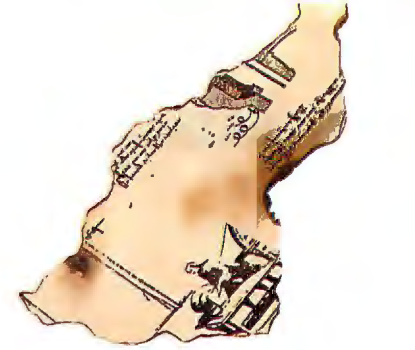
Next, I selected RenderApp from the utilities file on the Desktop and went to the Render menu and selected Render Setup. Here I named the image and selected where I wanted the finished image to reside: in a window, a PICT file, or a TIFF file. I chose a PICT file. I chose the Render A File selection from the Render menu and then selected a RIB file. Then I just sat back and waited while the Render Monitor processed the rendering (as I noted earlier, MacRenderMan asked me to exit from all other programs to save on system memory). With my 50-MHz accelerator, rendering time was about 45 minutes.

Small Projects Only

If you need photo-realistic rendering, this is the package for you, as long as you can wait for software developers to tack on the RIB format to their programs and you can afford a fast Mac. The amount of ROM is not as important, because the finished files are not huge.

I personally would not be able to use MacRenderMan as much as I would like, because most of my work is architectural CADD and animation. As I stated earlier, the time the program takes to get your model just right would be too costly for architectural renderings. But for people who create simpler objects and who don't mind the DOS-like nature of the RIB format, the program gives great photo-realistic renderings with a moderate amount of time and effort on your part. ■

Bill Calabrese is MIS/CADD director of Design Alliance, Inc. (San Luis Obispo, CA), an architectural design firm. He has been an avid Macintosh user since 1984. You can reach him on BIX c/o "editors."



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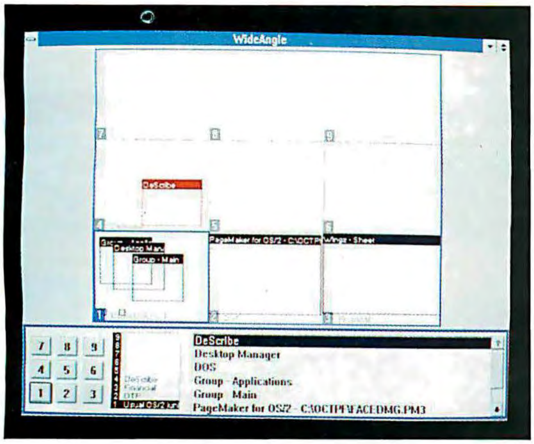
Howard Eglowstein

REVIEW

A New Angle on OS/2 and Windows



Nine virtual OS/2 screens. Each outline represents an OS/2 window. You can move windows among virtual screens by simply dragging them to a new location. The nine buttons at the bottom of the screen let you select the active screen by simply clicking on either the button or the descriptive text.

Wide Angle for OS/2 PM or Windows

Company
Inner Media, Inc.
60 Plain Rd.
Hollis, NH 03049
(800) 962-2949
(603) 465-3216

Hardware Needed
IBM AT or compatible

Software Needed
OS/2 version: OS/2 1.2 or higher
Windows version: Windows 3.0 or higher

Price
Either version: $129

Inquiry 1111.

You can never be too rich, and your desktop in a graphical user interface environment can never be too big. That's the thinking behind Inner Media's Wide Angle, a virtual desktop manager for OS/2 or Windows.

If you use OS/2, you've seen the problem. You open the OS/2 File Manager and a group window or two, and you've used up most of a standard VGA monitor. Next, you open a word processor to write a quick memo, but you need to incorporate some data from a spreadsheet. OS/2 can handle that by simply putting WingZ or Excel's window over the top of everything else. By the time you have opened two applications and the "standard" OS/2 stuff, the cursor is lost in a sea of overlapping windows.

Almost Like Having Nine Monitors

Wide Angle makes OS/2 Presentation Manager think your work area is nine times its actual size. It's almost like using a single monitor with a switch box and nine VGA boards.

You open applications as you normally would and put them in logical working groups. For instance, you might be working on a spreadsheet in WingZ while you are composing a sales brochure with DeScribe and PageMaker. WingZ likes to stretch out, so you might put it in a workspace of its own. Cutting and pasting text from DeScribe to PageMaker is considerably easier when the two applications are together in the same workspace. The photo shows Wide Angle's maximized window with this sample layout. Moving windows within a workspace or from one workspace to another is a simple matter of dragging the picture of the window to its new location.

If you put WIDEANGL.EXE in your STARTUP.CMD file and place your applications together in a group named WIDEANGL, Wide Angle will automatically open all your applications and put them in their proper location. In addition to the maximized view, Wide Angle keeps a smaller, resizable window onscreen with nine push-button window controls and a verbal description of each window. To change active workspaces, you either click on buttons 1 through 9, click on the text description, or double-click on the picture's window.

I tested my copy of Wide Angle on a Compaq 386/20 running Compaq's OS/2 1.2 with 6 megabytes of RAM. On that machine with three or four applications active, the switch-over between windows was almost instantaneous. I ran a version for Windows 3.0 on a 16-MHz 386 system with 5 MB of RAM and a 1280- by 960-pixel Radius TPD/PC monochrome monitor. Wide Angle (the Windows version) handled the large screen with no trouble.

Houdini Would Be Proud

Clever programming is sometimes indistinguishable from magic. Wide Angle manages to do its job in a mere 60K bytes of RAM under OS/2 or Windows, no matter what your system configuration is. How? Both OS/2 and Windows have some primitive capabilities for handling large screen areas, and the engineers at Inner Media have found a way, through the use of standard application programming interface calls, to get OS/2 to manipulate the virtual screens with little overhead.

Another neat trick is Wide Angle's control panel. This is a window like any other, except that it likes to float automatically to the top of the current window stack.

You'll find that you'll want to use this AutoRise feature often; fortunately, it's always visible. If it gets in the way, you can reduce it to a minimized icon (the nine buttons shrink but stay active) or turn it off.

As far as I know, there's nothing quite like Wide Angle on any other platform. The closest product I'm aware of is Stepping Out on the Macintosh, from Berkeley Systems. Like Wide Angle, Stepping Out enlarges your usable screen area, but it treats the enlarged area as a single virtual screen without the logical groups. It's up to you to remember where things are, and you have to do lots of scrolling from place to place. I much prefer Wide Angle's approach. It's easier to arrange your applications in groups and press a single button.

Best of all, Wide Angle works. The only problem I found is that it doesn't know anything about screen savers. Wide Angle kept popping up on the blank screen after my screen saver blanked the display. Disabling AutoRise solved the problem.

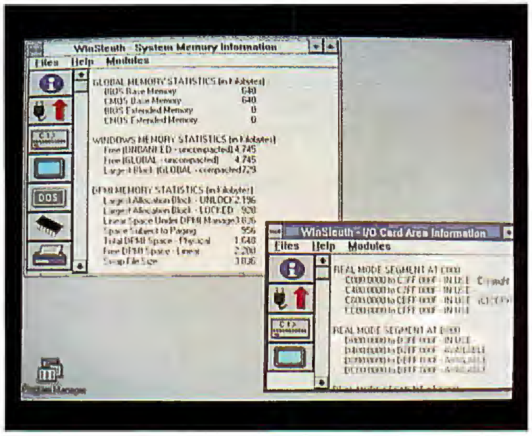
Priced at $129, Wide Angle may be just the cure for what ails OS/2. No longer do you have to use the Task Manager to find a window or waste time minimizing applications to get them out of the way. ■

Howard Eglowstein is a BYTE Lab testing editor. He can be reached on BIX as "heglowstein."

Jon Udell and Tom Thompson

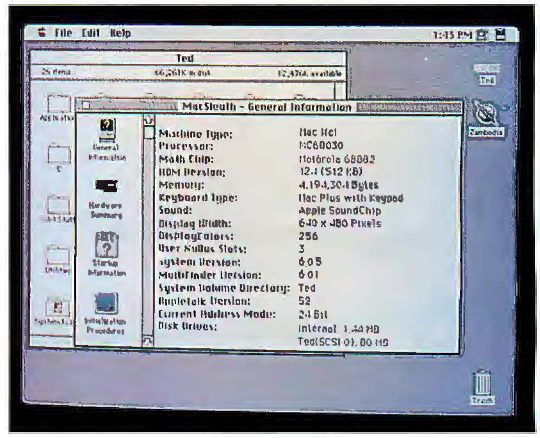
REVIEW

Two Bumbling Detectives



◀ *WinSleuth's actions are selected through a scrolling set of icons, but the output window is not scrollable.*

▶ *MacSleuth can get confused. It reported that our Mac IIci had a Mac Plus keyboard with a keypad, an impossible combination.*



Dariana Technology Group, creator of the venerable System Sleuth DOS utility, has recently branched out into two new areas: Windows 3.0 and the Macintosh. The company's goal was to create programs that could call out your system and software configuration in a flash. Our reviewers found both products disappointing.

WinSleuth:
A Solution in Search of a Problem

In my PC troubleshooting toolkit, I carry a copy of System Sleuth, Dariana Technology Group's handy snoop utility. It's a quick way to discover the amount of memory that is installed in a PC, the locations that are available for add-in boards, the type of video adapter and disk drive, and whether the system includes a math coprocessor. WinSleuth carries on the tradition of System Sleuth and adds a picture of your PC from Windows' point of view.

WinSleuth is made up of 11 modules, most of which work just like their System Sleuth counterparts. The General Information module, for example, describes your CPU and FPU, gives the date of the ROM BIOS, and identifies the number and type of floppy and hard disk drives. If you want to check out some low-level aspects of the environment—things like the partition table, TSR programs, and device drivers—you have to run WinSleuth under real-mode Windows.

The Display Information module describes your Windows display driver. It reports the display resolution and color depth, and it queries the driver (i.e., calls the Windows `GetDeviceCaps` function) for a list of device capabilities such as underlining, scaling, and (in 386 enhanced mode) virtual memory under the control of the Windows memory manager. The Windows Information module lists the Windows tasks currently running and optionally lists the dynamic link libraries running in support of those tasks. Network Information summarizes the capabilities of the current Windows network driver.

But what's WinSleuth's raison d'être? You can boot DOS on a naked machine, run System Sleuth from a disk, and find out lots of useful information quickly. I often do just that. You *can't* use WinSleuth that way, because, of course, you have to install Windows first. In any case, WinSleuth does not handle the basics as comprehensively as does System Sleuth. Once you've got a Windows environment up and running, WinSleuth can tell you some interesting things, but I don't see it as the vital diagnostic tool that its progenitor is.

Frankly, WinSleuth looks like a program thrown together in a hurry to cash in on Windows 3.0's popularity. It's not even a polished Windows 3.0 application. Information panes aren't scrollable, for example, and in one case, you can generate more output than will fit. Screens are loaded with typos, and they lack intelligent refresh routines. Even the packaging is evidence of a rush job: It announces the company as "Dariana Technogy." This isn't the best work that Dariana Technology Group can do.

—*J. U.*

WinSleuth 1.0

Company
Dariana Technology Group, Inc.
6945 Hermosa Cir.
Buena Park, CA 90620
(714) 994-7400

Hardware Needed
286-, 386-, or i486-based PC with 640K bytes of memory, a hard disk drive, and a compatible graphics adapter

Software Needed
DOS 3.1 or higher; Microsoft Windows 3.0

Price
$149

Inquiry 1110.

MacSleuth 1.0

Company
Dariana Technology Group, Inc.
6945 Hermosa Cir.
Buena Park, CA 90620
(714) 994-7400

Hardware Needed
Mac SE, II, IIcx, or IIfx

Software Needed
System 6.0.2 or higher

Price
$149

Inquiry 1109.

MacSleuth:
Full of Contradictions

MacSleuth 1.0 is supposed to be a diagnostic aid for Mac system woes. It's a Mac application that uses 13 diagnostic modules. These modules snoop through the Mac's innards and produce reports detailing the system's hardware configuration, INITs, cdevs, device drivers, interrupt queues, resources, and parameter RAM settings, to name a few.

Unfortunately, I found MacSleuth to be more of a hindrance than an aid in trouble-shooting. For example, it failed to recognize that a Mac IIci had a 24-bit color board (it insisted that the display had only 256 colors). On a Mac II with a paged memory management unit chip, the Resources module failed to work or crashed the machine. Network reports were incomplete at best on BYTE's LocalTalk network, which uses a Farallon StarController and one AppleShare file server.

As you click on the various module icons for additional information, MacSleuth's operation becomes more erratic. At certain times, opening a desk accessory while in MacSleuth confuses the application so much that it reports incorrect information. For example, on the Mac IIci, I got beeps when I tried to open a DA. MacSleuth reported that the IIci had a Mac Plus keyboard—an electrical impossibility, since the Plus uses a custom cable while the IIci uses an Apple Desktop Bus connection for its keyboard. By removing most of my INITs and the TMON debugger, I got better behavior out of MacSleuth, but isn't a diagnostic package supposed to deal with these things?

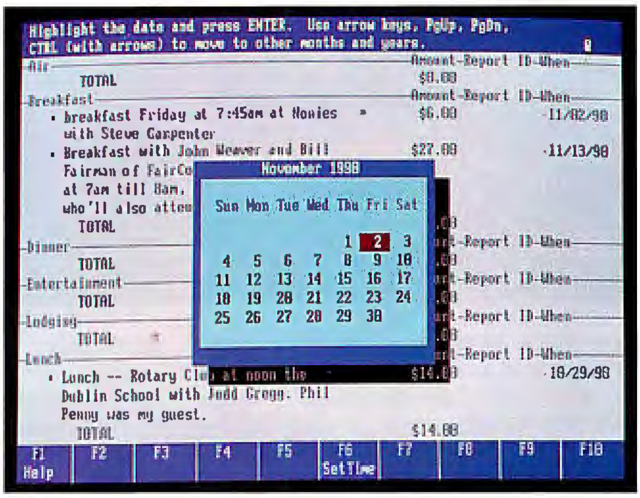
Free upgrades are promised for six months to correct MacSleuth's problems. However, a combination of freeware, shareware, and commercial utilities can provide the same information for far less than the $149 that MacSleuth costs. For example, you could use Randy Dees' AT View DA (shareware, $5) to examine your LocalTalk network, and Ken McLeod's freeware MacEnvy cdev to report on your system hardware, attached monitors, and parameter RAM. Symantec's SUM II disk utilities ($149) has an application that gives you an exhaustive report on drivers, interrupt queues, and memory while providing hard disk drive recovery tools as well. ■

—*T. T.*

Jon Udell and Tom Thompson are BYTE senior editors at large. You can reach them on BIX as "judell" and "tom_thompson," respectively.

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products previously reviewed in BYTE.

Ease of Use in Lotus Agenda



Agenda 2.0 now supports math to make filing expense reports easier, and its new streamlined date management includes a pop-up calendar.

Lotus Development opened up new territory when it released Agenda, its personal information manager (PIM), two years ago. This was new territory in that pioneering users of the first release were assailed by arrows flaming with difficulty and encountered seemingly endless hardships as they navigated Agenda's learning curve.

It wasn't just that Agenda was challenging to learn: It was based on new database and information management concepts that were not easy to grasp. Agenda stored data in *items*, which could have *assignments* to *categories*, which in turn could have *parent* or *child* categories. Agenda approached object orientation, yet it didn't completely fit the object-oriented model.

To make matters worse, Agenda applications were (at least at first) user-defined, impaling users with their own inabilities to understand Agenda.

Some pioneers survived, and others didn't. I was one of the survivors. For over a year and a half, I used Agenda to keep track of my contacts, telephone conversations, appointments, and other bits of information. I developed a love/hate relationship with Agenda.

I loved Agenda because it could compile lists of the information I put into it and otherwise make sense of it all automatically, as a good secretary might do. As my database grew, I hated Agenda for its clumsy way of handling a large list of categories—which sometimes made the program so slow that my 25-MHz 386 computer couldn't sort through my daily notes even if I left it running all night. In fact, without a good disk-caching program installed, the old version of Agenda would run my computer's hard disk drive almost constantly.

Agenda 2.0

Company
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(800) 343-5414
(617) 577-8500

Hardware Needed
IBM PC or compatible with 640K bytes of RAM and a hard disk drive

Software Needed
DOS 2.1 or higher

Price
$395

Inquiry 1204.

Canned Applications

To level out the learning curve, Agenda 2.0 includes four "starter" applications that Lotus claims are so easy that you can become productive with Agenda in only 30 minutes. Even though that's a lot to promise, Lotus is probably right. Anyone should be up and running with one of the applications in very little time. Proficiency may come later, but that's fair.

The applications are Activities Planner for tracking tasks and appointments (an updated version of the planner application released with Agenda 1.01), Account Manager for tracking sales calls, People Manager for tracking the goals of people you manage, and Information Sifter for sorting information that comes from external sources like E-mail.

And that's what makes Agenda 2.0 so much easier to learn—it comes with applications ready to use. Now, new users can spend their time learning how to run an application, rather than having to learn the conceptual underpinnings of how Agenda does its magic.

With Activities Planner, for example, you might simply type in a note (Agenda calls a note an *item*) like "Meet Joe for lunch at noon next Tuesday." Agenda will automatically set the date to whatever day next Tuesday happens to be. That way, when you call up your schedule for next Tuesday, your lunch with Joe will be plugged in at 12:00. Agenda will file the note (in Agenda-ese, it *assigns the item*) to the activity mentioned in the note, so that later you'll be reminded to fill in the amount you spent to track your expenses. The only thing you might need to do is enter Joe's name in the people column. I say "might" because once Agenda recognizes a name in a note, it automatically files the note under the name.

None of this is new to Agenda—you could make the old version do the same things. But now you don't have to teach Agenda how to do them. Also, Agenda 2.0 now supports simple math (see the photo). Thus, when you enter the amount of that lunch with Joe, Agenda will automatically total an expense report for you by week, month, type of expenditure, and so on.

A Rewritten Agenda

Beyond the canned applications, Agenda 2.0 is a rewrite of the program that attempts to improve performance. No, it's not a redesign of the basic concepts of the original Agenda. And that's good news, because those concepts, once you get the hang of them, work pretty well.

As for the problem of relentless disk access, a change in how Agenda manages memory dramatically improves performance on databases with large category lists. (The category list is all the individual things—such as people, activities, and tasks—that Agenda keeps track of.) Because Agenda is comparing the note text to the text of each category, it needs the complete category list in memory.

If the list was too large to fit into your computer's memory along with the program, as my list of over 3000 people and products was, the old Agenda had to swap parts of the list to and from the hard disk. Even using a disk cache, the swaps took an incredible amount of time—in my case, the better part of a day just to evaluate dates.

Thankfully, Agenda 2.0 takes advantage of more efficient expanded memory, if you have it (if you don't, you'll want it), to load the category list there. With my database, which has grown considerably, Agenda 2.0 uses a little more than a megabyte for expanded memory. Most important, though, it can evaluate all the dates in a fraction of the time of the old Agenda.

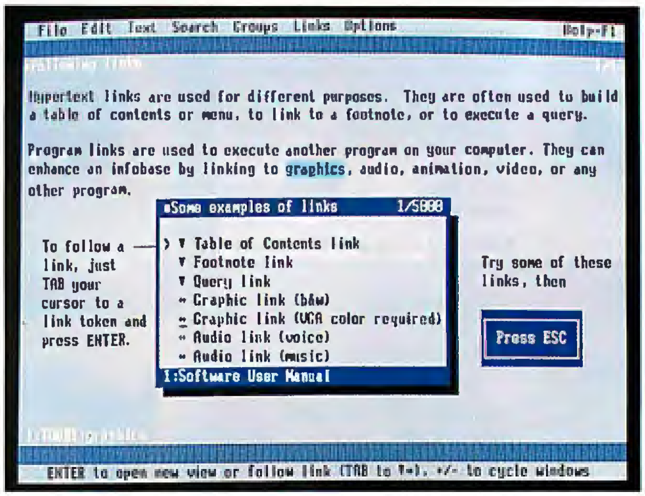
That's partly because Agenda 2.0 deals with dates in a more efficient way. In the earlier release, you had little control over dates, and many users programmed their own categories to handle dates. That typically increased the size of the category list by 365 (a category for each day of the year) just to have a schedule calendar.

Not only did that cause problems, creating more disk swaps for a larger category list, but every day Agenda would also try to evaluate each date category against the entire database. Agenda 2.0 solves the problem by introducing category types specifically for dates. The category types are so efficient that the "when" category can track all scheduling.

Combined, the enhancements in memory management and date handling make Agenda usable again on my database. My old love/hate relationship with it has ended—the hate part of it, that is. There are other good PIMs, like IBM's Current, you might consider. But neither Current nor any of the others will do so much categorizing for you automatically; nor will they allow you as much flexibility as Agenda 2.0—and none are that much easier to learn. Now, my biggest complaint with Agenda is that it doesn't fit into my coat pocket like a Day-Timer.

—Dennis Allen

Expanded Linking in Folio Views



Folio Views 2.0 adds hypertext linking to external sources so that you can link graphics or sound to an infobase.

Another upgraded product worth considering is Folio Views 2.0, a program that manages very large amounts of textual information. In a nutshell, Folio Views fully indexes your text and then compresses the text and index into a single file typically half the size of the original ASCII text file. That alone was a remarkable feature in the first release, because a full-text index can easily exceed the size of the text file.

But Folio Views was not without its problems. First, it had its biggest problem with scrolling through text. Another problem was that although Folio Views offered some hypertext linking, it was limited to a single database (which Folio calls an *infobase*). And finally, preparing text for Folio Views' proprietary format took a great deal of time and patience, because you had to manually insert formatting commands and otherwise translate a document from its original format.

Folio Views 2.0 fixes all those problems. The text scrolling should be fast enough to keep any browser happy. Although you can't whiz through a Folio Views document as though it were a XyWrite (one of the fastest word processors) document, you can browse text comfortably—and even as fast as most ordinary word processors.

As for the hypertext linking, two new features in Folio Views 2.0 make all the difference. First, you can link to external sources, like another infobase. Second, because you can now exit Folio Views and run another program (leaving just a 10K-byte kernel behind), you can make a hypertext link to another program. In other words, you could create a link to a CD-ROM or to a program (e.g., Viewer, which is included) that displays graphics or produces sound (see the photo). Maybe that doesn't make Folio Views a multimedia product per se, but it might make for interesting hypertext documents.

To make document conversions easier, Folio Views now automatically converts text and data from over 40 formats (e.g., XyWrite and other popular word processors).

When I first tested Folio Views (see "Text Retrieval with a Twist," July 1989 BYTE), I liked it a lot—even with its shortcomings. Now, with those shortcomings fixed in Folio Views 2.0, I like it even more. ■

—Dennis Allen

Folio Views 2.0

Company
Folio Corp.
2155 North Freedom Blvd., Suite 150
Provo, UT 84604
(800) 543-6546
(801) 375-3700

Hardware Needed
IBM PC or compatible with 512K bytes of RAM

Software Needed
DOS 3.0 or higher

Price
$495

Inquiry 1205.

Professional developers require

EDT+
by Boston Business Computing

EDT+ 5.0, the only complete emulation of DIGITAL's VAX EDT, is 50% faster than its predecessor and features multiple windows, interfaces for EVE, EMACS, vi and WPS, 132-column mode, status line and ruler, keystroke macros and much more. 30-day, money-back guarantee and free customer support and updates for 60 days. For MS-DOS and UNIX systems.

LIST: $295 **PS** Price: $279

FastFaxts 342-001

Circle 262 on Reader Service Card

SentinelScout
by Rainbow Technologies

The SentinelScout is a hardware key that attaches externally to the parallel port of an IBM PC or compatible to enable execution of authorized program copies. It does not interfere with printer operation, hard disk installs or backup copies. Featuring a fixed-response security system unique to each device, the economical SentinelScout offers a level of execution control perfect for lower-cost programs.

LIST: $295 (kit of 10 keys)

PS Price: $265

FastFaxts 1313-001

386 DEVELOPMENT

	Price
386 Max 5.0	$109
386|DOS Extender by Pharlap	495
DESQview 386	189
F77-EM32 + Lahey Ergo	1055
FoxBASE+/386	479
Metaware High C 386/486	919
MetaWare Pascal 386/486	839
NDP Fortran w/VM	829
NDP C - 386	829
QEMM 386	95
VM-386	229
WATCOM C8.0 386 Prof.	1155
WATCOM C8.0 386 Stand.	795
Zortech C++ 386 Dev.	865

AI-LANGUAGES

ARITY Combination Package	989
LISPC	269
PC Scheme	85
TransLISP PLUS w/source	99
PDC Prolog Compiler	239

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Turbo Debugger & Tools	119
Visible Computer:80286	85

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MS QuickBASIC V4.5	69
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EasyCase Plus	275
EasyCase Plus Prof. Pack	365
EasyFlow	135
Instant Replay III	99
Matrix Layout	211
MetaDesign by Meta Software	287
Pro-C 2.0w/Workbench Combo	735
ProtoFinish by Genesis	211
Show Partner F/X	198
Visible Analyst	585

COBOL

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Realia COBOL	859

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C Asynch Manager 3.0	139
Essential COMM by S. Mtn.	259
Greenleaf Comm Library	329
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dBFAST/PLUS	315
dBMAN V	178
dBXL	189
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FoxBASE + - V2.1	279
QuickSilver	399

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Cause Professional	499
CLARION Prof. Dev. V2.1	549
D the data language	199
Magic PC	379
Paradox V3.5	569
R:BASE 3.1	499

DBMS TOOLS & LIBRARIES

AdComm for Clipper	279
Artful.Lib	289
BALER Spreadsheet Compiler	399
CLEAR + for dBASE	179
Comet Multiport	169
dBASE BlackBox	65
dBASE Online	129
BRIEF w/dBRIEF	Call
dBX/dBport	425
dGE 4.0	279
dQUERY MU	179
dSalvage Professional	195
FLIPPER Graphics Library	179
FUNCky.LIB	179
Genifer - code generator	269
Net Lib	229
Pro Clip	149
R&R Relational Reportwriter	139
R&R Code Generator	129
Scrimage	139
SilverComm Library	229
SilverPaint	119

UI2 Touch & Go
by Wallsoft

UI2 Touch & Go is a subset of The UI Programmer 2, Developer's Release for less experienced programmers. It has a screen painter and integrated data dictionary and comes with the GENSYS template system, customized application generation without programming. GENSYS handles almost all application development needs, 'right out of the box'. UI2 Touch & Go generates dBASE III+ and IV, Clipper, FoxBASE+, FoxPro, Quicksilver and dBXL programs.

LIST: $395 **PS** Price: $319

FastFaxts 212-011

HiJaak Release 2.0
by Inset Systems Inc.

HiJaak 2.0 is a graphics conversion and capture utility that translates more than 36 graphics file formats. HiJaak provides batch conversion capability from the DOS command line or from the user interface. Supported formats include GEM, PICT I&II, CGM, HPGL, PIC, DXF, PCX, MAC, TIF, and support for more than 16 group 3 fax devices. A 5K pop-up provides capture function of text screens, graphics screens, and laser printer output.

LIST: $199 **PS** Price: $189

FastFaxts 1085-003

BTree/ISAM v3
by Softfocus

A powerful, portable indexed file manager for C programmers. Supports multiple indices, fixed or variable length records, rich assortment of key types, and single or multi-user operation. The latest release of a flexible, fully-functional and well documented product. Currently in use by thousands worldwide. All C source included along with complete documentation and example programs. Portable to all operating systems and C compilers, no royalties.

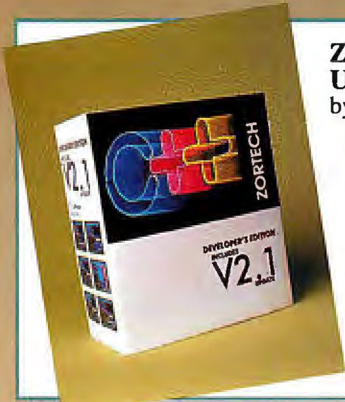
LIST: $179

PS Price: $149 w/source

FastFaxts 209-002

THE PROGRAMMER'S SHOP 1-800-421-8006

The Programmer's Shop is

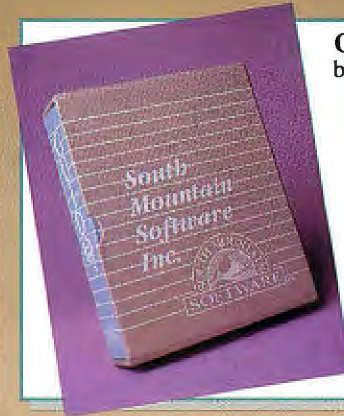


ZORTECH C++ V2.1 UNIX 386 Compiler
by Zortech, Inc.

Zortech's C++ V2.1 386 compiler for UNIX makes it easy to port applications among DOS, DOS 386, OS/2, and SCO UNIX 386. With the same tight, fast, globally optimized code of the DOS and OS/2 versions, the compiler takes full advantage of the 386. Included is an ANSI/UNIX/Zortech C++ compatible library.

LIST: $500 **PS** Price: $439

FastFaxts 1108-045



GUIDO
by South Mountain Software

GUIDO is a powerful library of C functions which enables you to easily add graphical user interface objects to your application. Available objects include menus, windows, data entry, radio buttons, user definable objects and more. An event driven, object oriented windowing environment is also provided. GUIDO does not require any other graphics library and includes support for Borland Turbo C, Microsoft C and Quick C.

LIST: $249 **PS** Price: $229
LIST: $499 (w/so.) **PS** Price: $459

FastFaxts 42-049

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dBXL/LAN	519
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Netware SQL	519
Netware C Interface	239

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Intek C++ 80386	298
M++ by Dyad Software Corp.	279
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Smalltalk/V	85
Smalltalk/V-286	185
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Turbo C ++ Prof.	259
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Zortech C ++ w/ source	269
Zortech C++ Debugger	150
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Fast!	45
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HiJaak	139
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Math Advantage	475
Norton Utilities 5.0	149
pcANYWHERE IV	159
PC Tools Deluxe 6.0	119
PC-KWIK Power Pak	119
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Remote2	139
SpinRite II	89
System Sleuth	89
The Duplicator Toolkit-Pro 3.0	119
Time$heet Prof.	76

TURBO PASCAL

Turbo ASYNCH PLUS	119
Turbo Pascal 6.0 by Borland	109
Turbo POWER TOOLS PLUS	98
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C Communications Toolkit	129
C Worthy w/Forms w/ARCH	359
Greenleaf DataWindows	339
HI-SCREEN XL Professional	289
MEWEL Window System	169
POWER SCREEN by Blaise	99
Vitamin C - source, menus	125
VC Screen - painter	109
Vermont Views Obj. + source	819

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C++ for Unix 386 by Zortech	43
Computer Innovations C++	469
db_FILE/RETRIEVE MU	399
ESIX Systems	
ESIX/V 386 Dev. (2 user)	569
ESIX/V 386 Dev. unltd	769
Informix SQL	Varies
Interactive Systems	
Architect Wrkstn Platform	1199
Architect Wrkstn Developer	1850
M++ for Unix by Dyad	679
M++ for Unix w/ source	939
Norton Utilities for Unix	249
SCO of Canada C++ for Unix	829
WordTech Quicksilver	839
XENIX 386 Dev. Sys.	689

WINDOWS & OS/2

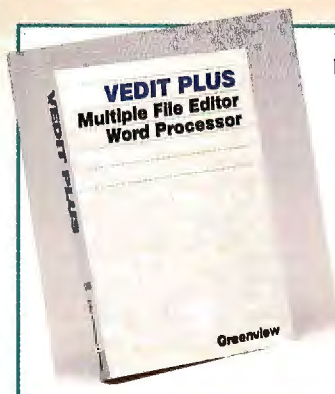
Actor 3.0	799
Brief for OS/2	Call
Case: W Corporate Version	905
Case: PM (for C or C+++)	1899
C_talk/Views	419
C-Trieve/Windows	349
dBFAST/Windows	315
Graphics Server SDK	455
Instant Windows	895
KnowledgePro Windows	589
M++ by Dyan Software Corp.	279
M++ w/source	499
MKS Toolkit	229
MS Windows 3.0	119
MS Windows DDK	365
MS Windows SDK	365
Multiscope OS/2 Debugger	375
Multiscope Windows Debug.	315
Object/1	598
OS/2 PM Toolkit	369
Smalltalk/V PM	469
Tempo for Windows	89

Expert Help
Expert Help Developers Kit
by SofSolutions

Expert Help replaces The Norton Guides with 100% file compatibility and incredible features! With Expert Help you can build your own Hypertext Databases or get instant reference from over 100 Databases that are available commercially. The Expert Help Developers Kit even lets you distribute The Expert Engine with your Databases (no royalty). The Expert Help Engine is memory resident, requiring 1k (with EMS).

	LIST	PS Price
Expert Help	$ 79	$ 69
Expert Help Multi-User	$279	$259
ExpertHelp Developers Kit	$199	$185

FastFaxts 876-023



VEDIT PLUS 3.40
by Greenview Data, Inc.

The new VEDIT PLUS programmer's editor integrates your favorite compilers, assemblers, linkers, debuggers and Make programs to really speed development. Its unique memory manager swaps out TSRs and network drivers during compilation. Features multi-file editing, windows, pull-down menus, mouse support, undo, regular expressions, a powerful macro language, and complete configurability. Exceptional speed for editing even multi-megabyte text and binary files.

LIST: $185 **PS** Price: $139

FastFaxts 25-007

Multi-Edit
by American Cybernetics

EASIER, FASTER & BETTER THAN EVER!

Multi-Edit has always been your best text editing value. Now version 5.0 adds: Windows/SAA-style interface, seamless Mouse Support, expanded online help & manuals (LOTS of useful examples), full EMS support, plus hundreds of new features! Inexpensive - NOT CHEAP! You've gotta see this! FREE DEMO

LIST: $99 **PS** Price: $95

FastFaxts 1067-006

THE PROGRAMMER'S SHOP 1-800-421-8006

AI: Metamorphosis or Death?

Is artificial intelligence dead? If it's not, it is without doubt undergoing a major transition, but whether that change precedes a death or a rebirth into a different form, I cannot say. The chasms within the AI community are widening to create the appearance of various disciplines, rather than different branches of the same tree. Which way AI as a whole—if such a concept exists anymore—is headed is a good question.

Whatever happened to the promise of the past? AI was supposed to inherit the earth, according to its proponents. What is the nature of an intelligent system, anyway? AI was supposed to make the creation of intelligent machines possible. In "AI's Identity Crisis" Bob Ryan addresses the questions of definition, validity, and direction that plague AI today.

Webster's provides several definitions for intelligence, including "the ability to apply knowledge to manipulate one's environment" and "the act of understanding." These definitions are applicable to *artificial* intelligence as well. The ability to categorize knowledge is the primary means by which an AI system acquires its form of understanding. In "Overturning the Category Bucket," Bill and Bev Thompson discuss the classical view—and a new view—of categories.

One AI area that has born the brunt of early failures is expert systems. Some of the first attempts were so amateurish as to invite scorn. However, first attempts are often just that—attempts. Since those early days, expert systems have matured a great deal. In "AI in Practice," Martin Heller roams DEC's corridors and explores many practical applications of expert systems that are in use there—applications that may give you ideas of your own for applying expert systems.

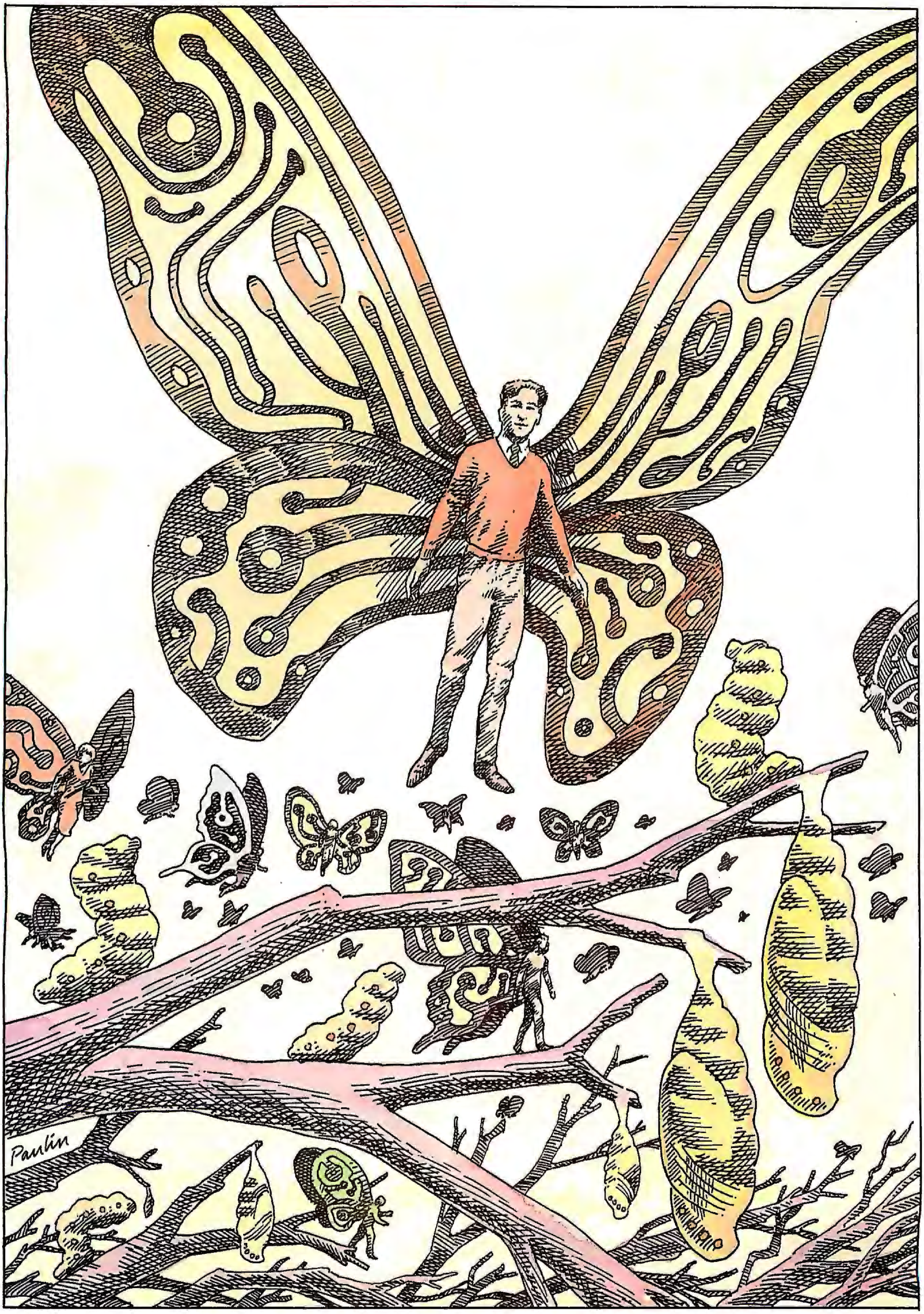
Another application for expert systems is the "assistant" programs that function as intelligent guides for new or unskilled workers and consolidate the knowledge of various experts. In "Putting the Experts to Work," Daniel W. Rasmus discusses some current microcomputer applications of expert systems. And in the text box "Solving the Unsolvable," Marge Sherald looks at the capabilities of systems formed by hybridizing expert systems and neural networks.

Expert systems have made inroads into a lot of areas, even such bastions of traditional programming as real-time environments. The constraints of real-time systems, and the response times required of them, make the advice of experts an increasingly valuable commodity. In "The Real-Time Expert," Thomas J. Laffey looks at the advantages of expert "help" in monitoring and controlling complex real-time systems.

One area that lies on the outer fringes of AI is artificial life. It does not, however, lie on the outer fringes of reality. One example of an artificial life organism is a computer virus—hardly a stranger to any of us. Artificial life as a field, however, is relatively unknown—but not for long. In "Real Artificial Life," Richard Marlon Stein takes the wraps off artificial life. Strange as it may seem, evolution, through its infinite variety, can provide an unlimited number of solutions to engineering problems.

Is AI dead? Not yet, but it's either going through the throes of a terminal illness or the agony of childbirth. Certainly some areas once considered the exclusive domain of AI are alive and well. But whether they will move out permanently on their own or regroup under AI's umbrella, I don't know. And I won't pretend to match my predictive powers against the likes of Minsky and Winograd.

—Jane Morrill Tazelaar
Senior Editor, State of the Art



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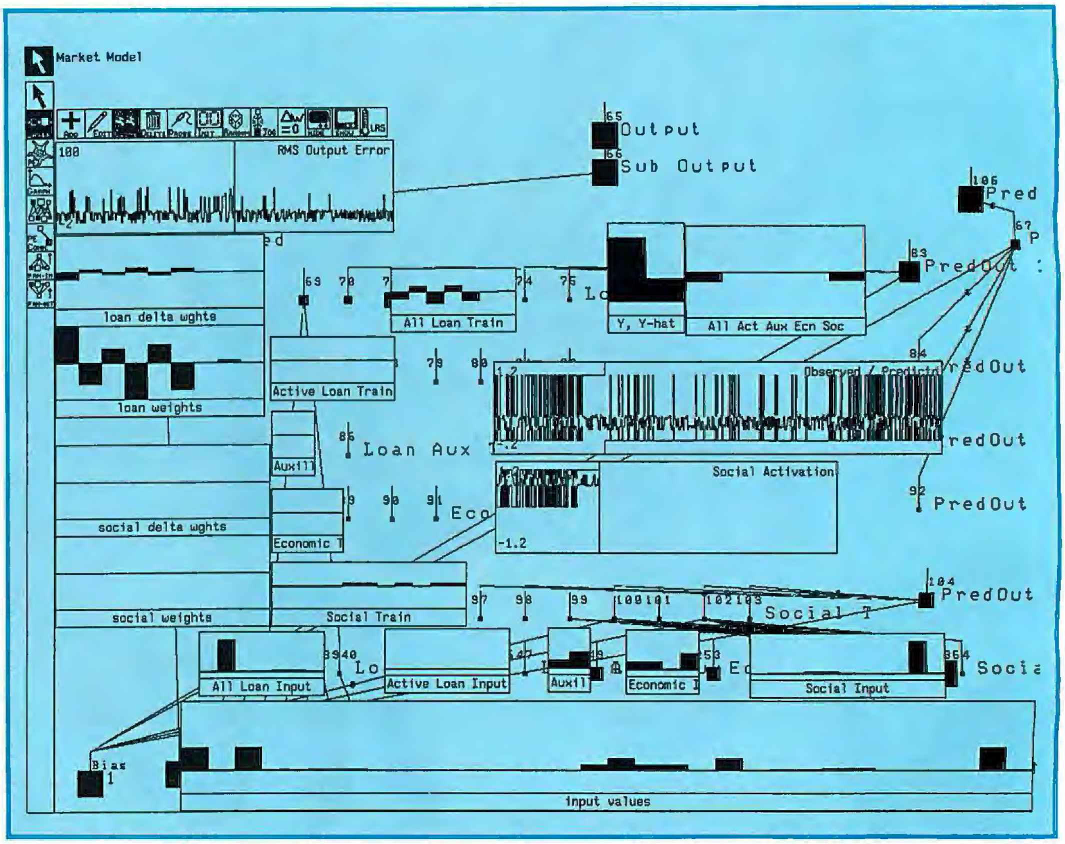

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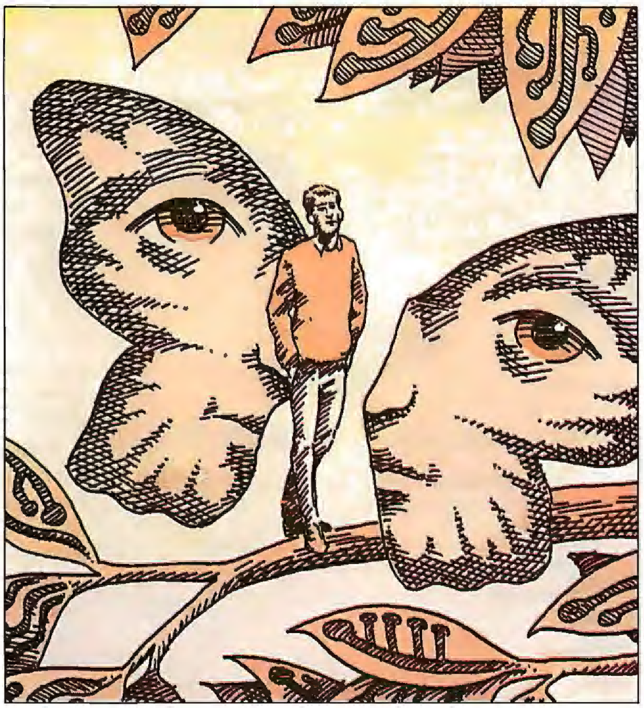
AI's Identity Crisis

What's important and what isn't? What to keep? What to discard?

Bob Ryan



For an outsider, perusing some of the current literature in the field of artificial intelligence borders on voyeurism. One part of you wants to shut the blinds, to turn away from the evident soul-searching going on, while another part is fascinated by the skeletons that prominent AI researchers are starting to rattle.

Probably because it is such a young field—and in part because it was once overhyped to the point of absurdity—AI is undergoing an identity crisis. B. Chandrasekaran of Ohio State writes, "AI is internally in a paradigmatic mess. There is really no broad agreement on the essential nature or formal basis of intelligence and the proper theoretical framework for it" (see reference 1).

Roger Schank of the Institute for Learning Studies (Evanston, IL) puts it another way. Talking about the public's identification of AI with expert systems and the criticism of AI from researchers in related fields of study, Schank states, "AI is in a serious state of disruption" (see reference 2). The resolution of this crisis—if it can ever be resolved—will determine whether AI can provide the kind of intelligent systems that will make all the work, and all the introspection, worthwhile.

What Is AI?

Ask a dozen different researchers the question "What is AI?" and you get a dozen different answers. Such is not the case with more mature disciplines, such as physics, medicine, and chemistry. To some people, this is evidence that AI can't be classified as a science and that it is, rather, simply a software-engineering discipline that has taken on airs. But this view discounts the fact that every mature science was once immature and groping for definition.

Patrick Winston, director of the MIT Artificial Intelligence Laboratory, has stated that the primary goal of AI is to make machines smarter (see reference 3), and many researchers agree. They see AI as a search for methods that will make computers far more intelligent (or at least make them *act* as if they were more intelligent) and, therefore, more useful.

Another oft-stated goal of AI is to investigate the nature of intelligence. From his work on robotics with Seymour Papert, Marvin Minsky of MIT developed the theory of agent-based intelligence that he laid out in his 1986 book, *The Society of Mind* (see reference 4). Minsky doesn't differentiate between human and machine intelligence; his work is as much an investigation into the psychology of humans as it is about the quest for intelligent machines.

Alan Bundy sees the confusion over

the definition of AI as a result of the many kinds of AI. He identifies three primary kinds: applied AI, which is the use of AI in commercial products; cognitive science, where AI is used to investigate the nature of intelligence; and basic AI, which is the exploration of computer-based techniques for simulating intelligent behavior (see reference 5).

According to this view, AI is an engineering discipline that develops commercial products—primarily expert systems; it is an engineering science that develops computational techniques for simulating intelligence and discovers their properties and interrelations; and it is a natural science that investigates the mind.

The fact that there are many kinds of AI leads to confusion among observers and AI workers alike. The work being done by one researcher may have no relevance to an engineer trying to install an expert system for a client. Such divisions also make it difficult to judge the progress or even the validity of AI as a whole; each field of endeavor must be judged on its own merits and using its own criteria.

Is AI Valid?

For much of its existence, the AI field has been dogged by questions about its basic validity. Some questions are motivated by the fact that, in the past, AI promised much more than it could deliver. Other questions concern the theoretical foundations of AI.

The fundamentals of AI were laid down in the decades preceding and following World War II. In "Computing Machinery and Intelligence," Alan Turing drew on earlier work that showed that formalized deduction—an aspect of intelligent reasoning—was a kind of computing, and that computing could be described as the manipulation of symbols. He came to the conclusion that, in theory, machines of the type we've come to call Turing machines can think (see reference 6).

This concept laid down the theoretical groundwork for the first researchers in AI, who equated Turing machines with computers and who came to identify computers not as muscle-bound numeric calculators but as symbol manipulators. The fundamental assumption of AI, as stated by two of its founding theorists, is that "a physical symbol system has the necessary and sufficient means for general intelligent action" (see reference 7).

According to this view, any system, such as a computer, that can process and manipulate symbols can be intelligent. The underlying assumption is that the human mind is simply one instance of a physical symbol system, and that what is termed "intelligence" is an artifact of that system.

Almost from its inception, this assumption has come under attack. The attacks have taken two forms: emotional arguments made by those who don't want to share the special status accorded human intelligence with machines, and logical arguments aimed at the assumptions that AI makes about intelligence. Some of the latter have been motivated by what many think is the lack of general success in the AI field.

For example, Terry Winograd of Stanford University thinks the fundamental view of intelligence that underlies AI is "shallow and inadequate." The problem, according to Winograd, is not the "insufficient development of the technology," but the "inadequacy of the basic tenets." He states, "There is no reason but hubris to believe that we are any closer to understanding intelligence

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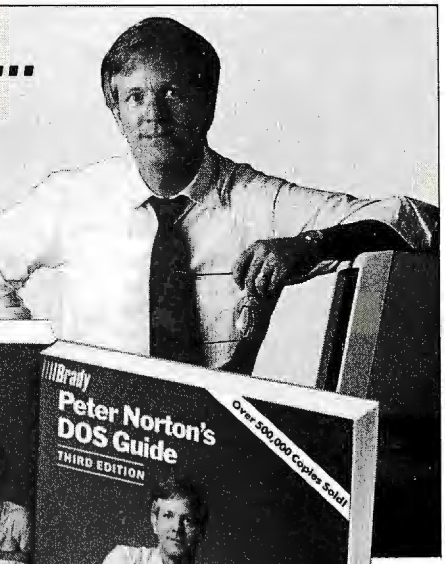

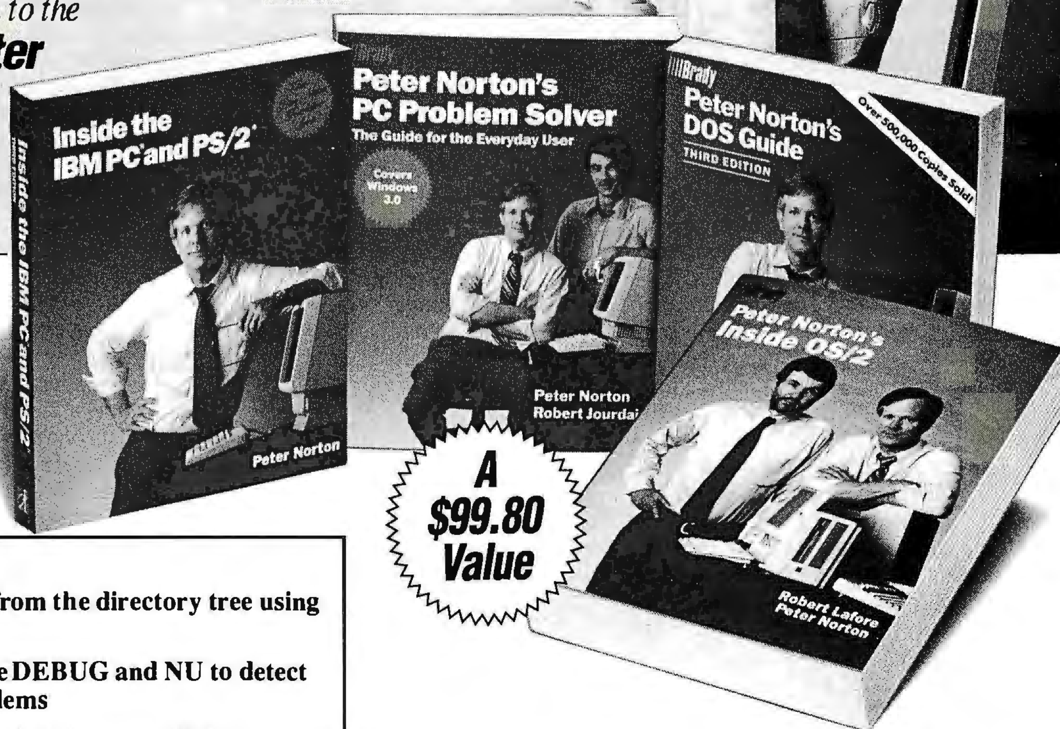

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than the alchemists were to the secrets of nuclear physics."

In Winograd's view, "The very notion of 'symbol systems' is inherently linguistic and what [AI researchers] duplicate in [their] programs...is really a form of verbal argument, not the workings of the mind." Winograd believes that a broader understanding of intelligence is necessary before a machine can display creativity, insight, judgment, or even common sense (see reference 8).

Eric Dietrich also takes issue with the theoretical basis of AI. He sees it as "based on a mistaken theoretical assumption: the idea that we now know what kind of computing thinking is."

Dietrich believes a robust science of intelligent systems will be established, but not from current AI. Such a science, he states, would not assume that we know what kind of computing thinking is; instead, "It is the goal of such a science to tell us what thinking is, and if it is computing, to tell us what kind of computing it is" (see reference 9).

To many people in the field, however, the question of whether physical symbol systems are necessary and sufficient for intelligence—whatever that is—is irrelevant. Their goal is to make machines smarter by learning how to represent and manipulate real-world knowledge with a computer, without worrying about whether the thinking their machines do is in any way related to human thought.

Most of the practical advances in AI come from this group. Their attitude toward the debate over whether machines can ever be intelligent was summed up by Ronald Brachman of Bell Labs in his overview of the knowledge-representation field in the 1980s, where he stated, "Regardless of the ultimate cogency of the arguments against formal AI, work in [knowledge representation] proceeded without heed" (see reference 10).

Certainly, the question of what constitutes intelligence is important not only to AI, but to science and society in general. But it is clear that those people who, in Bundy's classifications, are working in basic and applied AI are more interested in producing smarter computers than in creating an intelligent entity. So, although questions remain concerning the ultimate validity of symbolic AI as a model of the human mind, such questions have yet to have a great impact on researchers who pursue symbolic AI as an engineering science.

Connectionism Ascendant

From its beginnings in the mid-1950s, AI has been divided into symbolic approaches to simulating reasoning and nonsymbolic approaches. The most popular of the latter type are neural networks, which use the physical structure of the brain as their basic model.

Neural networks consist of many simple processing units called *neurons* that are interconnected and work in parallel. Neurons are arranged in layers and are connected both to neurons in the layer above and to those in the layer below.

The network is then trained to associate certain inputs with certain outputs. Thus, neural networks don't use discrete symbols to represent knowledge, but rely on weighted connections between neurons. The training provides the weighting factor. The importance of connections gives this field of study its name: *connectionism*.

In the 1960s, there was considerable excitement about a class of connectionist machines called *perceptrons*, which consisted of an input layer, a middle layer, and an output layer. Much of the excitement in perceptrons came from the 1962 publication *Principles of Neurodynamics* by Frank Rosenblatt (see reference 11).

By the end of the decade, however, the lack of practical results and the problems in scaling from small systems to large ones had cooled the interest in perceptrons within the AI community. The final knock on perceptrons came in *Perceptrons* by Marvin Minsky and Seymour Papert (see reference 12), who, at that time, were doing work with symbolic and connectionist systems.

In a clear analysis, Minsky and Papert proved conclusively that perceptrons were inherently limited. In their final chapter, they expressed the belief that extending the perceptron model to a multilayer system would be fruitless.

No one disputes the conclusions that Minsky and Papert reached about perceptrons. Many connectionist researchers, however, still take issue with the inclusion of the conjecture about multilayer systems, even though Minsky and Papert did identify the investigation of multilayer systems as an important research goal. Connectionists blame Minsky and Papert for the tailspin connectionism as a whole went into in the 1970s, when

grants for that type of research were difficult to obtain.

But connectionist research did go on, ironically along the lines suggested by Minsky and Papert. People began investigating the capabilities of multilayer networks and developed new neuron types and connectionist architectures that overcame the limitations of perceptrons. Such developments, however, did nothing to mend the rift between connectionists and the rest of the AI community.

By the mid-1980s, the renaissance in connectionism was well under way, and the AI establishment began to take notice. Minsky and Papert reissued *Perceptrons* in 1987. In the new prologue, they state, "Some readers may be shocked to hear it said that little of significance has happened in this field." By significant, they mean that "there has been little clear-cut change in the conceptual basis of the field."

In the epilogue, however, they go on to state their belief that connectionism is an important part of their view of the brain as "large numbers of relatively small distributed systems arranged by embryology into a complex society that is controlled in part (but only in part) by serial, symbolic systems that are added later" (see reference 12).

As connectionist machines continue to produce results in areas such as speech recognition and machine vision—areas formerly the exclusive reserve of symbolic AI—the debate about which method is best for representing and processing knowledge will intensify. Some AI researchers believe that, in some areas, the future belongs to connectionism.

Brachman writes that the fact that connectionist systems can handle noise better than symbolic knowledge-representation systems "seems to indicate that connectionist systems will eventually take over the role now being played by traditional [knowledge-representation] systems." In comparing connectionist and symbolic knowledge representations, he states, "When one looks at the natural world, it becomes apparent that the symbol-manipulation view of intelligence . . . is the more radical view" (see reference 10).

How will this symbolic/connectionist debate play out? That's an open question. With a decade of steady progress behind it, connectionism, in the form of modern neural networks, is clearly here to stay and is perhaps better suited to acquiring and representing knowledge about the real world than is symbolic AI.

When it comes to manipulating that knowledge, however, symbolic AI still can't be beaten. Undoubtedly, as old antagonisms wear thin, there will be more research into systems that combine both approaches.

Issues to Investigate

With all the controversy surrounding AI, it isn't hard to find lines of investigation. For the cognitive scientists, the questions revolve around the nature of intelligence, and how and if computers will ever be able to achieve it. Over the next decade, the question of the physical-symbol hypothesis, and of any theories that try to supplant it, will be uppermost.

In an interesting way, Schank has tied the issues he thinks are most important in AI to the definition of AI. His point is that AI is not defined by the methodologies it uses but by the problems those methodologies address. As he puts it, "A rule-based system is not an AI program

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just because it uses rules or was written with an expert-system shell. It is an AI program if it addresses an AI issue."

Because issues constantly change, Schank notes that the definition of AI is also changing. But he does point out 10 issues that he thinks will endure:

- *Representation*: At the heart of AI is the question of how to best represent knowledge in a computer.
- *Decoding*: How do you get real-world knowledge into an internal representation? In some AI fields, such as voice recognition or machine vision, decoding is the central issue. Schank thinks that decoding systems and representation systems must be considered together when building a system.
- *Inference*: AI systems must be better able to extract meaning from input. They must be able to infer meaning from limited clues.
- *Control of combinational explosion*: Putting it simply, an intelligent program must know when it knows enough about a subject.
- *Indexing*: Schank sees knowledge retrieval not as a search problem but as the optimization of the organization and labeling of memory. AI systems must be able to get at what they know.
- *Prediction and recovery*: An AI system should be able to make predictions about events in its area and be able to explain when the predictions go awry.
- *Dynamic modification*: In Schank's view, the ability of a system to change its internal representations based on experience—in other words, learning—is the quintessential AI issue.
- *Generalization*: AI programs need to be able to draw generalizations from different experiences.
- *Curiosity*: Schank believes that truly creative computers could surpass human beings and that AI must become familiar with investigations of creativity in other fields. (See reference 2.)

Whither AI?

From fundamental questions of intelligence to the issues and characteristics an intelligent system must address, AI has many possible venues to explore. In the short run, however, sorting out what's important and what isn't, and what to keep and what to discard from the past, will keep AI in a state of turmoil. And the only way to decide what to keep and what to throw away is to find out what works. As Schank says, "The time to build is now."

What effect will this have on us? In the near future, it will simply mean better, more intelligent expert systems. In time, it will mean computers that are better able to communicate with us, anticipate our needs, and solve our problems. ■

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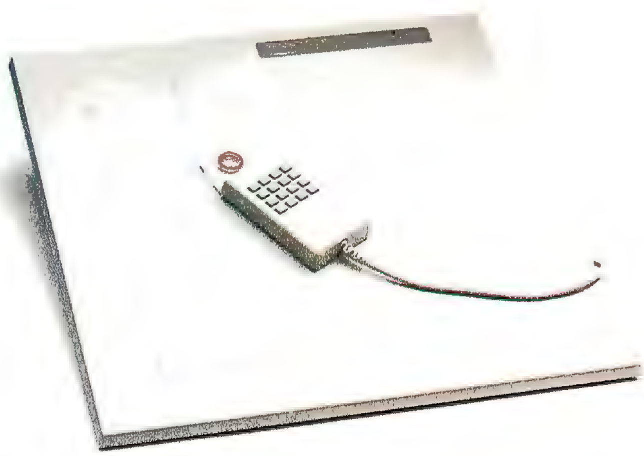

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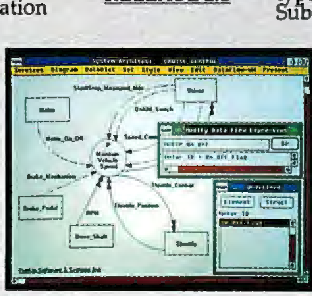

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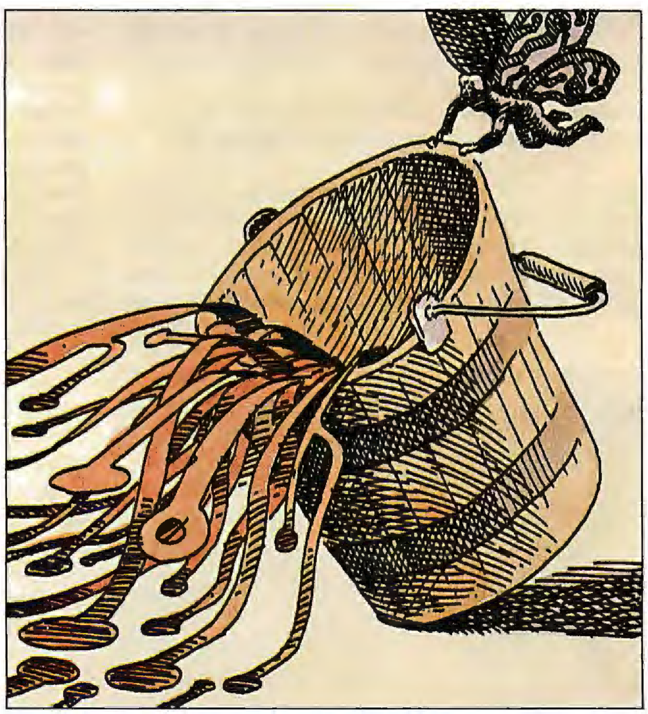
Overturning the Category Bucket

Categories are central to a human being's picture of reality—and to knowledge representation and reasoning in AI

Bill Thompson and Bev Thompson



Although Webster would have you believe differently, categorization and classification are not the same thing—at least not in AI. Classification methods, which assign objects to categories, are discussed in detail in numerous books and articles, but categorization is often not given the same attention. However, it is important not only to certain AI methods, but also to how human beings think and reason about the world.

We form categories about physical objects and abstract concepts. They help us make sense of the world we live in. Because of the fundamental connection that categories have with thought processes, a theory of categorization is central to our basic picture of reality. It is also central to knowledge representation and reasoning in AI.

Our own curiosity about categories began after reading *Women, Fire and Dangerous Things* by George Lakoff (University of Chicago Press, 1987), which provides a systematic discussion of what categories are, how they are used, and what they reveal about the mind. An awareness of the new views of categorization, expounded by Lakoff and others in the fields of cognitive science, linguistics, anthropology, and psychology, forms a steady thread through much of the work in these fields.

What Is a Category?

There was a time when you could simply present the definition of a category and encounter almost no dissent. In the *classical* view, a category is a group of objects whose members all share certain similar properties. The shared properties alone define category membership. A category is thus viewed as a kind of bucket with objects either inside or outside the container.

This classical view has been predominant for the past 2000 years in Western philosophy and science. Its applicability has been a background assumption that has formed a basic building block of many techniques and theories in many fields, including AI.

In this view, the properties that define a category are considered to be more primitive concepts than the category itself. This belief prompted theoreticians to search for ways to identify an ultimate set of primitives to which all other concepts could be reduced. For Aristotle, these primitives included substance, quantity, relation, time, position, status, activity, and passivity. However, it's basically impossible to define an ultimate set of primitives. Even Aristotle was unable to settle on one definitive set.

In 1629, Leibniz sought to represent primitives as prime numbers. He represented compound concepts by multiplying the prime numbers of the primitive concepts together. (In fact, he invented the first calculating machine in order to simplify his computations.) A little less than 300 years later, with the availability of computers, Roger Schank's conceptual-dependency graphs and semantic-net theories in computational linguistics echoed a similar theme.

A New Interpretation

The classical notion of a category as a container for objects sharing similar properties is now rapidly losing acceptance. The impetus behind this dissatisfaction came primarily from research in psychology, linguistics, and anthropology. Notably, Eleanor Rosch and her colleagues at the University of California at Berkeley were involved in pioneering work that questioned the basic definition of a category. Rosch examined certain implications of the classical theory.

Rosch's criticism of the classical view is described by Lakoff: "First, if categories are defined only by properties that all members share, then no members should be better examples of the category than any other members. Second, if categories are defined only by properties inherent in the members, then categories should be independent of the peculiarities of any beings doing the categorizing."

Contrary to these implications, experimental evidence indicated that, in general, categories have best examples called *prototypes* and also that human characteristics are integral to the process of categorization.

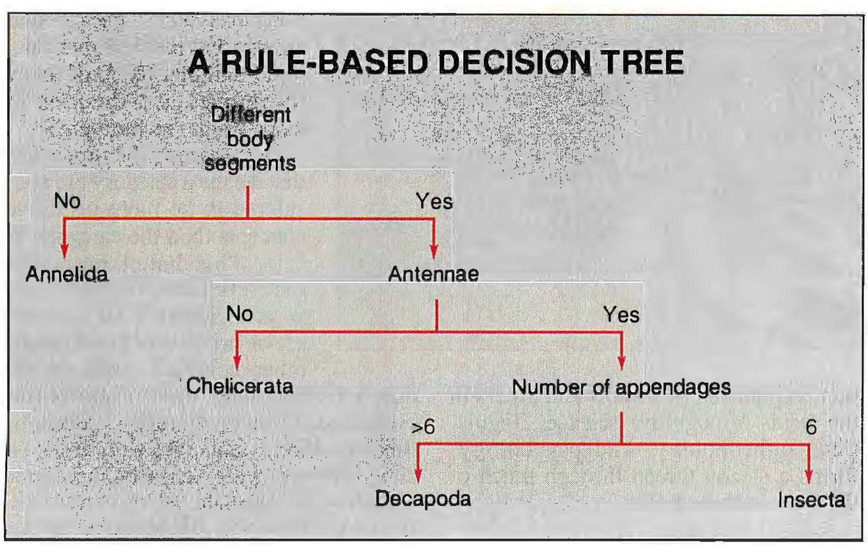
The classical notion of a category is now rapidly losing acceptance.

Categories and AI

The view of human reason that follows from the classical notion of a category is described by Lakoff as "the mechanical manipulation of abstract symbols which are meaningless in themselves but can be given meaning by virtue of their capacity to refer to things either in the actual world or in possible states of the world."

Once you accept this view, it is an easy next step to assume the possibility of a nonhuman or machine intelligence. This position holds that thought is disembodied; that is, it is not at all dependent on the characteristics of the "thing" doing the manipulation. This idea of categorization, sometimes referred to as *objectivism*, has been steadily losing ground, however, and currently only the proponents of the so-called "strong view" of AI favor it.

Once you question the classical definition of categories, an alternate view of reason emerges. In that theory, categorization, and thus reason, cannot be separated from human experience and imagination. This theory of embodied reason implies some interesting propositions. Among them, the mind is not separate from the body, and there is not a correct "God's-eye view of the world." Lakoff has termed this philosophical position *experiential realism* or *experientialism*.



With rule-based systems, you often classify objects using a decision tree. The limitation of such a system is that the structure of the tree predefines the categories available.

Categorization and Classification

In AI, many of the most well known techniques deal with some type of classification of data. In classification, the goal is to identify the category or class to which an object belongs. It is assumed that the possible categories are known before classification begins. Methods commonly used for classification include rule-based expert systems, induction systems, neural networks, and genetic algorithms. In a rule-based system, you construct a decision system that represents the understanding of an expert. This knowledge either is already well defined or is massaged into an orderly structure by knowledge engineering. Many expert systems are based implicitly on decision trees.

It's easy to see how the decision-tree model follows the classical theory of categories. Each leaf of the tree is a category—a bucket into which you place a classified object. Membership in the category is based solely on properties that the objects in the bucket share. For example, in the tree shown in the figure, membership in the category *Insecta* is determined solely by the presence of antennae and six appendages.

This representation suggests that for each of these objects, the properties describing them and their categories are well-defined "things" that exist in the "real world." Membership in the final category is an all-or-nothing proposition. No objects are better or worse members of the category. Although many schemes have been proposed to allow measures of uncertainty in the classification process, they are often poorly understood by the experts building the systems and thus have met with limited success.

Since building decision trees is such a labor-intensive process, many AI researchers attempt to construct methods that can learn rules from existing data. Induction systems, neural networks, and genetic algorithms are examples of such methods. In each of them, the system "learns" by being trained with sample data. This data usually contains a set of objects along with information describing selected characteristics of each object in the data set. In order to learn, these systems must also be provided with the known category in which each object belongs. The learning method uses the

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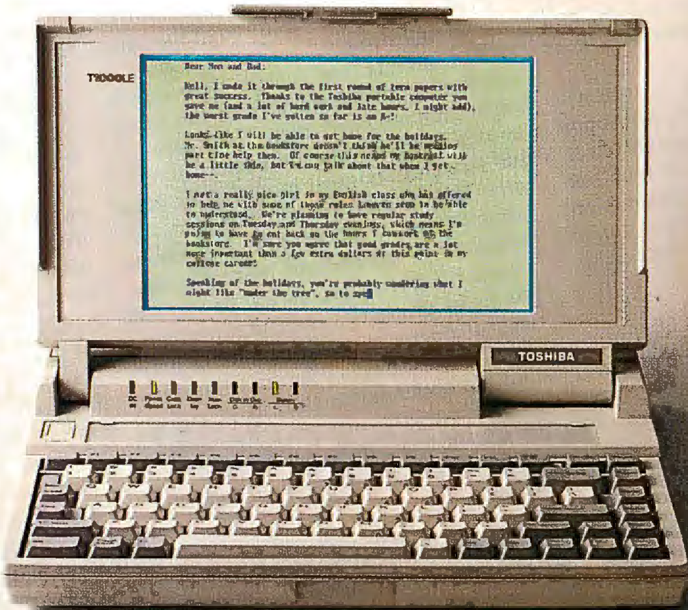

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sample set to construct a series of relationships that will allow the system to predict the categories of new objects. Table 1 shows a typical sample set for a learning algorithm.

Of the three techniques, induction is the closest to basic rule-based systems. Most induction systems examine each attribute used to describe the objects (the columns in table 1) and decide which one most evenly partitions the objects. Induction is basically a counting method that shares the classical bias for fixed categories.

Genetic algorithms and neural networks work in ways that are philosophically closer to the modern notions of categorization. It's interesting to note that even the names of these techniques are derived from biological systems, implying a search for a more "embodied" theory of learning.

Genetic Algorithms

Genetic algorithms represent the properties of objects with a string of bits (see table 2). The algorithm first creates bit patterns—randomly or based on some heuristic—that represent a rule for classification. For example, using the scheme in table 2, you can encode the proposition "if there are more than six appendages and it's a sea creature with antennae, then it's of the order *Decapoda*" with the bit pattern 011010100 10.

Next, the algorithm tests the generated rules against a sample set. This testing may be somewhat complicated, forcing the generated rules to bid for the privilege of being tested against an element in the sample set. Based on bidding successes and failures, the algorithm assigns strengths to the generated rules. Because the strengths of the rules are constantly changing, this process is an iterative one that passes through the sample set many times.

At intervals, the genetic algorithm is invoked to select rules from the set to mate, mutate, and die. The rules are chosen based on probability according to the strength assigned to each generated rule. The operation of both phases of this technique tends to identify and reward "successful" bit patterns by replication. These bit patterns, which represent groups of properties, constitute categories that emerge as significant in the generated rules. Category formation is very fluid, and boundaries shift as emerging category patterns influence the model. You can observe these relationships by examining the evolution of the genetic system.

Learning in Neural Networks

A neural network is made up of layers of neurons: an input layer, one or more middle layers, and an output layer. Neurons can be adapted to handle numeric, symbolic, and image data. Each input neuron represents one property described in the sample set. The output is usually a classification category based on the internal state of the middle layers of neurons.

The training set of a neural network is a set of objects whose properties are presented as input to it. The algorithms used in the model adjust the strengths of the connections among the neurons until they achieve the desired output. Since the readjustment changes the response of previously tested objects, the method loops through the training set and refines the connections until it reaches some optimum conditions. Like the genetic algorithm, the operation of the neural network relates the objects' properties to categories in a manner difficult to describe in classical terms.

Although genetic algorithms and neural networks take the interesting first step of representing a category as something other than a single group of objects sharing similar well-defined properties, this doesn't mean that they approximate human reasoning methods. Researchers who subscribe to the nonobjective view of reasoning will be quick to remind you that no matter how clever the manipulation of symbolic representations, reasoning is not an abstract process separable from the "wetware" that performs it. Lakoff's book contains numerous examples of metaphors and image-schematic structures that illustrate this point.

Forming Categories

All the learning systems described thus far require a sample set of objects that have already been classified. This implies that for a given set of objects, you already know which categories exist and how the objects are distributed among them. Category formation, on the other hand, involves analyzing a set of objects to find which subsets have enough similarity to be clustered into a category. There is no a priori knowledge of an optimal classification scheme. Category-

INDUCTION TRAINING SET

Table 1: *The induction learning method uses the sample set of data to construct a series of relationships. Knowledge of these relationships will enable the system to predict the classes of new objects.*

Object	Appendages	Habitat	Antennae	Usefulness	Classification
Horseshoe crab	>6	Sea	No	None	Chelicerata
Bee	6	Land	Yes	Food	Insecta
Spider	>6	Land	No	None	Chelicerata
Lobster	>6	Sea	Yes	Food	Decapoda
Silkworm	6	Land	Yes	Silk	Insecta

GENETIC TRAINING SET

Table 2: *Genetic algorithms represent the properties of objects with bits. The algorithm begins by creating bit patterns that represent a rule for classification.*

Object	6 "legs"	>6 "legs"	Sea	Land	Antennae	No antennae	Food	Silk	None	Class
Horseshoe crab	0	1	1	0	0	1	0	0	1	01
Bee	1	0	0	1	1	0	1	0	0	00
Spider	0	1	0	1	0	1	0	0	1	01
Lobster	0	1	1	0	1	0	1	0	0	10
Silkworm	1	0	0	1	1	0	0	1	0	00

Classification values: Insecta = 00, Chelicerata = 01, Decapoda = 10

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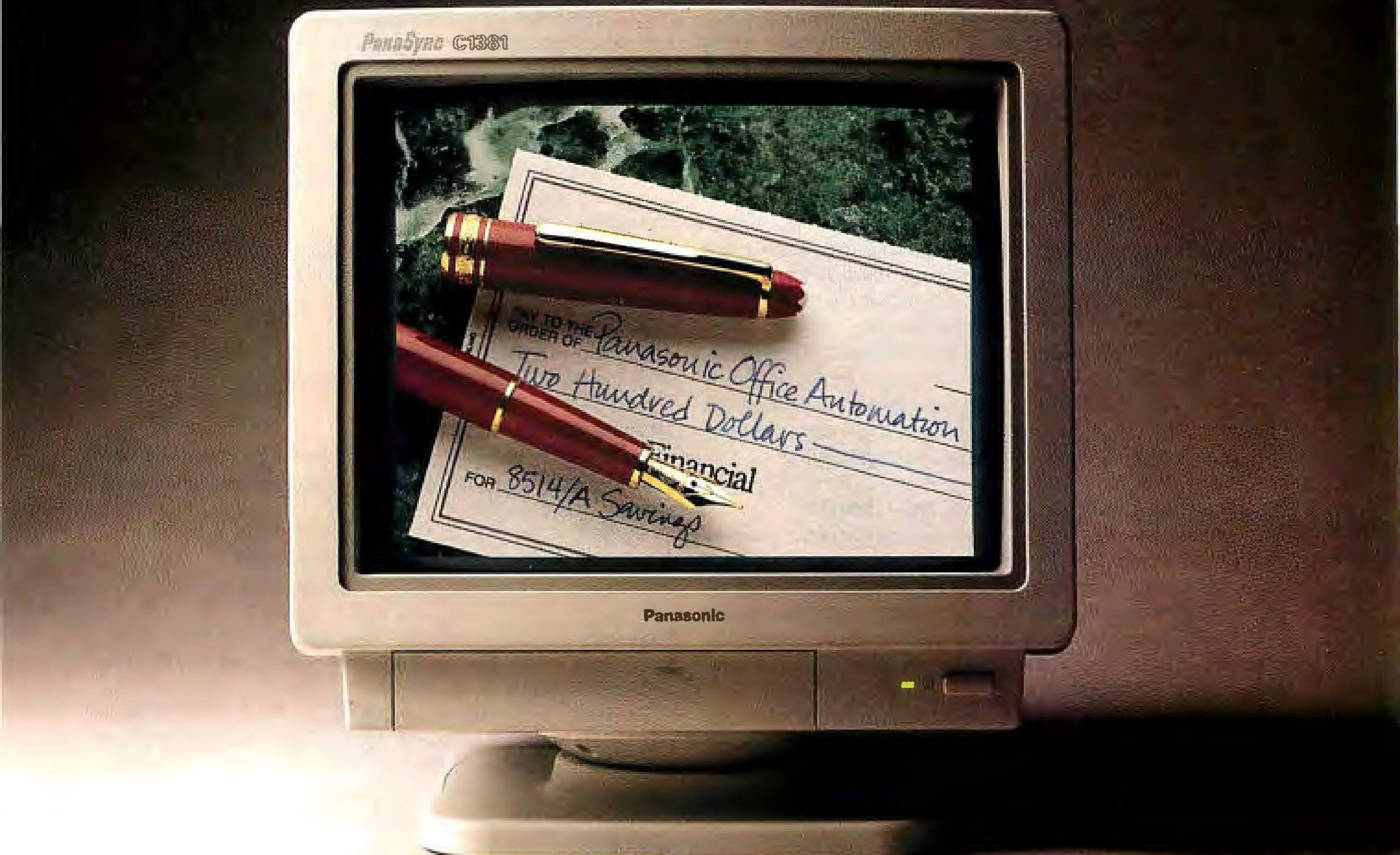

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Creating Conceptual Clusters

Conceptual-clustering methods start with a group of objects with certain known properties. A clustering algorithm then measures the amount of similarity between objects, and among groups of objects, to build meaningful clusters. As an example of one of these techniques, we've written a program called Concept that is based on a well-known program called Cluster/2, written by Ryszard Michalski and Robert E. Stepp (see reference 1).

Concept partitions a set of objects to form conceptual clusters. (Cluster/2 also constructs a classification hierarchy, but we will concentrate only on the partitioning module.) Fisher and Langley (see reference 2) also describe Cluster/2 and give a good overview of conceptual clustering and a description of several other clustering programs. Concept is based on the description of Cluster/2 from Fisher and Langley.

We wrote Concept using the Windows version of Knowledge-Pro because, having designed the language, we know it intimately. However, the clustering method doesn't depend on the choice of a particular language. You could use any language, such as Lisp or Prolog, that supports list programming.

Representing Concepts, Objects, and Clusters

Conceptual-clustering programs usually represent a concept as an attribute-value pair. For example, `appendages:six` associates the attribute `appendages` with the value `six`. You can associate attributes with more than one value by representing the values as a list surrounded by square brackets. For example, the concept `habitat:[sea,land]` assigns the values `sea` and `land` to the attribute `habitat`.

An object is a list of concepts in which each attribute has one and only one value. The objects we use in Concept are shown in table A. A cluster is a group of objects. You can describe a cluster by providing a list of its objects or the concepts associated with the objects in the cluster. For example, the cluster `[bee, lobster]` is defined by the concepts

```
appendages:[six,more_than_six]
habitat:[land,sea]
antennae:[yes,yes]
commercial_use:food
```

OBJECT DESCRIPTIONS

Table A: *Objects are lists of concepts in which each attribute has one and only one value.*

horseshoe_crab = [appendages:more_than_six, habitat:sea, antennae:no, commercial_use:none]

bee = [appendages:six, habitat:land, antennae:yes, commercial_use: food]

spider = [appendages:more_than_six, habitat:land, antennae:no, commercial_use:none]

lobster = [appendages:more_than_six, habitat:sea, antennae:yes, commercial_use:food]

silkworm = [appendages:six, habitat:land, antennae:yes, commercial_use:silk]

The first step in creating a conceptual cluster is to select two objects as *seeds*. You can think of seeds as cluster starting points. In a sense, they are like the prototypical members of a category. You can choose seeds at random or by some measure of the difference between the seed objects. Although choosing seeds that are as different as possible will usually improve the performance of the clustering algorithm, we randomly chose the first two objects, `horseshoe_crab` and `bee`, as seeds.

The seed objects, shown here as lists, are

```
horseshoe_crab
[appendages:more_than_six, habitat:sea,
antennae:no, commercial_use:none]

bee
[appendages:six, habitat:land,
antennae:yes, commercial_use:food]
```

Discriminating Concepts

Once the seeds are selected, the program generates the most general concept that distinguishes the two seed objects. For example, the list

```
[appendages:more_than_six, habitat:sea,
antennae:no, commercial_use:[none,silk]]
```

represents a concept that can discriminate `bee` from `horseshoe_crab` in the data set. This concept contains all the non-`bee` attribute values from the set.

To find a concept that distinguishes one seed object from the other seeds, take each possible value of the attribute and check to see if it appears in any of the other seed objects. If it does not, add that value to the distinguishing concept.

Performing this process on the data set from table A gives you the list

```
[appendages:more_than_six, habitat:sea,
antennae:no, commercial_use:[none,silk]],
[appendages:six, habitat:land,
antennae:yes, commercial_use:[food,silk]]
```

which discriminates between `horseshoe_crab` and `bee` in the set of objects. The first sublist identifies non-`bee` objects; the second identifies non-`horseshoe_crab` objects.

Next you combine the items in the first sublist that discriminates a `bee` from a `horseshoe_crab` one at a time with each of the items on the sublist that discriminates `horseshoe_crab` from `bee`. For example:

```
[appendages:more_than_six, appendages:six],
[appendages:more_than_six, habitat:land],
[appendages:more_than_six, antennae:yes],
[appendages:more_than_six,
commercial_use:[food,silk]],
[habitat:sea, appendages:six], ...
```

This way, you create 16 concept pairs that you use one at a time to generate clusters. To form the clusters, select a pair of concepts and find which one describes each object. If, for example, you select the concept pair `commercial_use:[none, silk]` and `commercial_use:[food,silk]`, you find the following: `commercial_use:[none,silk]` describes `[horseshoe_crab, spider, silkworm]`, and `commercial_use:[food,silk]` describes `[bee, lobster, silkworm]`.

Because the goal is to partition the objects into disjoint clusters, remove any duplicates from the lists and place them in an exception list. In this case, remove `silkworm` from the list. Next, add the exceptions back into the clusters in a manner that keeps the clusters disjoint. To accomplish this, generate the maximally specific concepts that describe the disjoint clusters formed after `silkworm` is removed.

The concepts unique to `[horseshoe_crab, spider]` are

```
[appendages:more_than_six], habitat:[sea,land],
antennae:no, commercial_use:none]
```

The concepts unique to `[bee, lobster]` are

```
[appendages:six,more_than_six], habitat:[land,sea],
antennae:yes, commercial_use:food]
```

Next, add the first exception into one cluster and find the unique concepts that describe it. Here, adding `silkworm` into the first cluster results in the clusters `[horseshoe_crab, spider, silkworm]` and `[bee, lobster]`. The concepts that describe these two clusters are

```
[appendages:[more_than_six, six],
habitat:[sea,land], antennae:[no,yes],
commercial_use:[none,silk]]
[appendages:six,more_than_six], habitat:[land,sea],
antennae:yes, commercial_use:food]
```

Adding the silkworm to the second cluster forms the new clusters `[horseshoe_crab, spider]` and `[bee, lobster, silkworm]`. The concepts that uniquely represent these clusters are

```
[appendages:more_than_six, habitat:[sea,land],
antennae:no, commercial_use:none],
[appendages:[six,more_than_six],
habitat:[land,sea], antennae:yes,
commercial_use:[food,silk]]
```

Next, evaluate the clusters in terms of their related concepts. There are various methods to evaluate the concepts, such as searching for similarity, intercluster difference, or simplicity. In the sample program, we attempt to build clusters that have a large intercluster difference among their related concepts.

The intercluster difference is the sum of the disjointness of all concept pairs. The disjointness of a pair of concepts is the number of attributes that do not intersect. If you look at the concepts in each of the competing clusters shown above, you will see that the first clustering has an intercluster difference of 1 because `commercial_use` is the only attribute with no overlap of values between the two clusters.

The second set has an intercluster difference of 2 because both `antennae` and `commercial_use` fail to intersect. Thus, case 2—the clusters `[horseshoe_crab, spider]` and `[bee, lobster]`—has the larger intercluster difference and becomes the selected representation. If there are more exceptions in the original clusters, add each exception to one of the successive clusters created.

The clustering algorithm repeats this process for each of the 16 original concept pairs. The cluster with the maximum intercluster difference becomes the best cluster for the set of objects. In selecting concept pairs, discard those that cannot describe all the objects, since they don't successfully partition the data set.

For example, the concept pair `[antennae:yes, commercial_use:[food,silk]]` doesn't let you describe `bee`, `lobster`, or `silkworm`. In this set of data, this cluster has the maximum intercluster difference.

Real-World Correlations

As it turns out, the cluster that the program chooses mirrors the biological classification of the actual creatures. Horseshoe crabs and spiders belong to subphylum *Chelicerata*; the other objects belong to subphylum *Mandibulata*. Although you might be tempted to say that this proves that the technique is useful for discovering some natural order existing in the world, you should remember that this partitioning depends on the attribute `commercial_use`, which is not a natural attribute.

Even though we have used intellectually loaded terms, such as *concept*, in describing its workings, the Concept program merely manipulates data structures. You must supply the meaning of the structures representing items like *concept*. Notice also that, philosophically, Concept is a classical method for creating categories. Membership in a cluster (i.e., a category) is based strictly on the similarity among shared values for attributes.

As you can see from the example, Concept extensively searches the space of possible partitions. Each step in the search is fairly expensive because of the amount of list manipulation involved. Michalski and Stepp describe some advanced heuristics that you can use to prune the search. Even using advanced heuristics, Fisher and Langley report that the partitioning system appears to run in time proportional to m^k, where k is the desired partition size and m is a linear function of the number of attributes and the average number of values for each one. However, because this method performs such an extensive search, it can usually discover relatively good clustering, even in poorly structured data.

Editor's note: *Concept is available in electronic format.* *See page 5 for details.*

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2. Fisher, D., and P. Langley. "Conceptual Clustering." In *Artificial Intelligence and Statistics*, William A. Gale, ed. Reading, MA: Addison-Wesley, 1986.

formation techniques are often referred to as "top-down methods," in contrast to the "bottom-up methods" associated with classification systems.

You can use the output of a categorization system to create a hierarchical tree with which to classify the objects in an AI system. You can also use the output to analyze how a set of objects can share certain properties. One method for categorizing objects from the top down is *conceptual clustering*. (For information on this method and a program that will let you try it, see the text box "Creating Conceptual Clusters" on page 254.)

Three Main Points

In sum, there are three main points to consider. First, categories are important in AI and deserve more study. Classification systems have been one of the most well known and commercially exploited technologies of AI. Even though categorization is related to classification, an explicit understanding of categories and their roles is not usually discussed when describing systems that use classification.

Second, the new view of categories points out that philosophy, AI, anthropology, linguistics, and psychology have much to say to each other if a common language can be found. Third, metaphysics matters. It can point in the direction of developing powerful new techniques, as well as illuminate the possible limits of existing ones. ■

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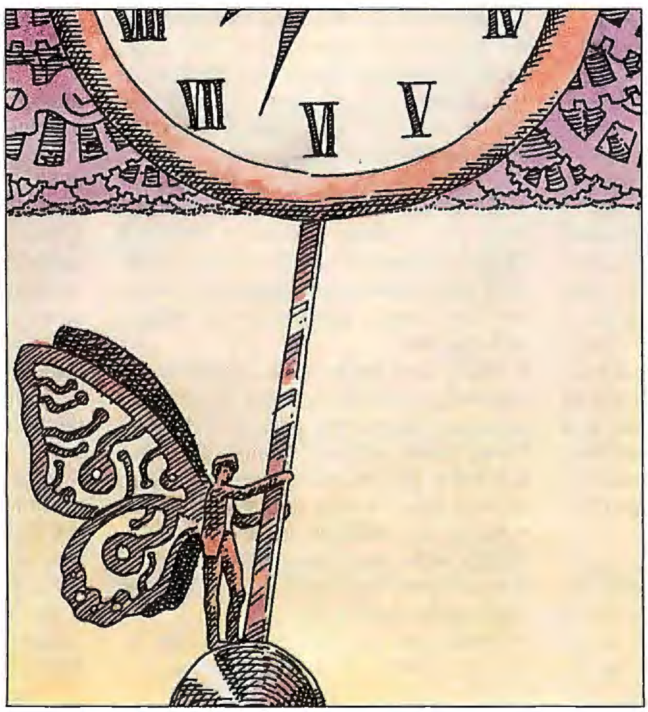

We live in an age of information overload. The growing complexity of computerized systems, as measured by the volume of low-level information that they produce, in many cases outstrips the capacity of people to monitor and control them. Operators are overwhelmed with information; already some spectacularly expensive accidents (e.g., Three Mile Island and Bhophal, India) have been attributed to this "cognitive overload."

The profitability of a company, the quality of its products, and the safety of its operations can all be adversely affected by cognitive overload. Real-time computer systems, which are showing up in a growing number of applications ranging from the simple controllers found in household appliances to large, complex systems for industrial and military purposes, challenge even the most well trained experts with the sheer volume of information they produce. One possible solution to the problem is to use real-time expert systems that combine the subtlety and flexibility of human expertise with the speed and precision of the computer.

Problem Indicators

The complexity of real-time computerized systems is increasing in many areas. Compared to systems available just a few years ago, real-time systems today control an increased number of functions at a faster rate and with a greater number of factors that you must consider before a control decision can be made.

Indicators that you might need a real-time expert system, especially when conventional techniques have failed or are impractical, are many. They include problem-solving situations where people suffer from cognitive overload, fail to effectively monitor all available information, are unable to resolve conflicting constraints, are expensive or scarce, make high-cost mistakes, miss high-revenue opportunities, or cannot provide a solution quickly enough.

An example of a situation susceptible to operator overload is the control room of an oil-drilling platform, where an operator can be confronted with as many as 500 analog and 2500 digital signals. In the event of a system problem, this can result in a considerable cognitive load. And the problem is just getting worse. Future oil platforms will require that two or three operators monitor as many as 20,000 signals.

In other domains, such as satellite control, qualified personnel—those who are able to evaluate complex situations and recommend actions—are becoming increasingly difficult to find. For example, the Hubble Space Telescope has more than 6000 sensors that need to be monitored in real time. Similarly, in financial markets, good traders who can quickly assimilate and evaluate information and act on it are scarce and expensive. Financial trading is a fast-moving activity that depends on a wide and complex scope of political, economic, climatic, and financial factors.

Used properly, a real-time expert system can result in more sophisticated monitoring and control strategies in such fields as

- space operations;
- military command and control;
- nuclear/electrical power-plant monitoring and control;
- air-traffic control;
- environmental systems;
- transportation systems;
- radar/signal understanding;
- aerospace systems (e.g., monitoring electrical, power-propulsion, and life-support systems);
- communications-network monitoring and control;
- factory monitoring and process control, including factory-wide decision support;
- medicine (patient monitoring); and
- econometric and financial areas (e.g., market monitors, advisers, and traders).

What Is Real Time?

As discussed by O'Reilly and Cromarty (see reference 1), many definitions of real time exist. It is commonly assumed to mean "fast," in the sense that a system is considered real-time if it processes data quickly. Real time is also thought of as "perceptually fast," or at least "faster than a human can do it." A better definition states that "the system responds to incoming data at a rate faster than it is arriving." Although scarcely precise, this definition does link the concept of real time to problem-relevant performance measures.

J. A. Stankovic divides real-time systems into *hard* and *soft* (see reference 2). With a hard real-time task, the correct action or solution depends not only on the results of the computation but also on the time it takes to produce the results. For these tasks, the system must meet timing constraints. An example is a navigation system on board a missile, which requires responses within a certain time increment. Failure to produce a response during this time may cause the missile to go out of control. A response produced after the time increment is useless.

In soft real time, the tasks also have time constraints, but there is still some value in completing tasks after their deadline, although typically the value of completing the tasks degrades monotonically over time. Most systems today have both hard and soft real-time requirements.

Real Time and Traditional AI

Until recently, knowledge-based systems have been sheltered from real-time requirements. Historically, AI researchers have concentrated on problems where time is not a factor, such as medical diagnosis (MYCIN from Stanford University), computer configuration (XCON from DEC), and evaluation of geological sites (Prospector from Stanford Research Institute).

These systems are characterized by the fact that a human operator supplies the inputs, data does not change during the problem-solving session, and response times are generally slow, measured in minutes or hours. This contrasts with current real-time systems where data changes rapidly and response time is often measured in milliseconds.

Because a real-time expert system must satisfy demands and operate under constraints (e.g., time and memory) that do not exist in conventional domains, most knowledge-based building tools (i.e., shells) are not generally appropriate for real-time applications. They fall short for the following reasons:

- Shells are not fast enough. Research from the Defense Advanced Research Projects Agency (DARPA) Pilot's Associate program has indicated that current tools are two to three orders of magnitude too slow.
- Shells have little or no capability for reasoning about the behavior of data over time, and about how past, current, and future events relate. In many real-time problems, decisions are based not just on current data, but also on historical data.
- Shells are difficult to integrate efficiently with conventional software (e.g., data compression, signal processing, and application-specific I/O).
- Shells have few or no facilities for focusing attention on significant events.
- Shells offer no integration with a real-time clock. In a real-time system, you often need to link events to absolute times or specific time intervals.
- Shells have no facilities to handle asynchronous events.
- Shells cannot efficiently take input from external sources other than human operators.
- Shells don't provide reliable response times. Many AI algorithms are search-intensive and exponential in nature.
- Shells are not built to run continuously.
- Shells cannot adapt to changes in work load or resource availability.

To handle such requirements, the framework of a real-time knowledge-based system is fundamentally different from that of a traditional expert system. Rather than coming from people, inputs come from automatic sensors that monitor a process. The outputs of a real-time expert system go to effectors that perform a control action on the process of interest, with messages to the operators informing them about what's going on and possibly recommending desired actions.

Tools for Real-Time AI

Recently, a few companies have developed specialized knowledge-based tools targeted specifically at the vertical real-time market. For example, my company, Talarian, offers R*Time, a family of products optimized for intelligent monitoring and control. Like other real-time expert systems, R*Time has extended many of the traditional knowledge-representation methods to handle the real-time domain.

To achieve high performance and maximum modularity, R*Time breaks its major tasks into three types of processes: inference-engine processes, used to analyze dynamic data by means of objects, classes, and rules; data acquisition processes, used as links to the external world (these acquire, filter, and send the incoming sensor data to other processes); and human-machine-interface processes that provide point-and-click graphical user interfaces.

With a traditional expert-system shell, the inference engine, data acquisition, and user interface would all be grouped together into one large process, potentially tying up resources, such as memory and CPU, and making it difficult for the system to react quickly to critical events.

By breaking these key functions into independent processes, a real-time expert system can distribute its processes anywhere on a LAN and exploit the inherent asynchrony in the system to maximize throughput and response. Such a distributed architecture also has the advantage of being able to exploit multiple CPUs if performance requirements call for it. Figure 1 shows an example of R*Time processes distributed across six workstations to monitor the electrical-power, pointing-control, and thermal subsystems of a satellite in real time.

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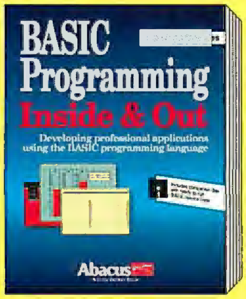

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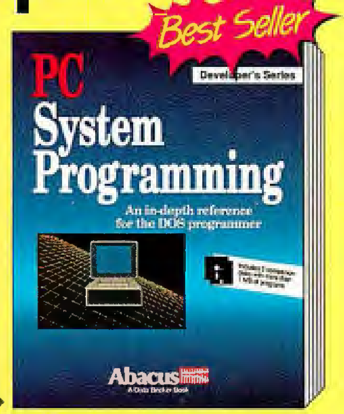

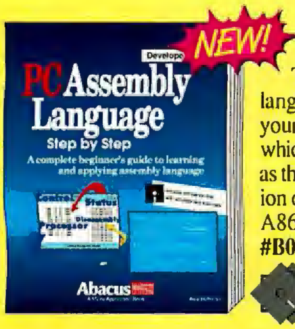

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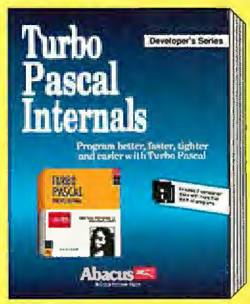

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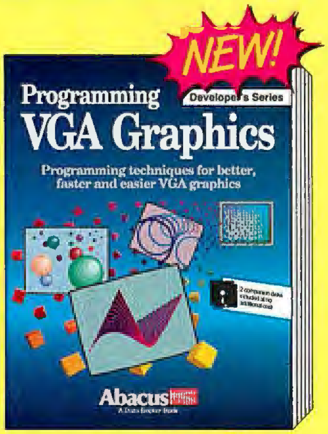

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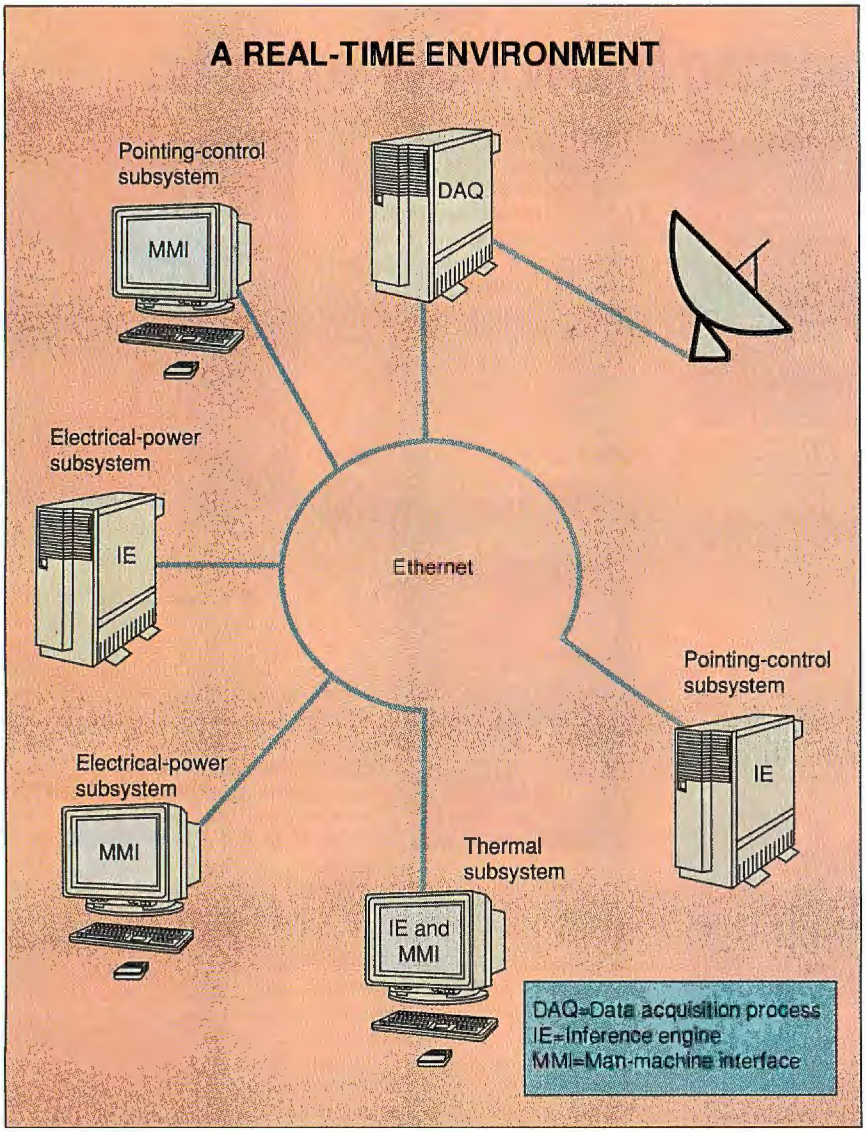

Figure 1: *By distributing different functions to different processors, a knowledge-based system cuts down the load on any one processor, making the system faster and more responsive. In the example, the inference engine, data acquisition, and man-machine interface processes reside on different processors.*

TEMPORAL RULES

```
RULE           : "Inadequate battery voltage";
CONTEXT        : { Maneuver };
TEST INTERVAL  : 10 seconds;
PRIORITY       : 100;

IF      battery1.voltage < 27.5
THEN    battery1.status := abnormal;
        Alert( "eps", "battery1", "Present voltage of
                                   battery 1 is inadequate to
                                   support maneuver" );
```

Figure 2: *Instead of being driven by goals or by data, a real-time system must be driven by time. This rule is applied every 10 seconds, regardless of the voltage or the status of the battery.*

R*Time contains examples of many enhancements that real-time expert systems employ to apply knowledge-based problem-solving methods to real-time problems. The key features are four:

Time-triggered rules. In traditional expert-system shells, you encode rules in an IF-THEN syntax that you test or invoke in two ways: when the data in the antecedent (IF) clause changes (usually called forward chaining or data-driven inferencing), or when one of the consequent (THEN) clauses is needed to achieve a goal (called backward chaining or goal-driven inferencing).

In a real-time system, you also need to be able to tie the triggering of a rule to time (e.g., test this rule every 10 seconds) in order to ensure a reliable response. Figure 2 shows a time-triggered rule to detect a power-battery anomaly in an application that monitors a satellite maneuver. The test-interval slot in the rule's header causes the voltage to be tested every 10 seconds when the satellite is in the "maneuver" context. In addition to ensuring reliable response times, these time-triggered rules can increase performance, as the rule need not be tested every time data in its antecedent clause changes.

Temporal reasoning. Object-oriented methods are an integral part of today's expert-system shells. Typically, objects and their attributes are defined and assigned to classes (frames) that are organized into a hierarchy via different types of links. For example, you may have an object, named battery-1, belonging to the class battery, with attributes such as voltage, current, and status.

The most recent value of an attribute for an object is stored in a *slot*. Production rules interact with the frames by inserting and retrieving values from their slots. In a real-time system, you often need to reason about the behavior of data over time. R*Time, for example, extends the traditional class representation in the temporal dimension by allowing the slots to point to ring buffers (see figure 3), where the system keeps a series of values and their associated time tags.

With data history available, you can create rules that can reason about past, present, and future events. Figure 4 demonstrates a rule that checks to see whether the voltage of a battery has stayed above 35 volts for at least 30 seconds. Although easily expressed in R*Time's syntax, such a rule would be very difficult to express in a traditional expert-system framework.

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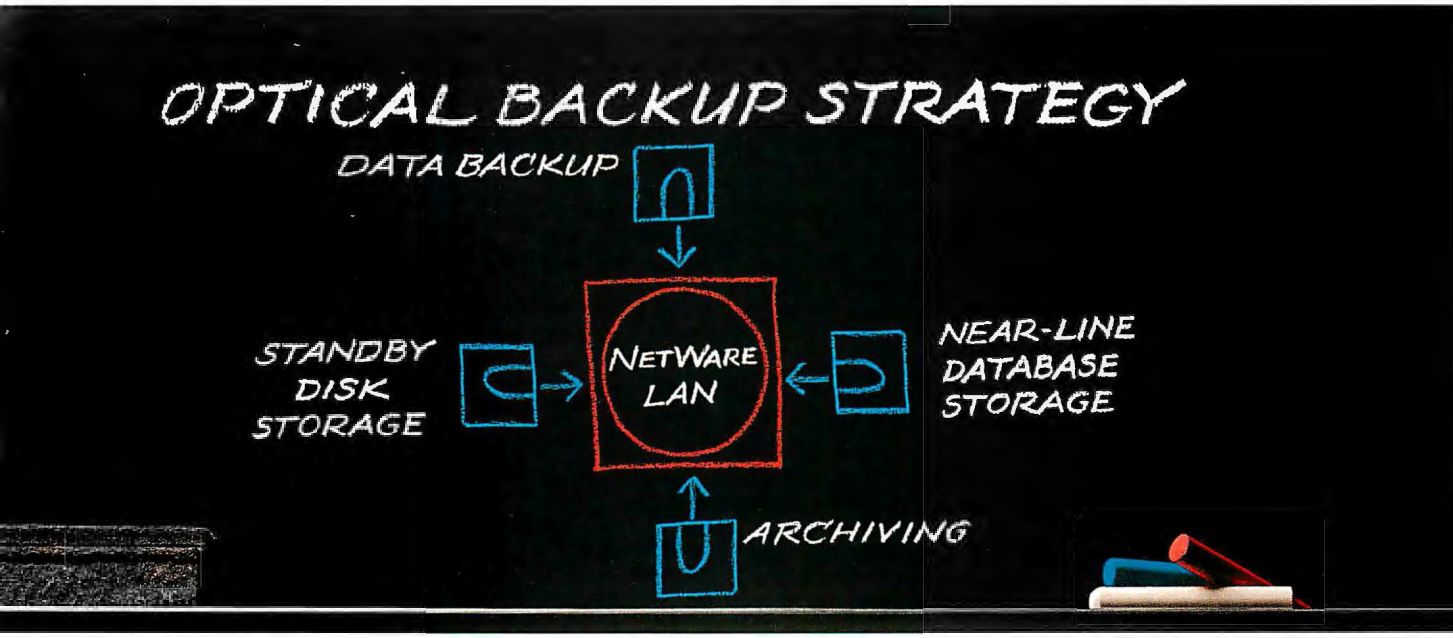

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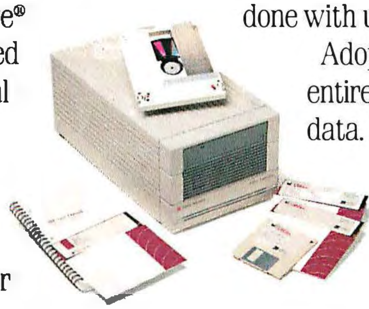

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Focus of attention. When a significant event occurs, it is important that a real-time expert system be able to focus its resources on important goals. For example, several methods for focusing attention on significant events include changing the set of sensors the system is currently monitoring; invoking a new set of rules that specializes in the current problem; changing the sampling rate or filtering scheme of the data being analyzed; and activating another inference engine to analyze the event. This ability to focus attention lets a system maintain a very large body of knowledge while applying only what is needed at any specific time.

Continuous operation. Many real-time systems need to operate in a continuous and reliable manner. Early expert-system shells, often written in a symbolic language such as Lisp, have traditionally had to interrupt processing while a "stop and copy" was performed to free space that the system was no longer using. Even with ephemeral garbage collection, most systems still must stop and copy at some point. A real-time system can't take time out for garbage collection. One method is to free memory as soon as it is no longer in use, so memory allocation can be kept relatively constant.

From Art to Discipline

Real-time problem solving exaggerates many human limitations—tendencies to overlook relevant information, to respond inconsistently, to respond too slowly, or to panic when the rate of information flow is too great—just when the need to overcome these shortcomings is the greatest. This explains the considerable interest in intelligent real-time systems—interest that is bound to intensify as real-time systems become even more complex.

Applying knowledge-based methods to real-time systems can result in many significant benefits, including reduced staffing levels, reduced need for the continuous presence of highly skilled operators, reduced training costs, increased safety, higher quality, higher throughput, less downtime, and more consistent, higher-quality monitoring.

The aerospace industry was one of the first to adapt expert-system technology to real-time problems. Today, AI systems monitor such complex devices as the Hubble Space Telescope, NASA's space shuttle, the Magellan space probe, and several military satellites. In almost all situations, the expert system acts as an adviser to a human operator who has ultimate responsibility for monitoring and controlling the vehicle.

Real-time expert systems have also been installed as process controllers in manufacturing facilities. Today, expert systems are in operation at many paper, chemical, water-treatment, and other types of plants throughout the world.

As the application of knowledge-based systems evolves from an art to an engineering discipline, you can expect real-time expert systems to address ever more challenging applications. A knowledge-based system operating in a real-time situation must respond to a changing task environment with an asynchronous flow of events and dynamically changing requirements with limitations on time, hardware, and other resources. During the 1990s, you will see expert-system technology play a crucial role in the monitoring and control of a growing number of complex systems. ■

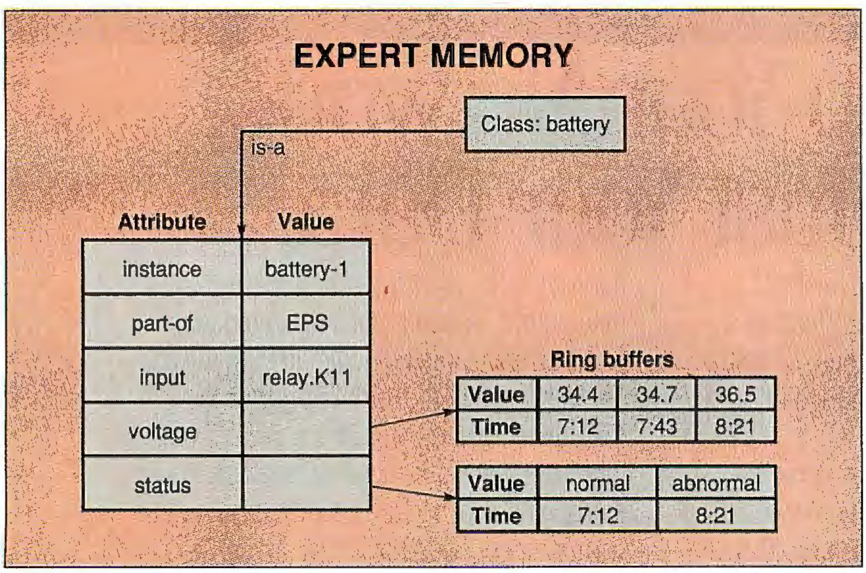

Figure 3: *To function in a real-time environment, an expert system must be able to remember historical data. The figure shows how ring buffers let a frame-representation system remember information about battery voltage and status.*

TEMPORAL REASONING

```
RULE            : "Inadequate battery voltage";
CONTEXT         : [ Maneuver ];
TEST INTERVAL   : 60 seconds;
PRIORITY        : 100;

IF     Min( battery1.voltage, 30 seconds ) > 35
THEN battery1.status := abnormal;
       Alert( "eps", "battery1", "Battery 1 voltage has
                                  exceeded upper limits for
                                  at least 30 seconds" );
```

Figure 4: *With the capacity to remember the past, a real-time expert system can then build rules that take advantage of this feature. This rule checks the recent voltage values to see if the battery is in an abnormal state.*

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Thomas J. Laffey is president and CEO of Talarian Corp. (Mountain View, CA), where he leads a group applying AI and advanced software methods to complex real-time problems. You can reach him on BIX c/o "editors."

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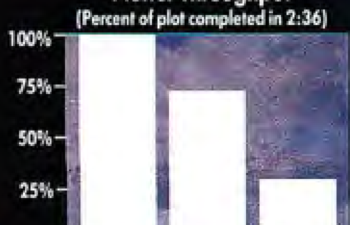

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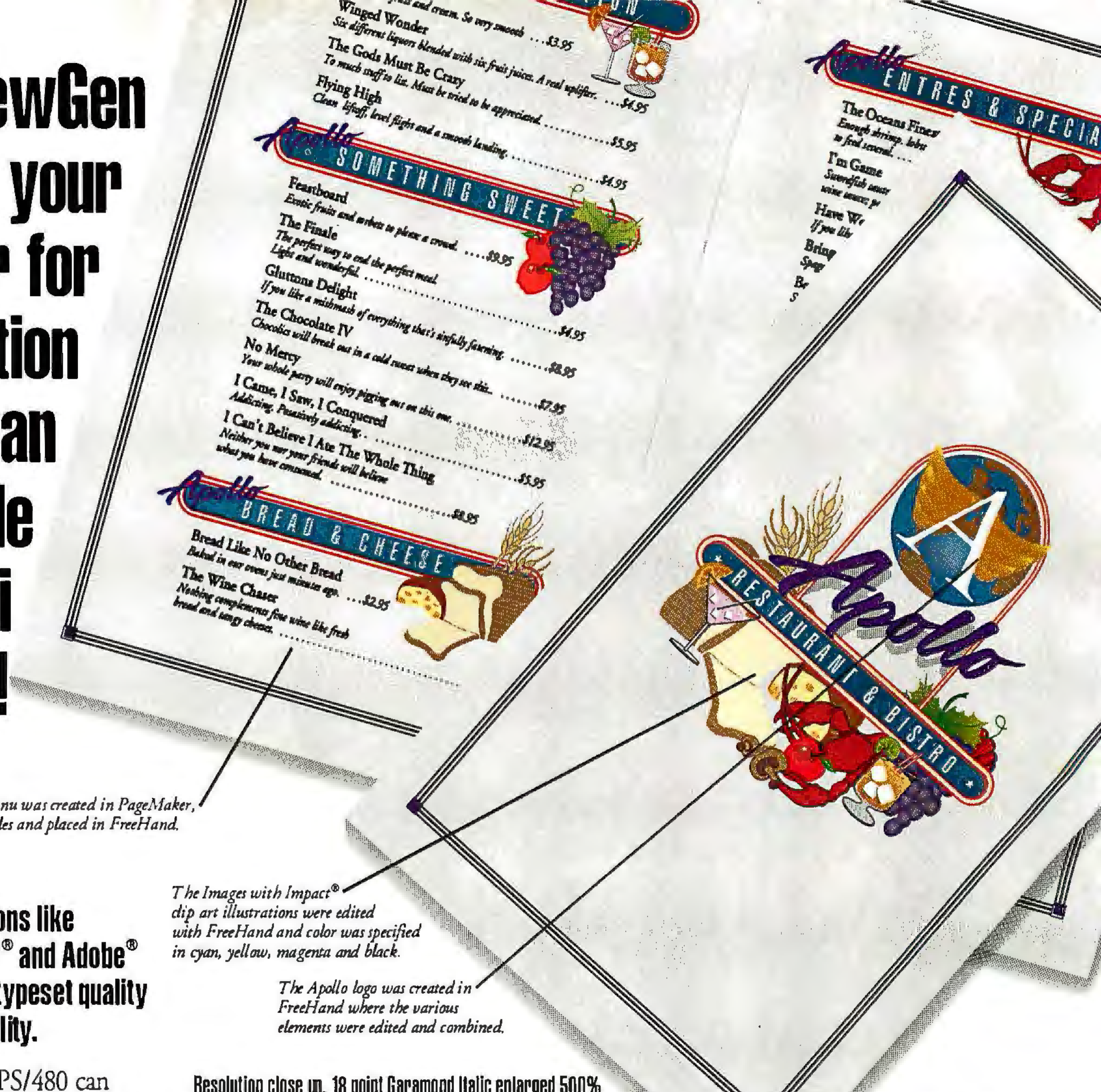

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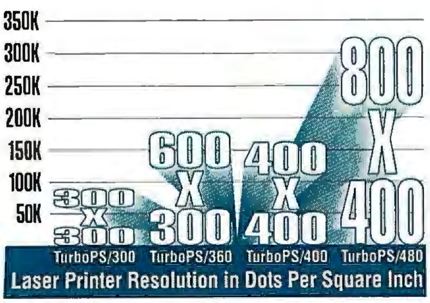

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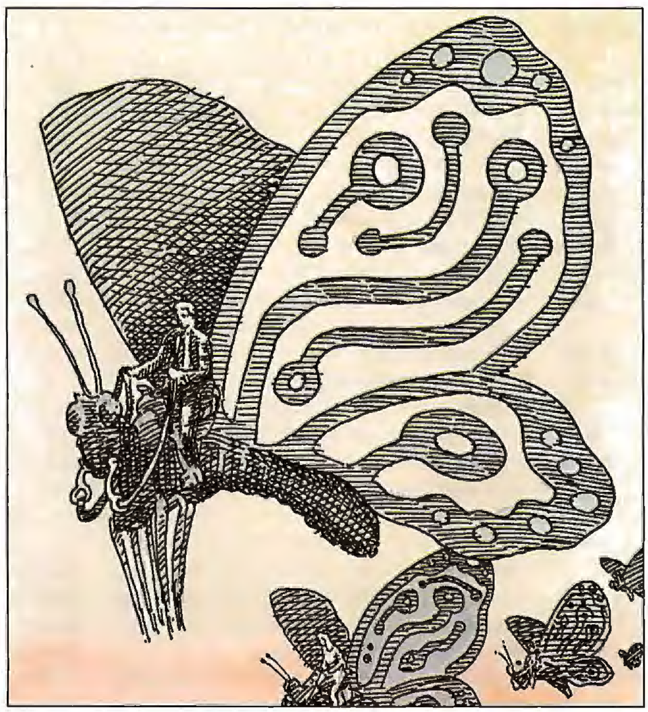
AI in Practice

Once it works, does it still qualify as AI?

Martin Heller

When you think of artificial intelligence, the picture that usually comes to mind is of a hopelessly impractical academic research project that somehow survives from grant to grant, producing unreadable papers and fascinating but useless demonstrations. At some companies, however, the focus for AI has long been on practical applications.

The question is, does their practicality make the applications any less "artificially intelligent"? In other words, once it works, is it still AI? Or is AI simply a phrase used in the theoretical and planning stages of a problem that does not lend itself to traditional programming solutions? I'll discuss these questions in the context of a real company's real-world use of AI techniques and methods.



Expert Systems

Expert systems have many virtues and some drawbacks. Since expert or knowledge-based systems are built using high-level, nonprocedural if-then rule structures, they are easier to understand, build, and change than conventional programming systems. But they are harder to control, less modular, and slower than procedural systems.

In the past, the answer to the speed complaint has often been specialized hardware, such as rather expensive Lisp machines. This sort of thinking has limited the market for expert systems; now AI developers seem more willing to separate their development systems from their delivery systems.

A knowledge-based system that is developed using an expert-system shell might eventually be partially or completely translated to compiled Lisp. For even greater speed—and even less flexibility—the application might finally be translated to compiled C code.

People rarely think of C code as being AI. Lisp, sure. Expert systems, certainly. But C? C is for systems programmers, right? And programming isn't related to AI, is it?

System Configuration

DEC started building its first expert system back in 1978. XCON, developed in cooperation with Carnegie Mellon University and deployed in 1979, has been the system used to configure VAX and PDP-11 computers for production ever since. Over the last dozen years, XCON has undergone continual updates to handle new products and at least one major rewrite.

DEC has built this experience into an AI business that could easily stand on its own, employing about 500 people worldwide. The company currently has more than 50 mission-critical knowledge-processing systems in daily operation, systems that save it about $200 million a year.

XCON was written in OPS5, a forward-chaining rule-based language that was developed at Carnegie Mellon; it was DEC's third try at a technical configuration system for VAX computers. The first two attempts (using conventional programming) were dismal failures. It was simply too difficult to manage the scale and complexity of all the combinations of thousands of different components in a procedural way. The OPS5 environment provided the developers with the capability to handle XCON's scale and complexity and with the flexibility inherent in the rule-based architecture.

Most expert systems start as prototypes, with fewer than 100 rules. Some grow then to more realistic systems, with up to 1000 rules. Relatively few become much bigger than that, because it's difficult to manage even expert systems when they become that complicated.

There is no magic about expert systems; they just operate at a higher level than most languages. It is important to know right at the start of building a little prototype that you will be able to scale your system up later.

OPS5 is implemented primarily as a pattern-matching engine. Variables are *named slots*, and every rule attempts to match its *if* pattern to all the objects in its world. The rule fires only if it sees a match. There is no hierarchy of class, and the named slots are not typed. When the rule does fire, it can change any variable in its world, according to its *then* clause.

Sometimes known as a *blackboard system*, this sort of framework lets every rule know about everything else going on in the system, but it is the very antithesis of modular programming, which emphasizes minimizing side effects by restricting the scope and accessibility of data. OPS5 has enormous flexibility, at the expense of modularity and speed.

In a volatile domain like XCON's (new products are introduced on a continuing basis), it makes sense to emphasize flexibility. There is little penalty for errors. The typical failure mode of an incorrect OPS5 rule is that it does nothing: It never matches anything, or it changes a variable that isn't used by any other rules. This is less demanding than in a language like C, where one uninitialized pointer can crash the system.

The OPS5 language provides a simple mechanism for focusing control on specific rule groups in a sort of procedure-call manner. A data element is labeled the *control element* by convention and may also be manipulated as data. However, this powerful, yet fairly low-level, feature alone does not guarantee good use of control. New OPS5 programmers can get carried away with their new tool and its control structures.

There is no magic about expert systems; they just operate at a higher level than most languages.

CASE? That's Not AI

Tom Cooper, Judy Bachant, Ken Gilbert, and their colleagues at DEC have developed a software-engineering methodology to help knowledge engineers become more disciplined in using OPS5 properly. This methodology is called RIME, for R1 Implicit Made Explicit (R1 being the original name for XCON).

The RIME methodology is aided by a software-engineering tool set called SEAR. Using SEAR, OPS5 programmers can select a template for the type of control structure they would like to use. SEAR then generates the OPS5 code for the control framework, and the programmer fills in the specific rules to go in each part of the framework.

SEAR includes a graphical problem-solving method definer with its own OPS5-like meta-language, a compiler for SEAR code, a rule checker for OPS5 code, and a rule editor. The methodology and tools help to decompose a problem into manageable pieces and to avoid side effects. Historically, some OPS5 rules were very complex because some of the programmers thought that was efficient; with RIME and SEAR, rules are "atomic," easy to understand, and have no unexpected side effects.

SEAR is not an optional tool for maintaining XCON: It is mandatory. Although knowledge engineers are free to write OPS5 code by hand, all new rules for XCON are passed through the rule checker when the knowledge engineers log onto the source code–control system; programmers whose rules fail to meet a SEAR standard receive E-mail warnings at their terminals.

But the difference between code written before RIME and after is obvious. Pre-RIME rules must often meet a dozen or so conditions before they fire, and perhaps take half a dozen actions if they do fire. Post-RIME rules tend to have half a dozen or fewer conditions in their *if* clauses and only one action in their *then* clauses.

A typical problem-solving method implemented in SEAR is the *propose-apply* paradigm. *Propose* rules start a logical subprocess in which a number of possibilities are put forward; then, *eliminate* rules in the subprocess choose the preferred possibilities by removing less-desirable alternatives from consideration. When the subprocess reaches a goal (by elimination and iteration), control returns to the calling process with the goal defined. In this way, the programmer can control the order of evaluation of groups of rules; XCON has over 10,000 rules in some 300 groups.

RIME combines software engineering with expert systems. Does the use of software-engineering techniques mean that the resulting systems aren't AI? If a system works predictably, is it by definition no longer artificially intelligent?

An Easy Solution

While RIME and SEAR are valuable for OPS5 programmers, they don't address the needs of people who want to build a small knowledge-based system only occasionally. These people are not likely to learn OPS5, or any other programming language, no matter how "English-like" or "high level" the language may be, and regardless of how good the tools are. For them, DEC's AI Research Group is now working on experimental tools and methodologies called Easy Programming.

Building on the premise that no programming language is likely to empower end users to build their own expert systems, and on the experience that many sorts of knowledge-based systems are structurally similar, Easy Programming generates knowledge-based processes by classification and description. You initially navigate a menu showing the hierarchy or tree of known applications, looking for a knowledge domain similar to your own. The system tries to quantize the "nearness" to help you recognize a similar domain.

Once you select a domain, Easy Programming draws on a template of highly parameterized meta-code for that domain and tries to extract as much information as possible from you to flesh out the application. Knowledge acquisition—so often the chore of a highly skilled knowledge engineer—becomes, at least in theory, the province of the Easy Programming system, the domain expert, an

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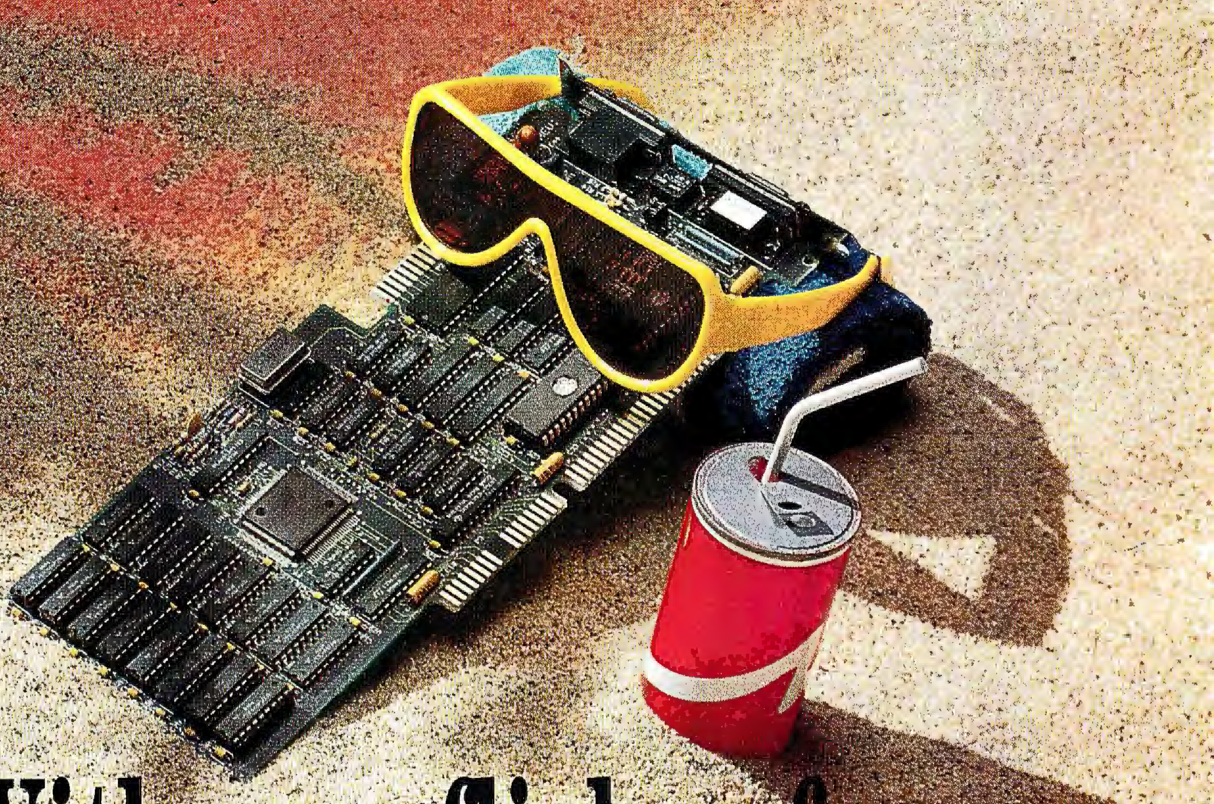

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Easy Programming allows top-down code reuse, in contrast to the bottom-up approach that object-oriented programming languages promote. It capitalizes on generic application areas like scheduling that remain essentially similar no matter what the domain. An appropriate application for Easy Programming would be, for example, a small business that wanted to automate its back-office applications. Easy Programming extends its applicability with an open architecture: The programmer can drop down to a low level when needed, instead of running into a wall when the application is almost complete.

Routing Trucks—Yes, Trucks

Not all the expert systems at DEC are built with OPS5. For one thing, not all applications lend themselves to forward chaining, which is most often used for design problems where the answers can't be enumerated ahead of time, but must be constructed by the application. Backward chaining is useful for diagnostic problems where the possible answers are known.

Hybrid methods sometimes work on problems that don't exactly fit the design or diagnosis class. Also, frame-based representation is critical in many applications. In cases like these, the company used Knowledge Craft, a product of the Carnegie Group, which allows forward-chaining rules, backward-chaining rules, object hierarchies, and Lisp code.

One such application is the National Dispatcher Router (NDR), which is a knowledge-based system that minimizes truck-transportation costs without reducing customer service. Since the company has a continuous-mileage agreement with several trucking companies, the per-mile cost of transporting goods decreases as the distance a truck travels on a single trip increases, as long as various constraints are met.

For example, trips are considered to end whenever a truck is idle for more than 24 hours, or returns to its point of origin and completely unloads. One driver can travel only 450 miles a day; a second driver can increase the daily mileage at additional cost—and those are just the simple constraints.

In 1985, Carnegie Mellon developed a prototype NDR system. While incomplete, the prototype demonstrated proof of concept, and the project was transferred to Janet Rothstein at DEC. A parallel effort to solve the problem with operations-research methods was not completed. One of the Carnegie Mellon researchers came to DEC for a month and worked directly with Rothstein.

One conclusion from the NDR project is that co-development or "apprenticeship" is a more effective approach to technology transfer than the usual drop-it-in-their-laps method. Later in the project, Rothstein and the Distribution IS Group used the same apprenticeship method to transfer NDR to the distribution group.

Rothstein originally wrote all the constraints and scheduling heuristics in NDR as rules, for flexibility. She tried depth-first and breadth-first searches, but eventually settled on a beam search for scheduling. The flexibility of rule-based programming proved useful.

All too often the experts had difficulty conveying all their knowledge at one sitting. Rothstein had the experience so common to knowledge engineers: The experts would say one thing, sign off on a specification based on what they said,

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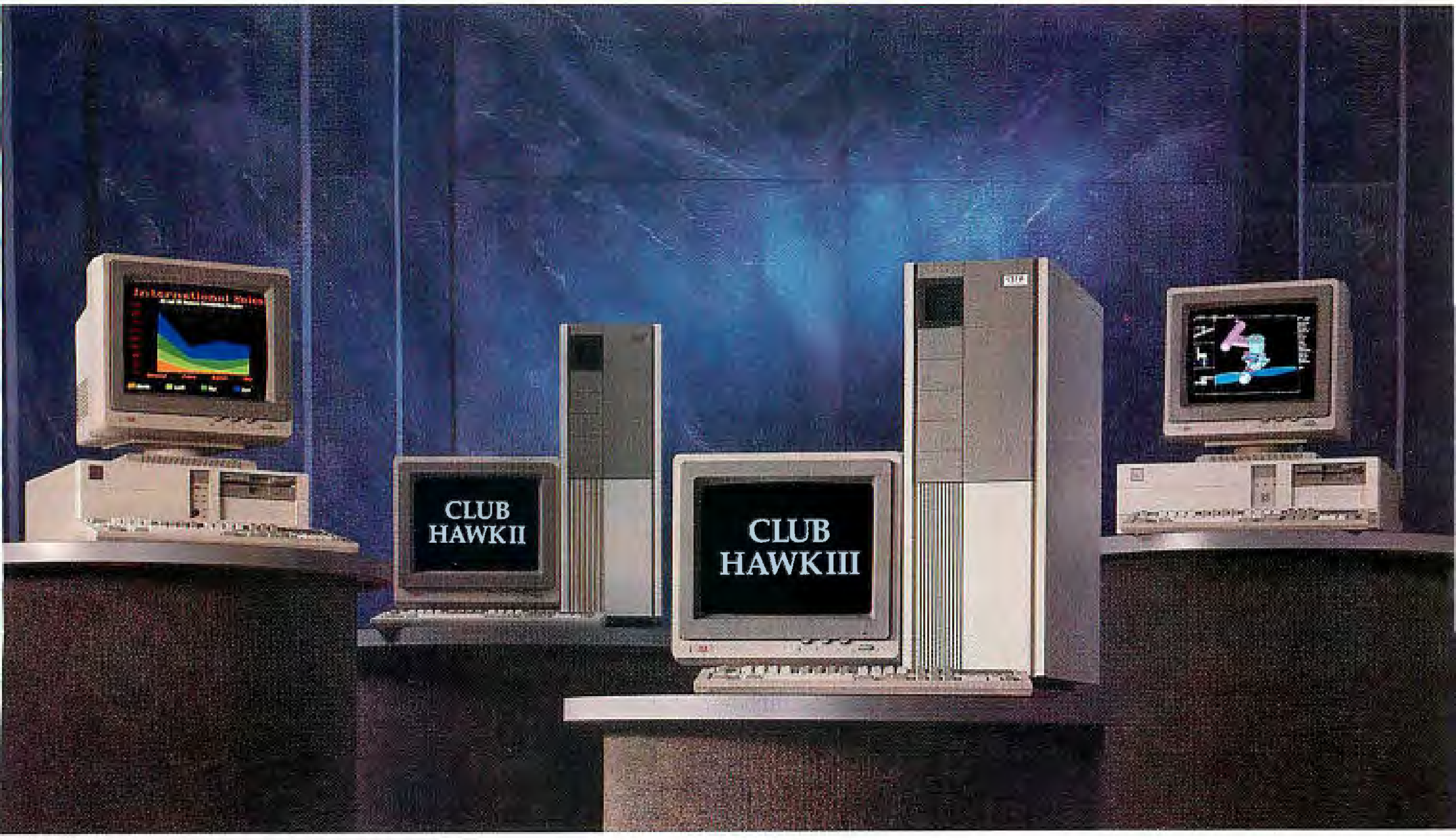

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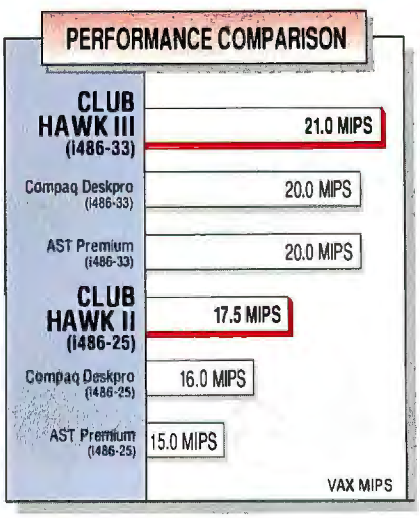

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and then look at the resulting system and say, "That's not right. We forgot to tell you about one more thing." While the knowledge was still formulated as rules, it was easy to change. Code would have been much more cumbersome.

On the other hand, once the scheduling mechanism was stable, Rothstein recoded the heuristics as Lisp functions, for speed. The whole development cycle took two years; NDR is currently in place and saving the company 10 percent of its continuous-mileage shipping costs, or about $1 million per year, after paying back its development costs in the first year of its use.

Unlike XCON, NDR has a fairly stable domain and needs little ongoing development. It works, and it saves the company money. Is it still AI? Does the translation of rules into code in any way change its intelligence?

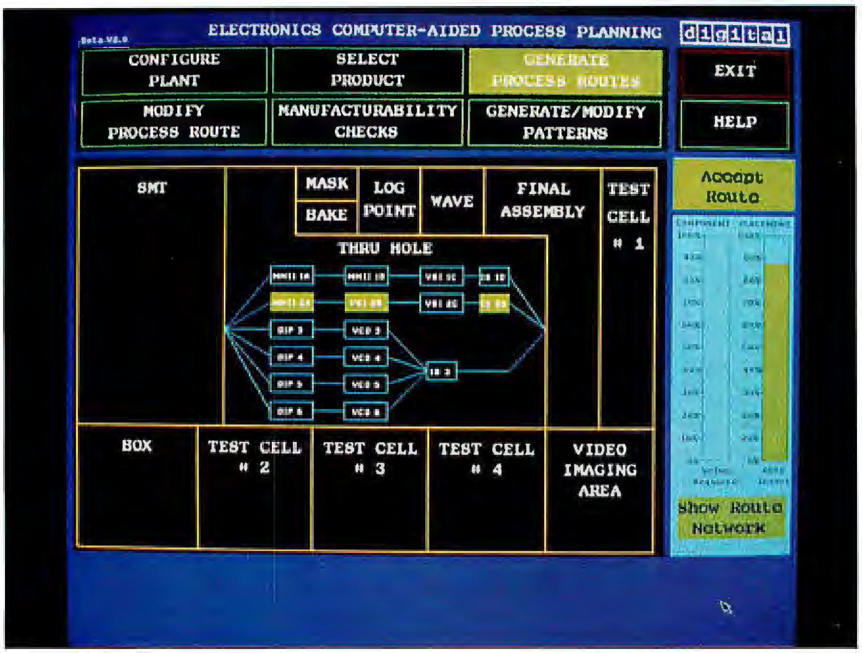


Photo 1: *All the feasible process routes for a printed circuit board shown on a layout of the factory floor. The recommended route highlights the selected machines. Note in the "thermometers" on the right that the recommended route has an 85 percent automatic assembly with no setup required. (Photo courtesy of DEC)*

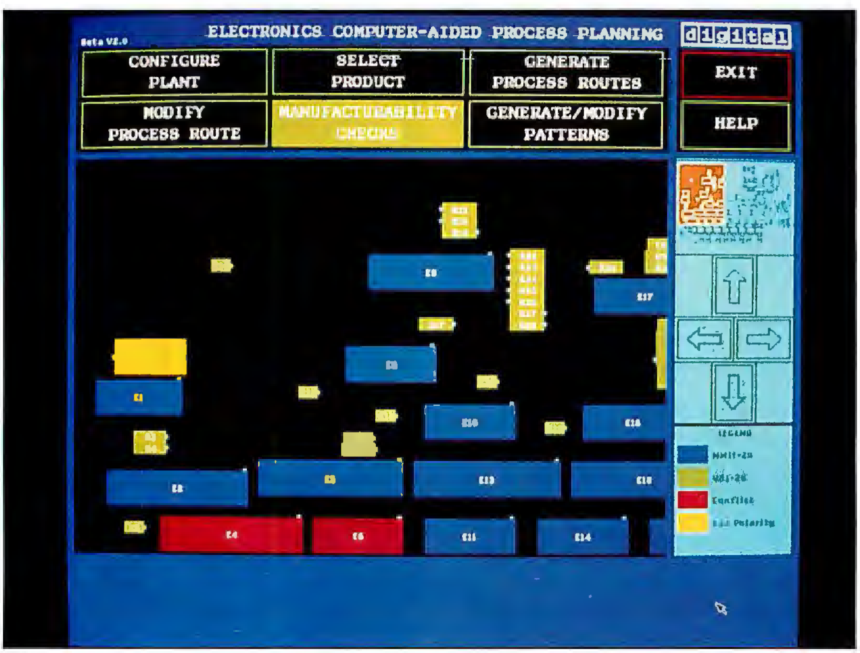


Photo 2: *A graphical display of the printed circuit board with its components color-coded according to the machine that will be used to assemble them. Components that exceed manufacturing constraints are highlighted: spacing-rule violations are shown in red; polarity-rule violations are shown in yellow. (Photo courtesy of DEC)*

Shortening the Circuit

The Electronic Computer-Aided Process Planning (ECAPP) system solves a different kind of routing problem. It helps DEC to plan the manufacturing process for assembling electronic components onto printed circuit boards.

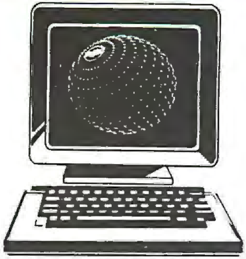
ECAPP uses the CAD information for a printed circuit board, along with its knowledge base, to generate all the feasible process routes for a product through a factory and to recommend the "best" route (see photo 1). Then it goes on to generate the numerical control code (insertion patterns) for the assembly equipment. Along the way, ECAPP checks the module for manufacturability and simulates the assembly process (see photo 2).

Like NDR, ECAPP was built with the Knowledge Craft expert-system shell, using both rules (for flexibility) and Lisp (for speed). It is currently in regular use at two assembly plants.

Overall, ECAPP has reduced the time it takes to introduce a new product into production from a few days to a few hours and has ensured consistent, high-quality process plans and correct insertion patterns. ECAPP led to a $500,000-to-$800,000-per-year cost reduction at one plant.

What makes the process planning in ECAPP different from other generative process planners for electronics assembly? All the knowledge in ECAPP is represented declaratively in the knowledge base, including process-planning and manufacturability rules. For example, if a new machine is added to a factory, all that is required for ECAPP to run correctly is that the machine and its characteristics be described in the factory's machine knowledge base. No programming needs to be changed.

The difference between ECAPP's rule-based approach to generative process planning and a brute-force approach is that the rules limit the search space for alternative routes. The process-planning rules in ECAPP consider only components, process operations, and assembly machines that are feasible alternatives



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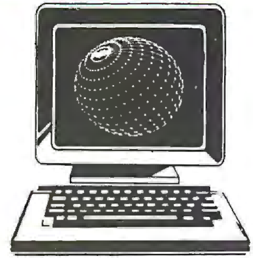

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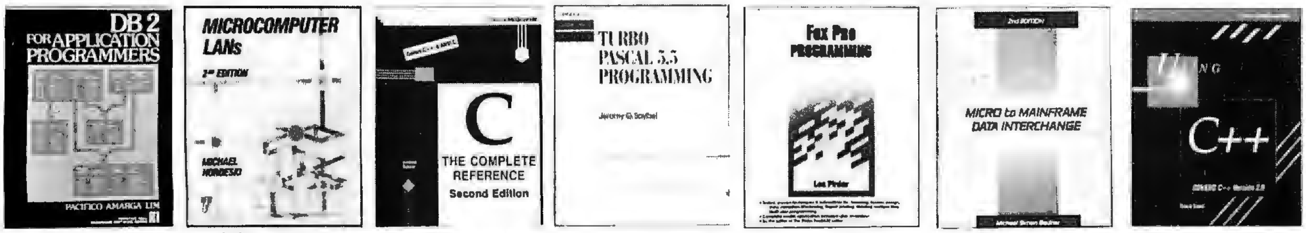

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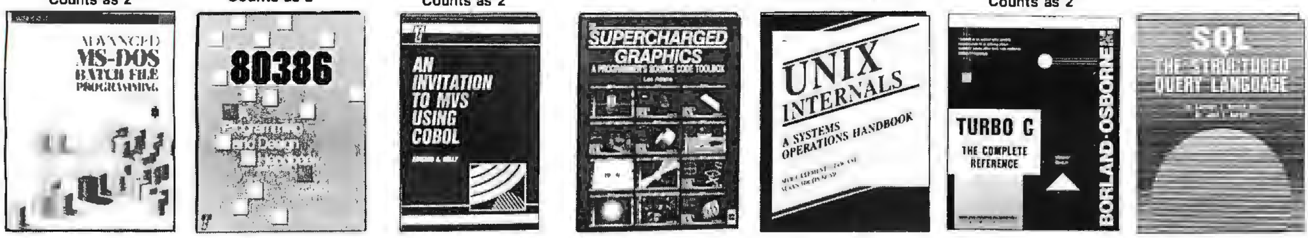

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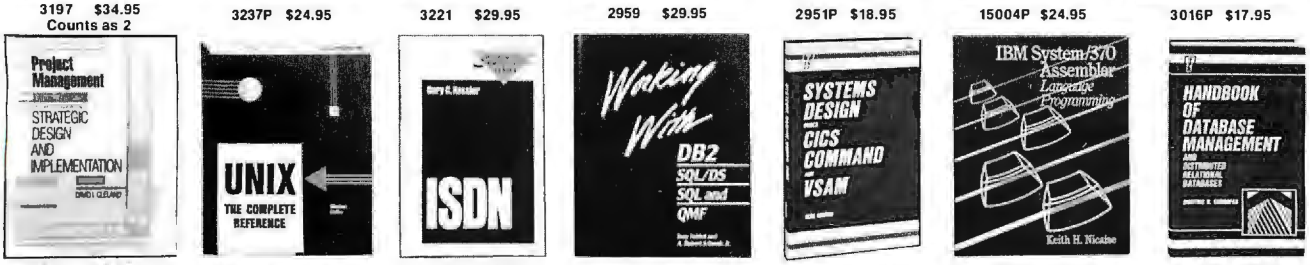

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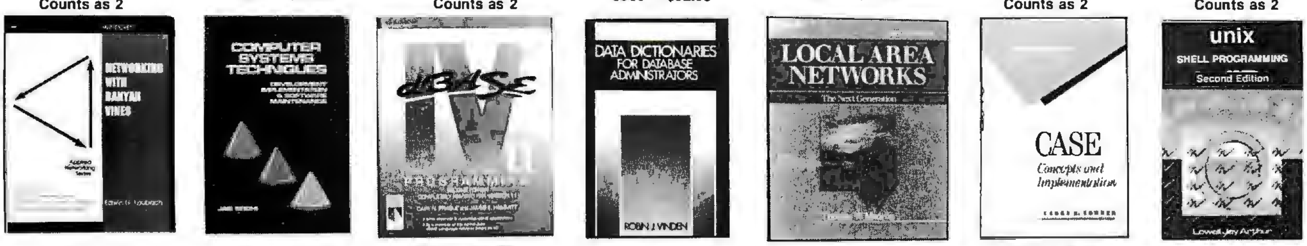

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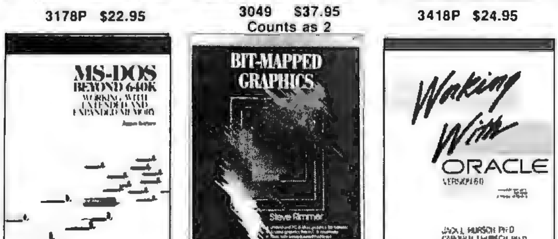

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for assembling a product.

When you run ECAPP, you do not really know that you are running an expert system. You are running a program that helps you manufacture better and faster. Does the fact that it uses rules and Lisp make it AI? Does the fact that it works predictably and acts as if it were programmed prevent it from being AI?

It's Not Just for DEC Anymore

Configuring computer systems with XCON is quite specific to DEC's product line, although the idea of doing configurations with a forward-chaining system is transferable to other enterprises. Process planning for electronic-circuit-board assembly could be applied by other printed-circuit-board manufacturers. Truck routing could be applied in some measure by any firm with a continuous-mileage program; certainly, the knowledge that a beam search works best for the routing problem is useful and transferable.

Another knowledge-based process, however, could be applied to any business: enterprise-wide modeling of business systems. Ty Chaney and his colleagues at DEC have developed a discrete modeling methodology and software tools built on top of Knowledge Craft that address the practical processes of doing business and aid in designing major business systems.

Business systems (both the software and the procedures to go with it) can take several years to develop and often require a corporation to change its routine ways of doing business. While competent people may do their own jobs efficiently, they don't always know how their methods interact with other people in other departments.

To optimize a business system in a global sense requires the combined input of people from many departments, people with different views of the company and the process, people who may in the normal course of business never interact directly. A key element of the symbolic modeling method is to bring together representatives of the business functions involved and to generate for each one of them a diagram of the system that conforms to that person's viewpoint.

In a conventional discrete-system modeler, such as SLAM II (from Pritsker and Associates of West Lafayette, IN), simulations can run at any level of detail that suits the analyst; there will always be some output from the simulation. The problem is that it's too easy to make assumptions that invalidate the model.

For instance, an analyst may assume in modeling a purchasing system that the buyers always understand what they are ordering or that the vendors always provide their current product specifications and price lists. Anyone who has ever written a purchase order knows that these assumptions don't always hold true. In fact, fulfilling a purchase order can be a complicated process, particularly if all the items are not found at one fulfillment site.

The symbolic modeling (SYMMOD) software has deliberately been designed *not* to generate any output unless the simulation has accounted for the actual transactions necessary to complete the activity's event network, supporting the business process being modeled.

SYMMOD uses frames to hold information—reflecting the processes modeled in enough detail to be realistic—and explicit messages between processes. SYMMOD objects have access only to

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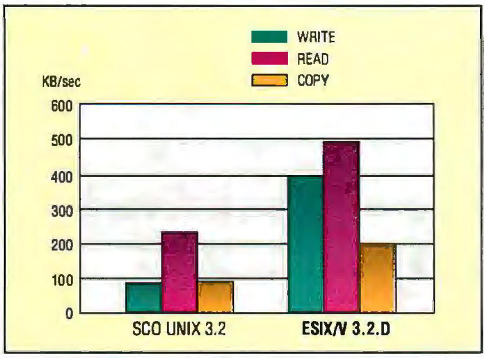

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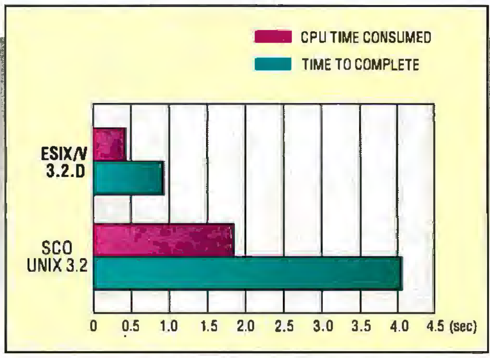

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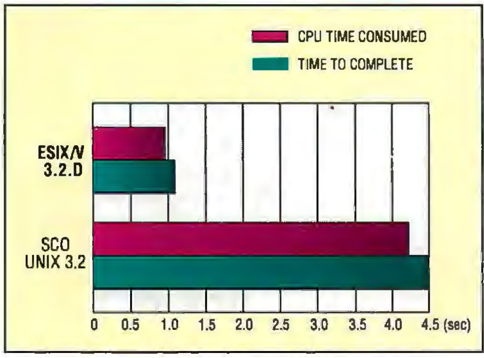

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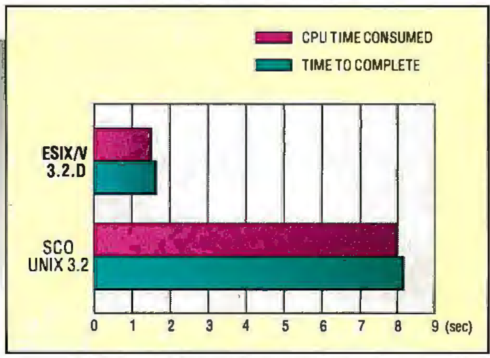

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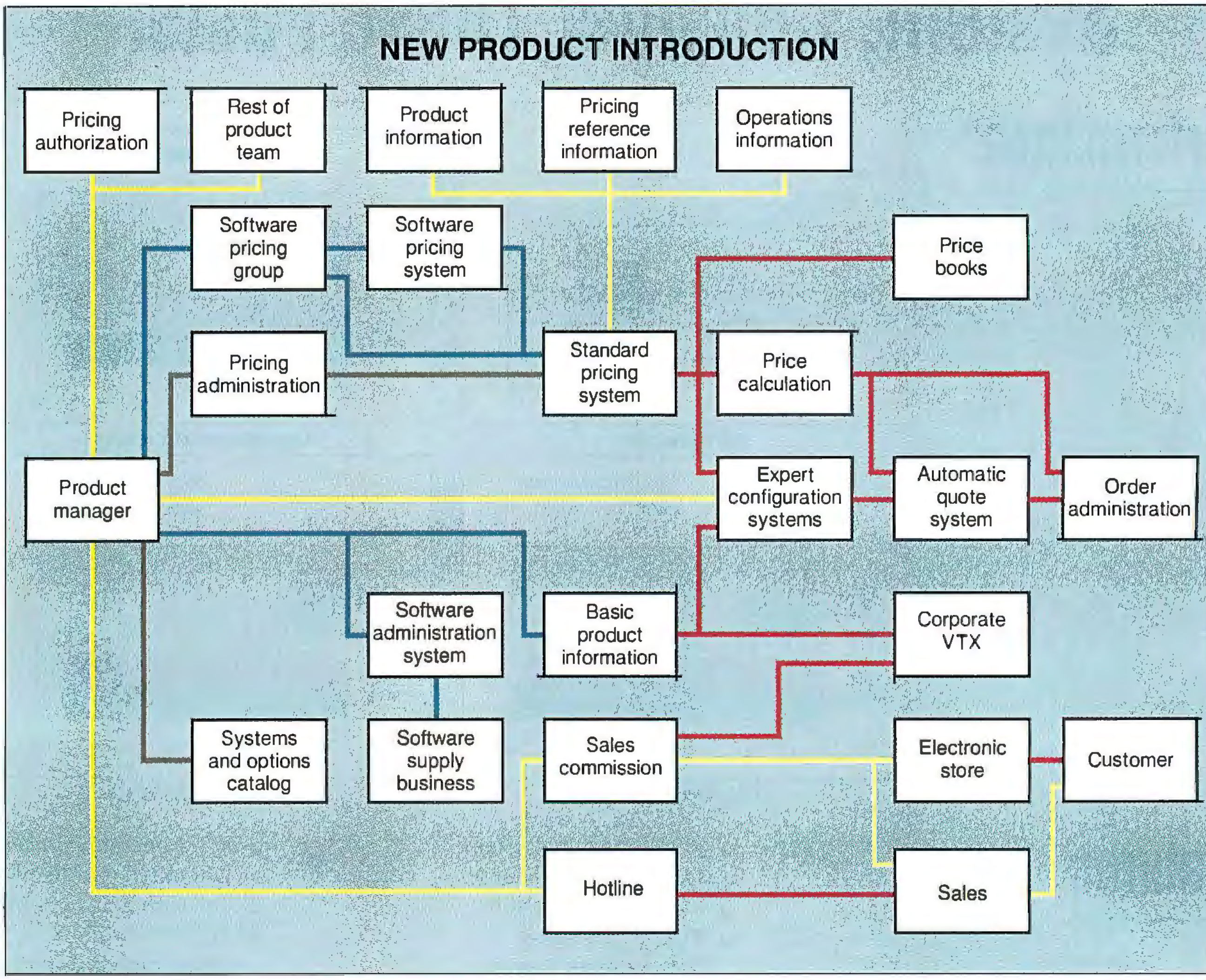

Incorporating a new product into an existing system. This diagram emphasizes how complicated it is to disseminate (or obtain) information in a large company.

their own status and to messages from other objects; they have no global knowledge at all, which reflects the real world rather well. Do you know the status of a project going on down the hall without hearing a report or receiving a memo?

Closing the Loop

In the course of building a model of how new-product introductions work, the group modeled the process of incorporating a new product into XCON (see the figure). The model highlights the complexity involved in extracting information within a large company.

The knowledge engineer first has to find out that there is a new product in the works. In some companies, this box might be filled in by "and then a miracle happened"; in others, notification would be part of a standard product-introduction procedure.

Once new-product notification has occurred, the developer must find out the product's specifications by obtaining the information from the product managers, design engineers, and manufacturing engineers. Sometimes there is an initial lack of information or a conflict in the information received from these sources. If conflicts arise, the knowledge engineer works to reconcile the difference.

Most computer models would ignore those instances in which the information is not provided or is incorrect; they would probably be fine 80 percent to 90 percent of the time. But the added realism of symbolic modeling empowers the analyst to deal with the unusual problem cases that eat up so much valuable time. (Pareto's principle tells us that 20 percent of the fields produce 80 percent of the crops; its flip side is that 20 percent of the wagons need 80 percent of the maintenance.)

The product specifications go into a review process, which gives the people who were unable to provide the information in the first place a chance to make corrections. Eventually, perhaps after several iterations, the information will be judged correct by all the people who know anything about it, and the approved specifications will be coded as rules. More feedback loops follow as the rules themselves are checked and corrected. Eventually, the new product is incorporated into the configuration process, and another new product comes down the line.

While this may appear a little bit chaotic, it is not atypical of business procedures that "just grew." The methods do work, though. The review process and feedback loops ensure that the result is correct. At companies where the review

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process is absent, more mistakes occur. Mistakes are not self-correcting, so you don't necessarily want to eliminate all the loops, the checks and balances in the design.

One of the major benefits of symbolic modeling is that it exposes inefficient processes to scrutiny and allows them to be replaced by streamlined processes, with just enough feedback in the system to keep it self-correcting.

SYMMOD combines the techniques of business analysis and discrete modeling with knowledge-based methods. Designing a symbolic model is like any other systems analysis: You draw boxes and arrows a lot and worry about inputs and outputs at each box. Writing a SYMMOD program is much like writing Lisp code. Running a SYMMOD program is like running any other discrete-system simulator. Does that make it any less artificially intelligent?

Currently, SYMMOD is used internally at DEC; it will shortly be used to model enterprise-wide processes for other companies. Such models can have high-leverage effects and lead to global streamlining of major aspects of a business operation. This is a far cry from stand-alone laboratory AI systems, but the "strange loop" that uses one knowledge-based process to model another would fit right in at any AI lab in the world.

Symbolic modeling exposes inefficient processes to scrutiny.

But Is It AI?

The question "Is it AI?" highlights a misconception. You can write ordinary programs in Lisp, supposedly an AI language. And you can write AI in C, a procedural language. Rule-based systems give you a lot of flexibility, while more traditional programming systems give you better speed. It's really a continuous spectrum. In the course of development, a project can shift back and forth across that spectrum. What's important is incorporating feedback from experts and users into the development cycle. Expert systems have everything to do with capturing knowledge in a form the computer can use, and nothing, other than some history, to do with reproducing the actual functioning of a human brain.

Is it AI? You can argue that question based on whatever arguments you find convincing. I see the continuous spectrum of languages with AI at one end and traditional languages at the other much like a base/treble spread on a receiver. As you turn the dial, the mixture varies.

Do these practical applications qualify as AI? Yes, they do—but not 100 percent. They were born of AI techniques, but they also contain elements that qualify as more traditional programming. They lie somewhere on the spectrum—but not wholly at either end. ■

Martin Heller is a software developer who contributes frequently to BYTE. He has a Ph.D. in physics from Brown University. You can reach him on BIX as "mheller."

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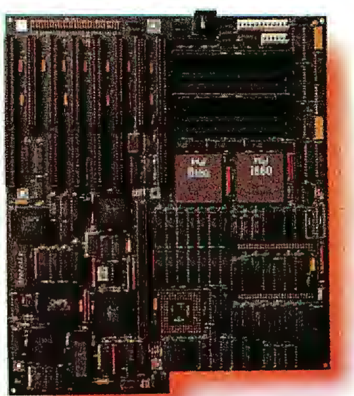

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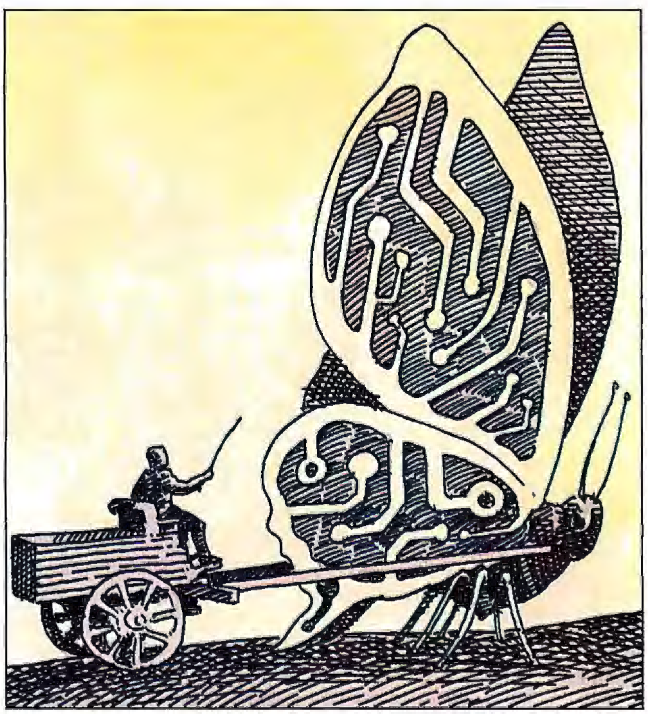
Putting the Experts to Work

Expert systems can capture and deploy the intricate thought processes of those who think for a living

Daniel W. Rasmus



Artificial intelligence has been a curiosity to many and a livelihood for a few. Each year, more and more people are participating in the technology, and each year more and more people are being touched by it without knowing it. But how has the technology of AI gone beyond the laboratory and extended itself into the real world?

Older computer packages, like general ledgers and payroll, were designed to work faster than people, but only when precise information was entered into their highly structured silicon calculators. Intelligent systems are designed to work on knowledge.

All knowledge workers have one thing in common: They think for a living. They may think about the strategic focus of a company, or they may think about the best way to repair a broken machine. But whatever they think about, and however they think about it, expert systems can capture and deploy the intricate thought processes of knowledge workers.

Applied knowledge usually takes the form of "assistant" programs, as intelligent guides for new employees or those less skilled in the work force. Some of these assistant programs encompass the knowledge of various experts and put it to work solving problems, like scheduling the workers in a factory, where the incoming data may be overwhelming.

Intelligence also involves how people react to the world. When I say something to others, I expect them to react. When I write a note, I expect someone to understand what I have written. This is a lower level of cognition, one most often taken for granted. It is also an area of AI research and application.

Many people think that AI is limited to expert systems, but it encompasses a broad spectrum of technologies. Robots, expert systems, natural-language systems, vision systems, speech recognition and synthesis, handwriting recognition, neural networks, and intelligent interfaces are all components of the AI equation.

AI in Databases

The personal computer database is a repository of much corporate and personal data, yet individuals often forget exactly what they have. Companies have vast databases of corporate information that churn daily on their mainframes, but it's often difficult to discover the connections between disparate systems. With expert systems, the programs find the data, no matter what file it's in.

Many expert systems are stand-alone applications. Some of them can access databases and ASCII files, but few can be embedded in C programs. Most early expert systems gave expert advice only and did little to talk to the real world.

Smart applications of expert systems are already turning up in products.

Today, however, things are different. For example, at Southern California Edison, AICorp's KBMS is used to implement company policy. KBMS is the knowledge processor in the PC Automated Configuration Expert that lets departments configure their personal computer purchases according to corporate standards. PACE retrieves price and product data from DB2 relational databases on an IBM 3090 and provides detailed configurations for PCs and Macintoshes, including peripherals, memory boards, and cables.

One fundamental change that expert systems make in the workplace is in how knowledge is distributed and retained. Much of the knowledge worker's job is taking raw data and applying intelligence to it, producing information. Expert systems can help retain this kind of knowledge even when the expert is unavailable. Intelligent systems also supply expert-level performance potential for new employees and employees with less skill.

An example of this kind of knowledge is found in the Aid to Evaluating the Redevelopment of Industrial Sites expert system developed for the Canadian Council of Environment and Resource Ministers. AERIS is a 300-rule Level 5 knowledge base that helps guide environmental engineers through the decision process on site redevelopment. dBASE files store parameters about the sites, and retrieved database records are used in the expert system to order and select questions.

The system was designed to help less-skilled engineers run site scenarios with less help, but AERIS is turning a several-week job into a several-hour job. Several cases a day can now be run, and more what-if information is possible than with manual methods. AERIS is helping engineers choose the best use for reclaimed toxic-waste sites.

Neural Networks

Intelligent systems are also making inroads into neural networks. To many, neural networks are even more removed from reality than expert systems. An expert system is at least programmed, and you can see what makes it tick, but neural networks are more of a mystery.

A simple, but very useful, neural network is NeuroShell from the Ward Systems Group. NeuroShell was originally shipped as a stand-alone backward-propagation neural-network implementation. Systems designers input the characteristics of a problem, provided several case studies, and then allowed the neural network to learn from the cases. When learning was complete, previously unseen cases could be presented to the system, and they would be classified according to the generalizations gleaned during the learning process.

The current version of NeuroShell comes in several flavors; one of those is a database version. The standard version of NeuroShell uses a characteristics file that must be entered. With the database version, the characteristics file is a dBASE file. Some fields in the database are described as defining characteristics while others classify them.

NeuroShell reads in the data from the database and learns the relationships between the defining characteristics and the classifying characteristics. Once the learning process is complete, the database version of NeuroShell facilitates distributing the knowledge contained in the database. (For more information on combining neural networks with expert systems, see the text box "Solving the Unsolvable" on page 284.)

Integration

Spreadsheets are an important component in the day-to-day lives of many knowledge workers. Recently, I had the opportunity to work with a manufacturing engineer who used a spreadsheet in his work writing shop-floor standards for new manufactured parts. He spent several hours every time a new assembly was introduced, churning through data and drawings to see how the part should be made and how long it would take to make it.

The problem was that the manufacturing engineer's information did not come in a form easily transferred to the computer. I called the CAD department and requested CAD data files for input to a "system" I was going to build. This "system" was an expert system.

While I was waiting for the data file, I went through the engineer's spreadsheet and made it more amenable to the project. I named cells and cleaned up formulas. However, I changed little of substance. The manufacturing engineer

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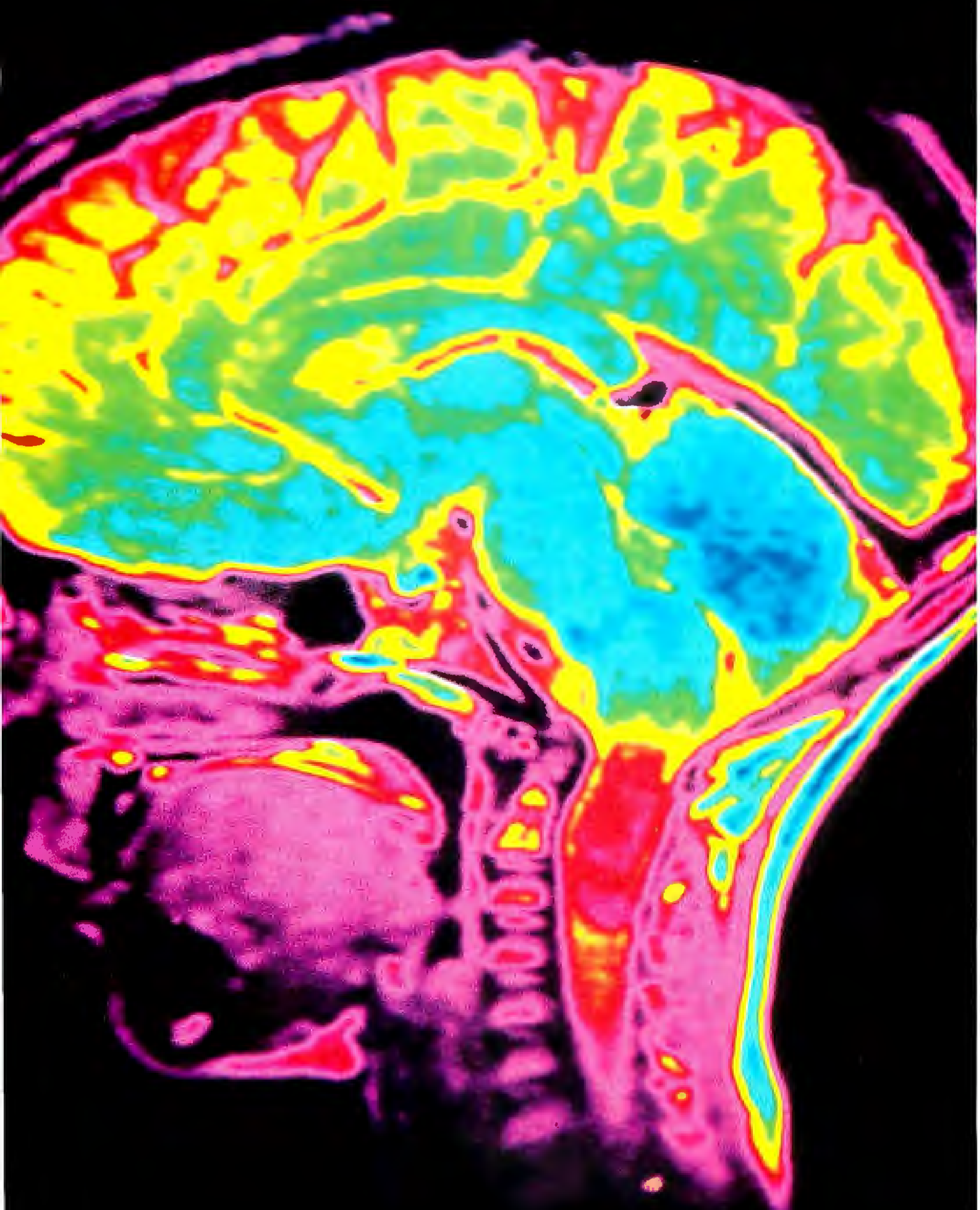

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Solving the Unsolvable

Marge Sherald

Given the recent advances in artificial neural-network technology, will AI ever approach human intelligence? Government studies have used one measurement of neural-network power, the number of neural interconnects, as an indicator of intelligence. Neural networks implemented on even the largest massively parallel computers were rated at less than 100 million connections; an average cockroach eclipses that power by an order of magnitude with its neural network of a billion interconnects.

That's not very encouraging for anyone working in AI. However, when you look beyond these "intelligence ratings" and see the number of real-world applications built with expert systems and neural networks, it's not so easy to dismiss the field as a high-tech fad. Even more reassuring are several new trends that may cause the field to take some giant steps in the direction of human intelligence.

The business, academic, and scientific worlds are developing applications that combine expert systems with neural networks or combine multiple neural networks into a single application. These new hybrids can tackle problems previously unsolvable by a single expert system or neural network.

One way to appreciate the synergy of expert systems and neural networks working together is to view it as a parallel to the combined functioning of the left and right sides of the human brain. Expert systems (the left brain) excel where there are hard-and-fast rules and when precise computations are needed. Expert systems can work with symbolic representations of data and can explain why they reached a specific conclusion.

Neural networks (the right brain) excel at problem diagnosis, decision making, and other classifying problems where "fuzzy" pattern recognition of data representations and relationships is required. Neural networks surpass expert systems in making decisions where a human counterpart uses judgment and intuition based on years of experience rather than a set of rules.

The same can be said when the rules are too numerous to be practical or when a change in the problem parameters would require a complete rewrite of all the rules. Like expert systems, neural networks can capture knowledge from databases and learn to make decisions in the real world.

According to industry expert Patrick Simpson of General Dynamics' Intelligent Systems Group, there are four common methods of combining expert systems with neural networks:

1. Expert systems can be used to train neural networks. The expert system can supply the training data that the neural network uses to judge the accuracy of its output. One obvious drawback to this approach is that the neural network can never get any "smarter" than the expert system, although the network may very well generalize better.
2. Neural networks can preprocess sensor data into representations that can be more effectively used by an expert system. For example, the neural network can make generalizations or preclassifications.
3. The expert system can control information flow through several neural networks. For example, the expert system can explain how the system works, elicit input to help make decisions, and serve as a dispatcher for passing data to the proper neural network for further processing. Neural networks have also been used as dispatchers.
4. The expert system can analyze the responses provided by the neural network and facilitate enhanced understanding of the results. This analysis can also result in new training patterns for the neural network and thus improve overall system performance.

Financial Analysis

Of course, these four methods are very basic, and some sophisticated systems incorporate several of the techniques. Don Barker, the coordinator of the Computer Assisted Learning Center at Gonzaga University, developed a prototype system to analyze the financial health of a business that also uses an expert system to call a neural network.

Barker chose the KnowledgePro expert system from Knowledge Garden, NeuroShell from Ward Systems Group, and dBASE III Plus from Ashton-Tate (Torrance, CA), explaining that "these software environments require little programming experience and provide for quick and simple data exchanges."

Barker's system examines four standard business ratios. The quick ratio indicates the amount of liquid assets available to meet a firm's current obligations. The debt-to-worth ratio shows the proportion of capital contributed by creditors as compared to the funds contributed by the owners. The sales-to-receivables ratio compares the revenues generated to the level of outstanding receivables carried. Finally, the profit-to-worth ratio shows the return the owners are receiving on their investment.

The expert system provides the user-interface screens, obtains the company's financial data from you, converts that information into common business ratios, and executes commands to search the database for average business ratios for the same or similar types of industry.

The expert system then calls the neural network to estimate the company's borrowing ability. Barker chose a neural network for this system subtask because the rules for making a loan decision are not as clear as the rules for computing business ratios. The sample cases that exist are inconsistent because different lending institutions apply different criteria for making loan decisions. "In the absence of clear rules or precise data, a neural-network approach has the best chance of producing plausible results," said Barker.

The expert system creates a file that contains the computed business ratios and passes the ratios to the neural network. The neural network has been trained on case histories that are stored in the database. Each case history includes the four business ratios along with a field that states whether the loan was approved or denied. Based on its previous training, the neural network instantly predicts the probability of the business receiving a loan.

The system passes the results back to the expert system, which then uses rules to interpret a business's ratios in comparison with the industry averages. You see a summary screen that displays the firm's business ratios and the industry's average along with an explanation of the comparisons and a display of the likelihood of the business being able to raise capital by securing a loan.

The purpose of Barker's prototype was to show that "symbolic (expert systems) and parallel distributed processing (neural networks) are not competing AI strategies but complementary. By uniting them, we can avoid many of the weaknesses inherent in each method while capitalizing on their unique strengths."

Underwater Vehicle Control

The necessity of working in a real-time environment calls for a different approach to integrating expert systems with neural networks. General Dynamics Electronics Division (San Diego, CA) was faced with the task of building a control system for an autonomous underwater vehicle. The software had to be capable of solving problems, such as the vehicle getting caught in seaweed or fishing nets, collision with ships or buoys, sensor or other hardware failure, and poor atmospheric or water conditions. After diagnosing a problem, the system had to be able to formulate a new mission plan.

Unlike the previous application, this system has an expert system, a neural network, and a model-based system—three "knowledge sources"—all working on the same problem at the same time. When the knowledge sources finish processing, their solutions appear on a "blackboard" where they are "voted" on before the underwater vehicle takes any action. A team from the Intelligent Systems Group at General Dynamics wrote the programs rather than using commercial packages.

One knowledge source can feed information to another and thus improve the quality of the solution. For example, if the neural network finishes its diagnosis first and posts that information on the blackboard, the expert system uses it to formulate a direction for the search through its knowledge base.

The system had to be capable of determining the most critical stimuli in the underwater vehicle's environment. The team created a prioritizer that determines the importance of a detected event and derives a time allotment, in seconds, within which the vehicle must respond. For example, an overheating motor requires a 1-second response, but a loss of altitude gives the vehicle several minutes to respond.

At the end of the time period that the prioritizer allotted, all the solutions proposed by the knowledge sources that appear on the blackboard are submitted to a "voting algorithm." This algorithm considers the expected precision of each solution, as well as how many solutions appear on the blackboard. For example, the model-based system is considered to be more precise than the expert system, which is considered to be more precise than the neural network.

According to the team, the model-based system is considered to have deep reasoning capability while the expert system's rules may be superficial when faced with a novel situation. The neural network usually provides the fastest solution and a robustness not found in the other systems. "If all else fails, the neural network can provide some kind of reasonable default response," according to the team report.

The team is now focusing its efforts on the mission-replanning system, as well as determining if additional knowledge sources are needed and deciding whether to use existing blackboard-system frameworks or to design new ones.

Solid Future

These applications detail some innovative implementations of expert-system/neural-network combinations. The synergy of the two might be just the step needed for AI to surpass the cockroach without a great advance in hardware.

When you project what is to come from the thousands of existing applications that are currently saving time and money, the future for AI appears solid.

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Marge Sherald is vice president of Ward Systems Group (Frederick, MD). She can be reached on BIX c/o "editors."

could still enter the data the same way.

But I needed to name the cells, because the expert system I was going to use, Neuron Data's Nexpert Object, writes directly to named cells. Nexpert Object has many features that make it appropriate for taking on real-world tasks. It talks to most major commercial databases and spreadsheets, uses an intelligent interface for knowledge engineering, executes C programs from within the run-time and development systems, and comes as a set of C libraries so its inference engine can be embedded in custom applications.

Writing directly to named cells avoids rewriting the spreadsheet in a database format and avoids creating new methods and systems for the users to learn. (As an information analyst, I am concerned about not changing the ways in which people work.)

Once the database file arrived, I built a basic retrieval engine with Nexpert Object that read the data into memory and created dynamic objects. I then added a few rules that helped to classify the information, which was then written directly into the spreadsheet cells. Information that I could not derive from the data, I requested from the engineer. Between the data and the questions, I could infer other needed information.

In the prototype of the system, what would have taken an hour of manual work took only a few minutes. The final document was neatly printed on a laser printer, but it told nothing of its expert-system origins.

The expert system not only classified the database data, it also asked all the nondatabase questions consistently. None of the required cells would ever arrive empty again. Spreadsheets, CAD data, and expert systems were working hand in hand. The ability for expert systems to interact comfortably with existing software will be a key factor in their survival as a technology.

The Help Desk

Another area where expert systems are making inroads into the real world is in help-desk applications. Help desks apply simple logic to solve problems that are very visible and very costly. When I call the manufacturer of a computer peripheral, I am often dismayed at the amount of time it takes for someone to respond. The savings generated just by answering service calls faster can sometimes justify much of the development expense of an expert system.

Some companies, like Emerald Intelligence, are adding a new look to their ex-

pert-system development environments. A new interface makes the systems more accessible to help-desk managers and technicians. Using the Mahogany Help-Desk point-and-click interface, you can describe symptoms and solutions in a tree diagram. Each node of the tree contains a custom question, explanation files, or graphics files with "hot spots" that equate to answers.

The logic engine in HelpDesk is the same as the one found in the standard Mahogany product, but developers no longer need to concern themselves with objects, inference mechanisms, rules, or data validation. HelpDesk takes the results of the simple dialog boxes that the developer fills in, and generates the user interface and the logic. Now, as with spreadsheets and word processors, it's more important to focus on the content of the problem that you are trying to solve than on the methodology you must use to solve it.

Embedded Systems

Several applications lend themselves to the embedded approach to intelligent applications. One of the most obvious is intelligent CAD equipment. When designers place components on a PC board drawing, or a new hole in a sheet metal part, an expert system could work beneath the CAD program to verify that the design is manufacturable.

The expert system may be able to recommend how to change the design to conform to manufacturing capabilities, or what manufacturing changes would be needed to accommodate the new design. Smart applications of expert systems are already turning up in products.

One air-conditioning manufacturer used the simple logic of Millenium Software's HyperX HyperCard expert system to write the logic for controlling a new unit. In the next few years, the use of inference-engine technology will become so commonplace that you may not even know that it's hiding under your word processor, CAD program, or hypertext authoring tool.

Inferences from the Edge

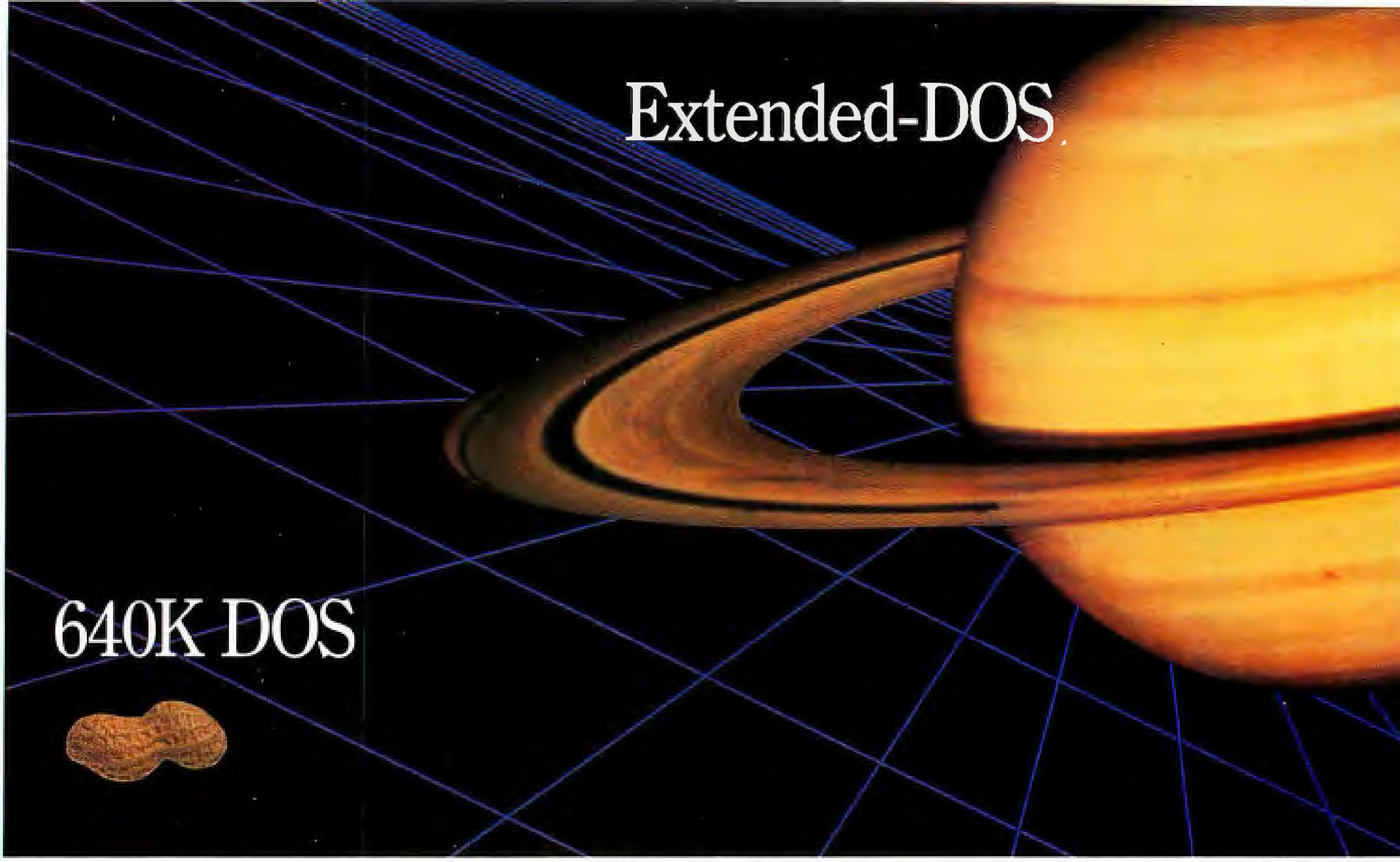
There are still many stumbling blocks to the successful implementation of intelligent-system technologies. Hardware tools like Voice Navigator and Personal-Writer require training, and expert systems require costly and time-consuming knowledge engineering to translate the knowledge of experts into executable code.

The hardware people will continue to rely on faster processors and better algorithms to bring us instruments that respond to us more naturally. And the expert-system people will create tools that use AI techniques themselves to sort through the conflicting data that confronts knowledge engineers.

The technology will continue to evolve, and we will see the infiltration of AI technology into every place the computer goes. The 1990s will see the walls between intelligent applications and conventional applications crumble.

Systems analysts will become knowledge engineers, and knowledge engineers will become systems analysts. Perhaps it is not too soon to start referring to these professions as "information analysts," for what they do is apply knowledge to data to produce information. ■

Daniel W. Rasmus is a freelance writer in Laguna Hills, CA, who specializes in expert systems. You can reach him on BIX c/o "editors."



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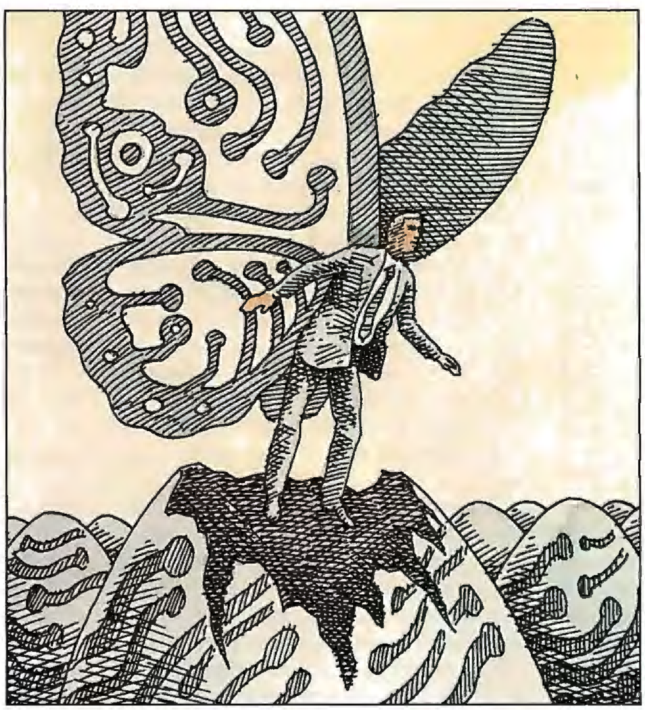
Real Artificial Life

How do algorithmic evolutionary mechanisms and knowledge representations combine to synthesize an a-life organism?

Richard Marlon Stein

One of the goals of AI research is to simulate complex biological processes, such as learning and memory. These natural functions are specialized operations, the product of millions of years of biological evolution. Mankind is now beginning to harness this evolutionary mechanism in the form of artificial life, a method for exploring complex biological processes. Through the study of a-life, investigators hope to discover how evolution synthesizes living systems.

This discussion is not so esoteric as you may think. Computerized a-life forms have already appeared. Computer viruses multiply and infect other computer systems, breeding within the host. They propagate through networks or are exchanged by concealing themselves within a file. A computer virus may be benign, or it can wreak havoc. A virus's behavior, while not necessarily indicative of intelligence, does mimic symptoms produced by naturally occurring parasitic viruses.



Worthy of Investigation

The first conference for a-life was held at the Los Alamos National Laboratory Center for Nonlinear Studies in 1987 (see reference 1). The conference was organized by Christopher G. Langton, who was "frustrated with the fragmented nature of the literature on biological modeling and simulation."

The conference participants realized a fundamental conclusion: "Artificial systems which exhibit life-like behaviors are worthy of investigation on their own rights, whether or not we think that the processes that they mimic have played a role in the development or mechanics of life as *we* know it to be. Such systems can help us expand our understanding of life as it *could be*" (see reference 1). Thus, a-life can be broadly classified as a form of computational biology, an analytical method for studying biological systems.

Biologists have traditionally explored living organisms such as bacteria, ants, fruit flies, and flatworms from a top-down approach. By dissecting an organism into its representative parts, you learn the form and function of each of its organs and chemicals. The living entity vanishes in the search for simplicity within an organism.

A living organism is not necessarily intelligent—by human standards at least. The vast majority, 99.99 percent, of all living, organic matter is not intelligent. A tree, virus, or bacterium possesses no known intelligence, but it is alive, and it represents considerable complexity.

Living organisms reproduce and function in specialized ways. At some point, a system exhibits lifelike behavior because its complexity produces action and

RULE-BASED SYSTEM

RULE 1	→ When hit by punch, recoil
PUNCH	→ A force >= 10 newtons
RECOIL	→ Translate −5 feet in the *z* direction

Figure 1a: *A rule-based production system, such as those created with Lisp or OPS5, can model specific aspects of behavior. The rules fire according to input conditions. Here, the recoil rule will fire if the hit is hard enough. You can also code these rules as IF. . . THEN constructs in C or FORTRAN.*

purpose of function for the system. In some cases, some specialized behavior emerges in living organisms, as when a bee forages for pollen. But specialized behavior is not necessarily a sign of intelligence.

The I in AI

Intelligent behavior requires knowledge representation, a framework for evaluating information. In classical AI research, this means a collection of data structures and procedures or methods for manipulating them. AI research has produced several methods and mechanisms for approximating intelligent behavior.

Rule-based expert systems are common working examples of knowledge representations (see reference 2). An expert system responding to a specified input produces an output based on the knowledge embedded in the data structures, objects, events, and other entities with respect to an interpretation of the production rules (see figure 1a).

The data structures represent a *context*, a scope of applicability for the knowledge base. The *interpreter* controls the processing of the context during each *cycle*. Which rules are applicable at any instant? What are their priorities? An expert system mechanizes queries into a knowledge base distilled from an intelligent source, usually a person.

A person becomes an expert—that is, acquires specialized knowledge, or learns—by trial and error. Doing course homework is an example of this; it is an individualized and sequential activity. You learn from mistakes and apply the understanding to memory for later use. This is a cognitive process that affects a single individual within a population.

AI is a form of computational psychology, where cognitive processes are analytically modeled. Learning is manifest as a neurological process. It operates on the brain of an individual but does not affect a population of organisms.

However, an expert system operates with a "cooked" specification. It is constrained to execute a knowledge base in a finite manner and does not necessarily alter its production system to accommodate knowledge outside its context.

A rule-based production system is not easily adaptable for knowledge representation. Production systems do not generally possess the structure to evolve knowledge representation; a programmer must encode knowledge by adding or modifying rules and data structures.

On the other hand, artificial neural networks *are* adaptable structures (see reference 3) and can be trained to perform specific functions (see figure 1b). They are also linear structures. A small change at the input produces a small change at the output. An expert system may generate widely different outputs for slightly different inputs, a by-product of the conditional constraints embedded within the rule structure. In addition, an artificial neural network is a tolerant computation structure. An unanticipated input will not cause it to crash.

Artificial neural networks are important mechanisms for knowledge representation in a-life systems, but they are not the only possible technique. Some researchers apply finite-state automata, such as those found in Conway's Game of Life (see reference 3), to serve as knowledge representation for an a-life creature.

A finite-state automaton uses a simple state-transition table to guide the organism. That is, it exists in some initial state, an input is applied, the state-transition table is consulted, and the organism then assumes a new state (see figure 1c).

The knowledge-representation scheme is of fundamental importance to a-life simulations. Whether it is a collection of rules, a neural network, or a finite-state automaton, it serves as the underlying agent, generating behaviors that emulate those found in natural systems. The behaviors found in living systems and those produced from some a-life simulations have one very important similarity: They change and adapt by applying an evolutionary process.

Survival of the fittest and natural selection mediate evolution in the natural world. If nature can evolve living systems, why can't humanity simulate this process, and understand and dissect the most successful specialization mechanism of the natural world? A-life studies focus on evolving systems, or systems that change their behavior through the course of their simulated lifetimes.

Distinguished A-Life

The principles of natural selection and survival of the fittest supply the mechanism for achieving a goal in certain a-life simulations. A-life relies on a computational representation of an organism, because the simulations of these artificial organisms are carried out on a computer. How do algorithmic evolutionary mechanisms and knowledge representations combine to synthesize an a-life organism?

Some computer viruses, such as the one that disrupted the Internet, operate from a predetermined, declarative instruction set. The Internet virus demonstrated the vulnerability of a computer network. Connectivity between computer systems will increase as computers become more prevalent and powerful, and this fact raises their susceptibility to viruses.

The disruption of the telephone system in the U.S. last year provides an analogous example of computerized a-life forms. In this case, switching centers, major hubs of telephone traffic, all performed according to specification. But a problem arose when a certain untested condition emerged between some of the switching centers.

The new and devastating behavior resulted from a superimposition of complex conditional constructs. The electronic spasm originated from the collective action of distributed parts and demonstrated behavior that was logical, under the circumstances, but unacceptable.

These two examples illustrate the chaos that can arise from the uncontrolled propagation and unanticipated behaviors found in a-life forms. These instances underscore the compelling need to analyze and study the formation of a-life systems, whether they are purposely created, unforeseen, or intentionally insidious.

The most interesting a-life forms evolve specific behaviors during their simulated lifetimes. In these advanced cases, the a-life entity will acquire a skill after several generations of breeding and attempting to solve a problem, like following a food trail. A-life simulations

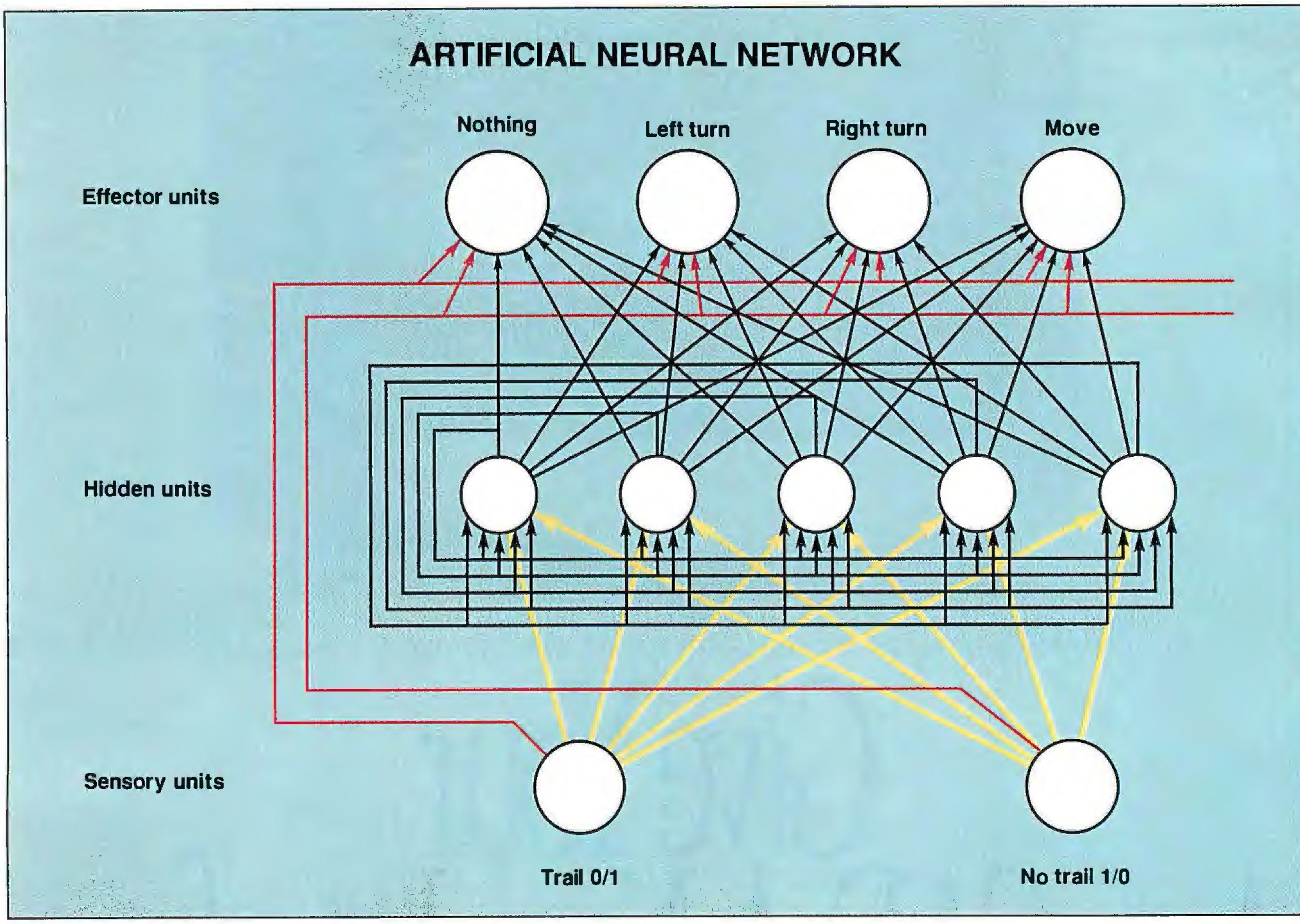


Figure 1b: *The artificial neural network may be used as knowledge representation for certain forms of artificial life. The sensory units act as input discriminators, the hidden units provide connection and feedback, and the effector units generate output conditions. (Figure courtesy of David R. Jefferson)*

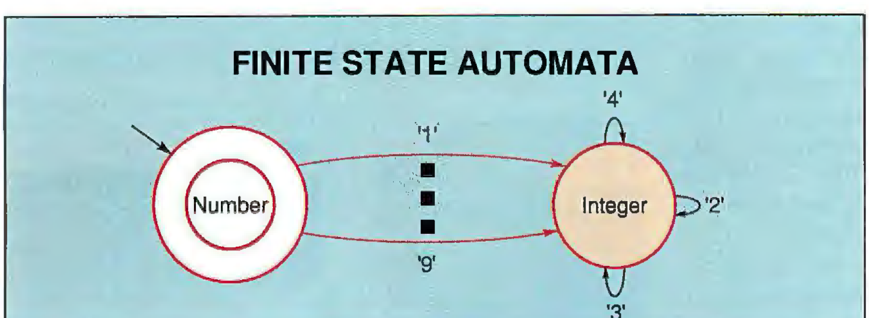


Figure 1c: *The state-transition diagram describes how finite-state automata can change. The machine starts in a known state, parses an input condition, consults the transition diagram (or table), and determines which state to engage next.*

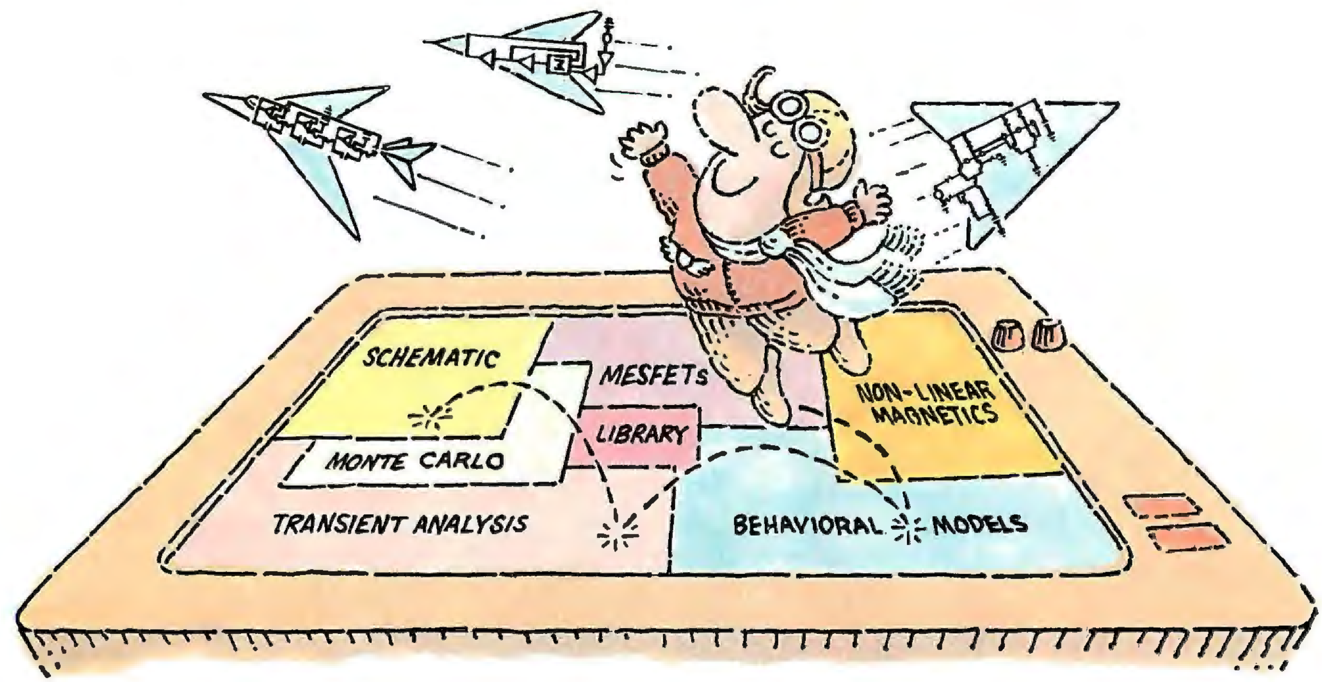
designed to explore fundamental questions about evolution use algorithmic techniques implementing survival-of-the-fittest and natural-selection formalisms.

Genetic algorithms (see reference 4)—a recent development for performing optimization—support the equivalent biological mechanisms of reproduction, crossover, and mutation within an algorithmic structure suitable for a-life simulations. Evolving a-life systems depend on a mechanism for transcribing instinctive behavior acquired from previous generations, and genetic algorithms are a fine vehicle for expediting this process.

Biological evolution shows that chance governs an organism's function. A cheetah is a cheetah because evolution made it that way. But some a-life simulations are goal-directed, while biological evolution is opportunistic and tries to ensure a species' survival. This notion differentiates a-life simulations from natural biological evolution. A-life simulations reach their goals—perform limited optimization on specific functions of arbitrary complexity—by applying evolutionary operators to knowledge representation.

The a-life simulation is clearly very different from a conventional expert system. A-life depends on *selective* coding of knowledge representation, rather than declarative coding. Selective coding arises from the crossover of genetic information in the form of an electronic genome, or *genotype*, the DNA of a-life. The genotype expresses the function, purpose, and potential behavior for an a-life organism, just as the DNA in a living body expresses those notions for a living organism (see figure 2).

A-life genotypes are simply long bit



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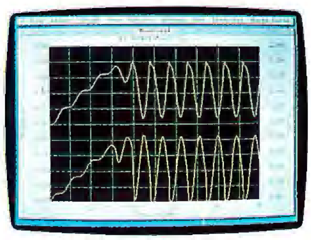

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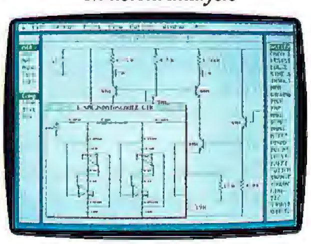

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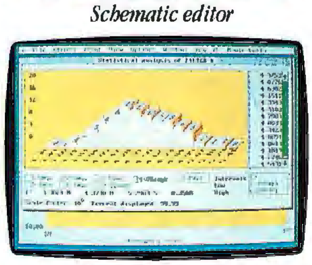

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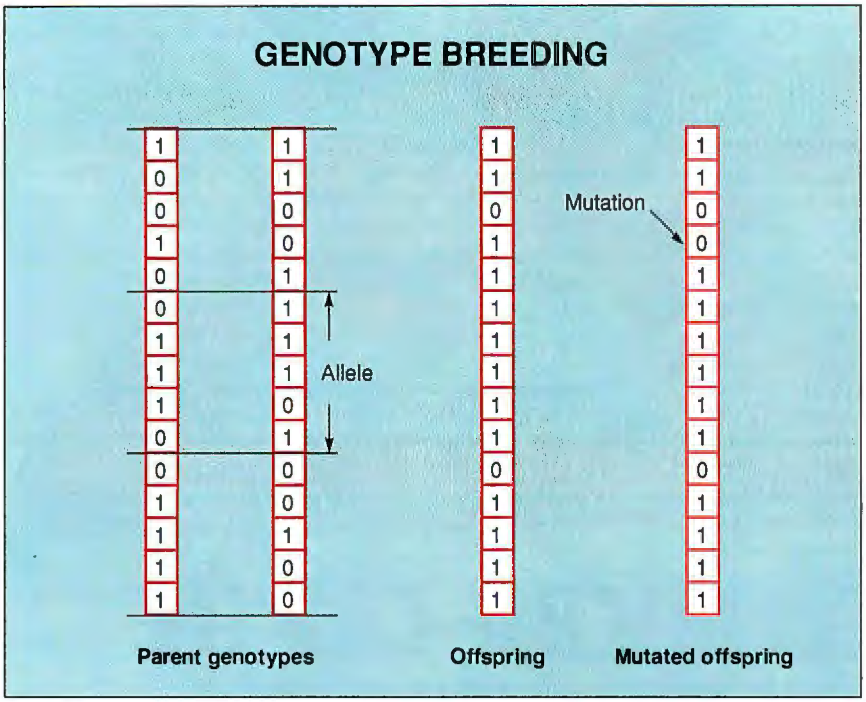

Figure 2: *The parent genotypes are bred together, producing an offspring that inherits a random contribution of alleles from both. The offspring's genotype is then subjected to a mutation, where some bits in the genotype are "flipped" to account for this random, natural occurrence. The mutation rate is usually much rarer than depicted here (about 1 bit per thousand is typical).*

strings, a sequence of concatenated 1s and 0s. Within each genotype, specific sequences of 1s and 0s represent a gene, or *allele*. The alleles direct the specific components of behavior for the a-life system. The success that a particular a-life process demonstrates during the execution of a task determines whether it will be selected for breeding in the next generation.

Evolving a-life simulations are scored with each generation. The highest scorers within an a-life population are selected to breed for the next. An a-life population consists of many separate genotypes—perhaps thousands of bit strings—each executing a unique context or process that aims at specializing performance for a specific function or goal. Each individual genotype executes a directed task, the task is scored, and the top scorers—say, the top 1 percent or the top 10 percent—breed the next generation.

The highest scorers from an a-life population are analogous to "survival of the fittest." The fitness criterion reflects the effectiveness of a genotype to specialize with respect to a given function. Those genotypes that are not high scorers eventually die off; their alleles cannot compete with their peers in the a-life population.

The successful genotype is selectively bred with its peers in the population, ensuring the partial replication of its survivability. Thus, each successive generation usually acquires more skill and more ability and becomes more specialized to achieve a particular goal or objective. Specialization of a genotype results from protracted evolution. Just as a particular plant or insect fills a niche in nature's scheme, so can an a-life genotype.

From a fundamental biological perspective, a-life simulations present a new opportunity to investigate evolution. For example, why does sexual reproduction require two individuals from the same species? On the surface, asexual reproduction, where an organism reproduces itself (like a bacterium), would seem twice as efficient. What allowed the sexual mechanism to emerge as the dominant reproductive theme for higher organisms? This question is hard to answer, but designing a *traditional* computer simulation to resolve it is nearly impossible.

Genetic Algorithms for A-Life

Genetic algorithms are ideally suited as the foundation for a-life investigations because they simulate the natural processes of biological evolution and produce specialized genotypes through the reproduction, crossover, and mutation operators. Genetic algorithms are an innovative alternative to traditional optimization techniques in that they have the flexibility and capability to evolve a complex system, rather than attempting to develop (and code) one from scratch.

Figure 3 uses a genetic algorithm to find a maximum for the function $f(x) = .25 \times x^2$ over the range $0 <= x <= 31$. A 5-bit, unsigned genotype is selected at random for each of the six members in a population. The function $f(x)$ evaluates the genotypes—those that score highest (fit best) are then selected to breed the next generation.

The crossover points, selected randomly, may be weighted by each genotype's percentage of fitness with respect to the total of all fitness scores. If f_i is the fitness of genotype g_i, "select %" is the ratio of fitness f_i to the average fitness for genotype g_i. The count column is the ratio of "select %" to the average selection percentage, an indication of the likelihood of breeding the particular genotype g_i.

The first generation in this example was created entirely at random, by flipping a coin. A heads toss produced a 1, and tails produced a 0. Random selection of mating genotypes produced the second generation. The crossover points represent the places within the bit strings where portions of one genotype are copied to the offspring. The crossover points were also determined by random draw.

The first generation shows an average fitness value of 31, while the second generation's fitness is 68, more than double the first. This indicates that the average population is evolving toward an optimum value of the goal function.

This process is continued until the maximum value is achieved. The genotype that belongs to this maximum value is the most specialized and highly evolved member. If the function were changed somehow, you could use this genotype as a seed for the new specialization activity, or it might be quicker to begin with a new, randomly selected genotype population.

A genetic algorithm achieves effectiveness through the large number of alleles sampled and compared for crossover during the reproduction process. If you consider a genotype with only 100 bits, the total number of strings that can be coded are 2^{100} (1.26×10^{30}). This implies that a colony of 10^{30} different (unique) individuals is possible.

A large population of genotypes has an extraordinary mix of individuals, some

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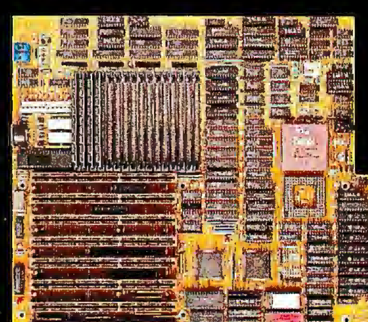

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more fit than others. Mixing genotypes through crossover and reproduction can generate a specialized a-life organism tuned to achieve the desired goal. The huge pool of possible genotypes and their effectiveness provide the possibilities to conduct a nearly global search for the most perfect genotype.

But performing a global search for the "fittest" genomes to breed counters biological observations. Organisms of like species residing in geographically distant places do not always come together and breed. Local groups of organisms tend to breed, and this tendency creates genetic diversification. Some a-life researchers have observed signs of diversification in genome fitness during simulations using localized selection criteria.

The Neural Connection to A-Life

The evolutionary characteristics of a-life are generally controlled with genetic algorithms, but their ability to demonstrate lifelike behavior and specialize in a dynamic, natural environment is a task for neural networks. The marriage between genetic algorithms and neural networks, the essence of a-life, is a very recent development pioneered by David R. Jefferson and his collaborators at UCLA (see reference 5).

To demonstrate how a-life systems evolve complex behavior with neural networks, Jefferson simulated an ant colony whose sole purpose was to navigate through a trail with twists, gaps, and turns. Each generation of the ant colony, composed of 65,536 independent neural networks, was simulated on a Connection Machine as 65,536 separate processes.

In this experiment, the ant genotypes were generated entirely at random, and their bit strings were used to compute the weights and interconnections for a neural network. A recurrent artificial neural network (see figure 1b), the computational representation for the ant, directed the movement of the ant along the trail according to the genotype contents.

At first, most of the ants did not take any steps onto the trail; they either spun around or did nothing. But a few ants did take a step or two onto the trail, and they were rewarded for their random efforts. Their fitness values were scored higher than those who did not walk on the trail.

GENETIC ALGORITHM

1st generation

i	g_i	decimal	fitness	select %	count
1	01100	12	36.0	0.193	1.15
2	10010	18	81.0	0.436	2.60
3	00011	3	2.3	0.012	0.071
4	01001	9	20.3	0.109	0.652
5	00100	4	4.0	0.022	0.132
6	01101	13	42.3	0.228	1.37
Sum			185.90	1.000	5.98
Average			30.98	0.167	1.00
Maximum			81.00	0.436	2.60

2nd generation

i	g_i	decimal	fitness
1	10101	21	110.25
2	01111	15	56.25
3	01000	8	16.00
4	10010	18	81.00
5	10011	19	90.25
6	01111	13	42.25
Sum			406.00
Average			67.66
Maximum			110.25

Figure 3: *The second generation promotes a higher average fitness value than the first. This implies that the average population is moving toward an optimum. No mutations were applied to this sample.*

The highest-scoring ant genotypes then became the parents to breed the next generation. The neural networks were recomputed from these second-generation genotypes. More ants in the second generation moved further along the trail.

After a few hundred generations, the genetic components of the simulation, reproduction, crossover, and mutation had produced super-ants who could expertly navigate the trail. The ants had "learned" to move through the maze by evolution directed through neural computation.

Their neural-network structure had acquired a precisely tuned, specialized configuration for locomotion along a fixed trail. The neural network served as the intelligent agent of the ant, while the genetic algorithm altered its genotype over several generations.

While the highly evolved ants could navigate their training trail, they performed very poorly on a different trail. Jefferson found that it was quicker to begin from scratch, with a new random ant-genotype population. The highly evolved ants had become overspecialized for a specific trail and failed to adapt rapidly to a new environment.

This finding indicates that overspecialization can result in an evolutionary dead end. Jefferson's a-life simulations demonstrated that genetic algorithms and neural networks form an effective combination for examining how specialized behavior evolves.

The larger the a-life population, the more varied the genotypes become. A large population is modeled, with each member acting as an independent process. In Jefferson's case, he used a massively parallel computation system, a Connection Machine, to conduct the a-life simulation.

The larger the population, the more genotypes there are enhancing the gene pool. Parallel-processing systems, especially SIMD (single instruction/multiple data) style systems, are ideal platforms for serious a-life research. It is not practical to execute 65,536 simultaneous processes on a supercomputer or a workstation.

Jefferson's ant simulation is intriguing for another, potentially fortuitous application. Although Jefferson did not develop a computational representation for the neurological motor mechanism in artificial ants, real ants possess an ingenious locomotive apparatus that coordinates all six legs. The Mars Rover, an autonomous vehicle for exploring the Martian terrain, could employ this mechanism, if scaled to sufficient size.

The Mars Rover must confront an environment with changing topography, shadows, crevices, and terrain. This is a tremendously difficult problem in real-time robotics control, machine vision, and adaptive learning.

A traditional software-engineering effort, organized to conduct an investigation with classical software techniques, would be prohibitively expensive. But a likely alternative would be to apply a-life simulation to evolve a smart machine capable of performing the task.

The Mars Rover must learn how to walk over terrain under independent, autonomous control. An ant, through the course of evolution, is perfectly adapted for this task. The Rover must learn to successfully walk through the terrain as well. A-life simulation techniques may be able to implement this navigation and terrain-negotiation function more easily.

Genetic-Algorithm Applications

Genetic algorithms are not restricted to the laboratory. Recently, Axcelis (Seattle, WA) announced its Evolver software, an add-on to existing spreadsheet applications, such as Lotus 1-2-3 and Microsoft Excel. The Evolver product enables you to perform optimization on a set of variables through the application of a genetic-algorithm structure that is built into the product. Evolver is a truly innovative piece of software, the first commercially available genetic algorithm for small systems.

With Evolver, you can determine what is the best time to deliver packages based on traffic flow, package volume, and fuel costs (should they vary hourly, daily, or weekly). Evolver lets you simply click on a spreadsheet variable and establish whether a maximum or minimum is desired. You can use Evolver to predict stock-market averages based on news feeds or other electronic information sources. You could also add it to the Intelligent Desktop, a multimedia environment being researched at the MIT Media Lab.

While Evolver performs optimization in a mode similar to simulated annealing (see "Configuring Parallel Programs," December 1989 BYTE), the U.S. Patent Office recently granted John R. Koza of Stanford University a patent (see reference 6) for using genetic algorithms to solve symbolic problems, such as computing where two lines intersect in space from an algebraic specification. Koza's approach with genetic algorithms is unique. He constructs populations of Lisp programs that attempt to solve a problem symbolically, as TK!Solver (Universal Technical Systems, Rockford, IL) does with analytical-function specifications.

The various Lisp programs are scored according to a fitness criterion. The highest-scoring programs produce an expression for the solution closest to the known analytical one. The programs that generate the analytical solutions are then used to breed the next generation. Rather than breeding a bit string, Koza's method breeds algebraic expressions.

This patent may prove useful for enhancing symbolic computation programs, where you need to solve more difficult algebraic systems than existing symbolic-manipulation systems can handle. Koza's method relies on the operator to discriminate between algebraic expressions and select the ones most suitable for subsequent generations. Placing the assessment responsibility on the operator implies manual intervention, rather than a completely automated evolution process.

Future A-Life

The interdisciplinary nature of a-life research serves as a rich backdrop for discovery. Molecular biologists, who study molecular evolution and immune-system responses, have a new avenue to explore their field from a less contrived and more suitable context.

Molecular computations for designing pharmaceutical products are enormously complicated and can scarcely provide meaningful information for any but the smallest systems. With a-life simulation techniques, the next 5 to 10 years should see a rapid rise in the development of new computational tools for investigating chemical and molecular systems.

Current a-life simulations produce genotypes tuned to achieve specific goals. Integrating robotic controls into an a-life simulation may produce a genotype for an autonomous roving vehicle used for future planetary exploration.

The organizations that can construct specific genotypes for solving important problems will dominate industries by the exploitation of a-life simulations. Computer simulations are far cheaper than people, and every organization has a requirement to reduce costs. If software can be evolved independently of the engineering process, then the cost to produce a specific product will certainly drop.

The rise of a-life simulation prospects is limited only by the inventiveness of software engineers who can adapt existing algorithms to evolutionary contexts. Nature's skill and craftsmanship, when harnessed toward the creation of a-life, present a virtually unlimited reservoir of possibilities for engineering solutions. Exploiting these opportunities are roles for the most innovative among us. ■

ACKNOWLEDGMENT
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see Resource Guide on page 300

Resource Guide: Intelligent Software

The commercialization of AI technology takes two primary forms: expert systems and neural-network simulators. Below are many of the companies producing products for these two areas (E = expert systems; N = neural networks).

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BIX COMMUNITY CALENDAR JANUARY 1991

CASE Trends Joins BIX

CASE Trends, the magazine for Computer-Aided Software Engineering, has opened a conference in BIX. Meet on line each month with the *CASE Trends* staff and special guest experts for discussions of CASE news, industry trends and CASE techniques.

■ Special Topics Each Month

This month Eliot Weinman, Executive Editor of *CASE Trends,* will host a month-long discussion on "CASE Technology: An Update of Recent Trends." Next month the special topic will be "CASE and Re-Engineering." And March will be the month for "Evaluating PC-Based CASE Tools."

In future months, we'll explore topics like "CASE and Object-Oriented Environments," "CASE and Information Engineering," and "Advanced Software Engineering/CASE & AI." (join case. trends)

IBM Exchange Update

■ PC Insider Info

In the IBM PC conference we're tossing around opinions on keyboards, high-res video adapters/monitors, tape drives/tape software, and fast CPUs, to name a few. Find out which hardware is a good investment for you. (join ibm.pc)

Need to know anything about MFM, RLL, ESDI, IDE or SCSI disks and disk controllers? Know something the rest of us should? We discuss it all in the IBM PC drives conference. (join ibm.pc/drives)

■ OS/2 Conference: Speculation Abounds

How do you use Named Pipes on an OS/2 LAN for remote control? Add your thoughts in the OS/2 LAN topic. (join ibm.os2/lan)

Also, join in on discussions of OS/2 Lite (the 1.3 version) and the upcoming version 2.0. Feel free to speculate on version 3.0 and whether it will support RISC architectures. Hypothesize on how IBM and Microsoft's new relationship will affect the future development and acceptance of OS/2. Check out the topic 'other,' beginning at message 3735. (join ibm.os2/other)

■ Free LAN Software

LAN remote control software is available in the LANS conference. Source code for both NETBIOS and Novell IPX is located in the 'lans' conference 'long.messages' topic. (join lans/long. messages)

Find executables in the conference's listings area. (join lans/listings)

This month we'll also be discussing how to diagnose and troubleshoot Novell NetWare. (join lans/netware)

■ Hot Topic: Microsoft Windows

Both users and programmers are giving their points of view on Microsoft Windows these days. We're also discussing upgrades to Microsoft C 6.0. The new DOS 5.0 version is causing quite a stir, as well. (join microsoft)

Mac Exchange Update

■ New Mac Conference

Now HyperCard enthusiasts have a conference of their own. If you're one, join in and swap HyperCard codes, share experiences and discuss techniques. (join mac.hypercard)

Talk in the Writers' Exchange

Our newest topic here centers around articles and book excerpts posted by science fiction and computer writer Michael A. Banks. Moderator Hugh Kenner hosts conversations on everything from school levies to computer store service. Drop in for entertainment in the form of provocative articles (posted before magazine publication), humorous articles and chit-chat. (join writers.talk/mike)

Conference Round-Up

Exciting things are happening at BIX in these conferences:

Aviation	Find out about the supersonic airplane that rides its own shock wave. (join aviation/wave.riders)
Gibson Research	Gibson Research is now on line to answer your questions on Spinrite or hard drives. (join gibson-research)
Tandy	Discuss your Tandy Model 2000, or other models. (join tandy)
DBMS	Consider the relative merits of the Network model and the Relational model in DBMS design. (join dbms)
Hamilton	Discuss *BYTE* author Douglas Hamilton's new C Shell for OS/2. (join hamilton)


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MICRO, MICRO: WHO MADE THE MICRO?

A lone California inventor says he did, but not everyone agrees

BYTE Staff

In the days to come, Gilbert Hyatt could become either a very rich man or just a footnote in computer history books.

Hyatt, an obscure 52-year-old systems designer, electronics engineer, and aerospace consultant, lives in La Palma, California. On July 17, 1990, after a 20-year battle with the U.S. Patent Office, Hyatt was granted patent #4,942,516 for a "Single Chip Integrated Circuit Computer Architecture." According to Hyatt, the patent establishes him as the man who invented the microprocessor—in contrast to popular belief, which credits engineers at Intel and Texas Instruments (TI) with the invention.

The announcement of Hyatt's patent grant triggered immediate and widespread controversy in the computer industry, not to mention the stock market. Although industry watchers say it's still too early to predict what effect the Hyatt patent will have on the computer industry, most agree that it could be enormous.

Hyatt's patent is sure to face challenges from the big guns in the semiconductor industry. If it can successfully survive those challenges, even minimum royalties could amount to some several hundred million dollars a year. Although Hyatt, who says he plans to set very reasonable fees for the use of his invention, will not receive retroactive royalties, he would earn proceeds from his brainchild for the next 17 years.

Currently, Hyatt is negotiating a joint-venture agreement with a "major American corporation that has an integrated circuit division." This firm, says Hyatt, proposes to take a license on the patent, to assist with financing, and, with its licensing capability, to license the patent to others. Hyatt says he won't sell the microcomputer patent. "I'm not giving it away. The joint venture is more a license for them and a little bit of technology exchange. We're negotiating with licensees now who have approached us."

While many have expressed their delight in seeing a lone-wolf industry engineer granted a patent for an invention with such all-encompassing ramifications, others look at Hyatt's pronouncements somewhat skeptically. Tyler Sperry, editor of *Embedded Systems*, comments, "Hyatt is a media darling. He's very carefully searching for a patron—if he doesn't get a major company to sponsor him, he's dead." Bruce Koball of the *Microprocessor Report* agrees, "This guy has nothing by himself. Either the Japanese buy in and use it against America, or vice versa."

In the Beginning

Where did Hyatt—who until recently was virtually unknown in the industry—come from? In 1955, Hyatt graduated from Long Beach Poly High School. He attended Long Beach City College for two years and finished his B.S.E.E. degree at the University of California at Berkeley. In 1963, after working in industry for a few years, Hyatt began working at Hughes Aircraft and going to school part-time. He obtained his M.S.E.E. in 1965 and later joined Teledyne as a research scientist.

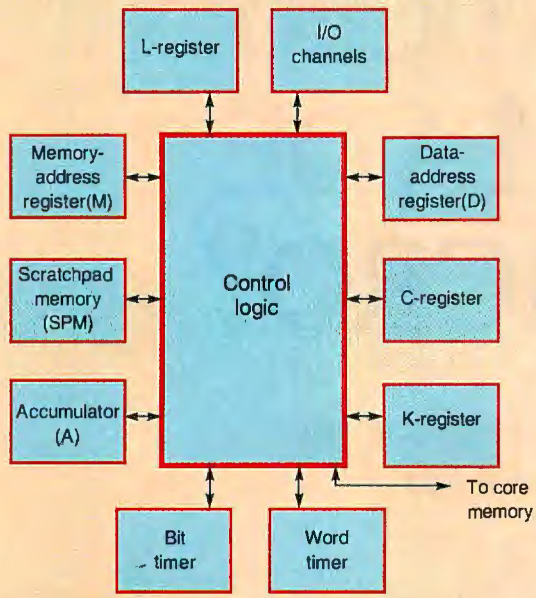
In 1968, according to Hyatt, he built the first breadboard for a new type of small computer in his home. "I trademarked the name *microcomputer*, because it was a computer smaller and more efficient than the minicomputer."

Hyatt formed a company called Micro Computer and built his first working computer later that year. He obtained venture capital financing from several sources, including Robert Noyce and Gordon Moore, both of whom were to play important parts in the creation of the microprocessor. "We had brought in—or I should say, the finder for the financing brought in—Dr. Noyce and Dr. Moore, the Intel founders," says Hyatt. "Essentially, we needed access to a chip-making capability so that we could put my computer on a chip." (See the text box "Hello, Mr. Chips?" on page 308.)

The "effective date" of Hyatt's patent filing is December 28, 1970, for a computer on a chip—the microcomputer having a CPU, operand memory, and ROM on an IC chip. The figure on page 306 shows a block diagram from Hyatt's patent, showing the data processor.

In 1971, after a dispute over Hyatt's refusal to assign the financial backers rights to his patents, the firm went out of busi-

GILBERT HYATT'S DATA PROCESSOR



This block diagram, from the patent granted Gilbert Hyatt, shows the components of his data processor. The basic timing functions derive from bit and word timers. Basic arithmetic happens in the A register. The C, K, and L registers handle instructions and control. The M register is used to address main memory. The SPM registers provide intermediate storage independent of the main memory. The I/O channels move data to and from registers.

ness. Noyce and Moore went on to become founders of Intel.

As most Silicon Valley history books tell it, the development of the first commercial microprocessor in the early 1970s was the result of work done by a team of Intel engineers led by Ted Hoff and Federico Faggin. Intel named its chip, which began shipping in late 1971, the 4004. In 1971, TI and engineer Gary Boone also were working on the development of primitive microprocessors.

So what's the connection between Hyatt, Hoff, and Faggin? According to Hoff and Faggin, they never heard of Hyatt until the recent announcement of his patent grant (see the text box ". . . This Is Intel on the Line" on page 309). Nevertheless, the Intel connection is hard to discount completely. According to Thampy Thomas, president of NexGen Software, "There are so many factors for the microprocessor—and who invented it—that it is difficult to count them. One interesting aspect is the folklore. [Hyatt's] company had the name Micro something in it before there were such things, and Bob Noyce and Gordon Moore were investors. That's interesting."

Slowly Grinds the Wheel

One of the biggest problems in proving the validity or nonvalidity of Hyatt's claim is the way patent applications are handled in the U.S. Patent filings are kept secret and only revealed when the patent is granted. In other countries, after a certain amount of time passes and while the application is still in process, the contents are revealed to the general public.

The granting of Hyatt's patent came as a complete shock to almost everyone in the electronics industry. Had it been known years ago that there was a contender for a patent on the microprocessor, evidence could have been saved, gathered, and presented for claims pro or con. But it is almost impossible 20 years later to go back and prove or disprove Hyatt's claim. This fact has led many to suggest that our patent system procedures be changed to handle such difficult cases.

Why did it take the Patent Office 20 years to approve Hyatt's patent? The broad-based nature and vast implications of his invention were the reason, says Hyatt. "The Patent Office gave [the patent] quite a bit of scrutiny and was very, very careful." Part of the reason for the extremely lengthy and long-drawn-out (even for the Patent Office) process is that Hyatt experienced at least seven continuations during the procedure, and the government twice rejected his patent. Both times Hyatt appealed his case before the U.S. Court of Appeals for the Federal Circuit.

"The decision the Court of Appeals made 2½ years ago clarified the issues and pointed the way to getting them resolved," Hyatt says. "However, they did not issue the patent then. We had to refile it and resolve the issues in the new filing. But the new filing still has the benefit of the 1970 'effective' filing date."

Hyatt's original filing attempts on the recent patent were made sometime in 1969, but, according to his longtime patent attorney, Gregory Roth, the original applications may not have conformed to the Patent Office's prescribed format. Thus, the effective filing date of December 1970 is the date when Hyatt's patent application, first complying with the office's requirements, was accepted.

In the late 1970s, Hyatt was involved in some patent-related litigation with toymaker Mattel over whether its electronic games infringed some of his patents. A federal judge threw out two of Hyatt's patents, ruling that Mattel had not infringed them. This verdict was upheld on appeal.

In Defense of a Patent

But there's a vast difference between getting a patent and enforcing it. What are Hyatt's chances of getting any money from some of America's largest corporations?

Michael Slater, editor of *Microprocessor Report*, says, "On the surface, the patent does indeed cover at least every single-chip microcomputer, and potentially a lot of systems that are not single-chip. It may be so broad as to cover anything that has a processor, ROM, and RAM. But I'm not at all convinced that if you look hard, you won't find other people that documented the same ideas at an earlier time. They may not have filed any patent claims, though."

According to Slater, the biggest challenge Hyatt could face is that he's grossly outgunned. "In reality, I think he's going to have a very long, hard battle in collecting any significant royalties," Slater says. "We have an individual inventor here who's written his own patents, and he's up against many of the largest companies in the United States. They can probably keep him in court for the rest of his life. If he makes it relatively inexpensive for people to pay him, though, then maybe they'll decide just to pay him instead of incurring the expense of fighting it."

Gary Hecker, a Los Angeles attorney who wrote Quarterdeck's patent on multitasking technology, says that there are several provisos concerning the Hyatt patent. "If the patent is valid, if it was infringed upon, and if it's asserted, then Hyatt might have a strong case. But there's going to be a lot of [scrutiny] by all parties involved. The industry won't simply roll over without very careful examination of this exhaustive file history. Of course, any litigation on a case like this would cost millions of dollars and take years."

continued on page 311

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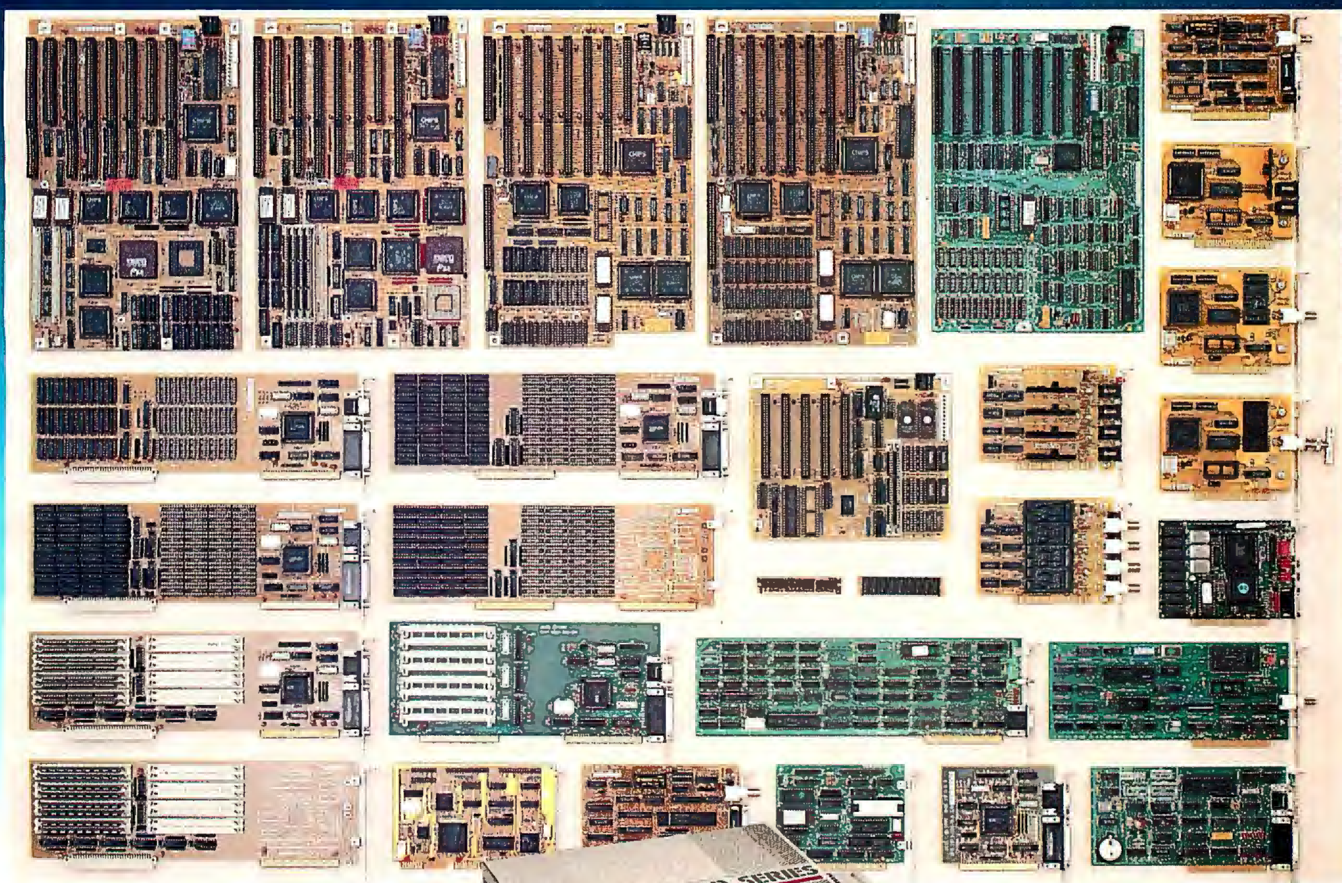

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Circle 165 on Reader Service Card

Hello, Mr. Chips?

An interview with Gilbert Hyatt, the man who currently holds the cards in the microprocessor game.

Gilbert Hyatt, an obscure southern California engineer, may have changed history. He waged a 20-year process that resulted in his being granted a patent for the creation of the microprocessor.

BYTE: ***What was the technology environment when you began work on the microprocessor? What were the technological forces that motivated you?***

Hyatt: There were two basic disciplines with problems that needed addressing. The microcomputer was a bridging technology that solved the problems in both of these disciplines.

The first was the integrated circuit discipline where they had just come up with LSI and were looking for ways to solve some horrendous problems that were preventing LSI from becoming widely used. The second was the computer discipline where the technology had sort of stalled at the minicomputer level. The old computer architectures did not permit them to make significant advances or take full advantage of the LSI technology.

Minicomputers used core memories that could not be miniaturized. They were working on monolithic ferrite memories that don't have the problems of core memories and were incompatible with the LSI technologies.

Literature is full of IC experts crying about all the problems with LSI—getting it to market and building systems with LSI. There was a well-known limitation on ICs that was called the gate/pin ratio. The microcomputer is quite different. A computer is an architecture that you can add a lot of memory to and not increase the pins. It is a heavily time-shared type of device with an I/O channel or bus or multiple channels so you really don't have to increase the number of pins even if you substantially increase the number of gates.

Another unsolvable problem with LSI was custom chips. When you build a logic gate, everyone can use it, because they all use gates. However, when you interconnect 100 gates, you get a very specialized device that maybe only one company can use for one product. It no longer is a general-purpose-type device. The more gates you interconnect, the more special-purpose the device gets.

I was convinced that we were on the threshold of some major technological advances, and I knew that I could come up with a solution to the problems and help with that revolutionary change. I was more technology- and problem-driven at the time.

BYTE: ***Exactly what does your patent cover?***

Hyatt: This patent application/disclosure has 30 or 40 different inventions in it. Patents have already been issued on several of them.

BYTE: ***Does the patent recently granted cover a microprocessor or a microcontroller?***

Hyatt: Well, I have claims—which are legal descriptions—being interpreted by laypeople, and certainly you come up with a lot of misinterpretations. The broader claims have three features.

Claim 1 has a read-only memory, an alterable memory, and a processor. If you find a computer chip that has a ROM on it—and there are a lot of nonmicrocontroller chips that have ROMs—and if you have alterable memory like registers, and certainly a processor, then you invoke claim 1. So that goes far, far beyond microcontrollers.

Many of the claims are not limited to a single chip and therefore can cover multichip configurations. For example, claim 36 and many of the claims subsequent to that are more general microcomputer-related claims that do not require a single-chip implementation.

BYTE: ***Did you actually produce a device or product?***

Hyatt: There was a whole range of computers. The first one was the breadboard—a fully operating hardware developmental model that I built in 1968. Then starting in 1969, I began building prototypes that used printed circuit wiring and continued with prototype development and pilot production through the 1971 time frame when the company went out of business.

The finder for the financing brought in Dr. Noyce and Dr. Moore, the Intel founders, in order to give us access to a chip-making capability so that we could put my computer on a chip. However, as you know from history, that never panned out. They did build micros, but not for me.

BYTE: ***Is it true that Ted Hoff received a patent for a microprocessor?***

Hyatt: No, it isn't. Hoff received a patent in 1973 on a coder circuit on a RAM chip that happened to be in a microprocessor environment. That is the novelty that he addressed. That was the case that was filed in 1973 and [the patent that was] issued about a year later—a Hoff, Faggin, and Mazor patent.

BYTE: ***What about Texas Instruments?***

Hyatt: TI patented a calculator chip, and now there's a challenge as to whether Gary Boone, the inventor named on the patent, really developed it, or whether TI got the design from somewhere else. There is no challenge to my patent right now.

BYTE: ***It's been mentioned in the press that you're working on an agreement***

continued on page 310

. . . This Is Intel on the Line

Ted Hoff, Federico Faggin, and Stanley Mazor, creators of the first commercial microprocessor (the Intel 4004), have been credited with fathering the microprocessor. We spoke with Hoff and Faggin to get their response to the Hyatt patent. Here's what they had to say.

BYTE: ***In our interview with Gilbert Hyatt, he stated that your patent—which we understood to be for the creation of a microprocessor—was for a coder circuit on a RAM chip in a microprocessor environment, and not a microprocessor per se. Comments?***

Hoff: That isn't quite true, but Intel did take a rather casual attitude toward filing for a patent on the microprocessor. Rather than concerning ourselves with filing for a patent, we focused our application on the techniques that made our chip feasible and devoted our efforts to actually making the first microprocessor—the 4004. It was formally proposed to a Japanese firm [in] September 1969 as an alternate to a calculator chip set that it wanted Intel to build.

My contribution was the architecture and the instruction set. Stanley Mazor also made contributions. Federico Faggin, who joined Intel in April 1970, did the detailed circuit design and layout. I believe the processor ended up containing just over 2100 transistors. Based on the number of transistors needed to produce Hyatt's processor, it wouldn't have been practical at that time.

BYTE: ***How can you draw that conclusion?***

Hoff: I've seen the Hyatt patent. There were so many aspects of chip design that needed to be considered in those days, which were not addressed in the Hyatt patent. In the specifications portion of the patent application in the December 1970 filing, Hyatt made no mention of a single-chip implementation.

Hyatt used the term "monolithic" but defined it as meaning using semiconductor memory rather than core memory. That's different from today's meaning of all-on-one-chip. One claim out of 80 in that application cites a computer with RAM and ROM on one chip. In March of 1970, nine months before Hyatt's application, I published an article stating that it was feasible to produce a central processor on one chip. Previous articles had discussed "computers on a slice" but concluded they weren't yet practical.

BYTE: ***But does this fact preclude his having been the first one to apply for a patent, just because it was previously mentioned in a reference?***

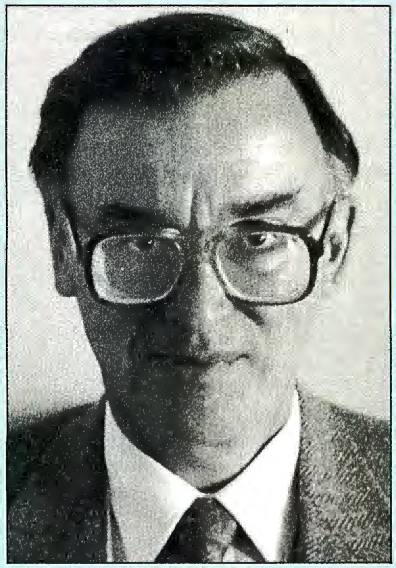
Hoff: Generally, you can't file for a patent on something that has been public for a year or more. Also, you aren't supposed to file on someone else's work, but it's all right to file on unique additions or refinements to prior work.

By 1970, putting a computer on a slice of silicon had been discussed for several years. One such article appeared in 1964, but the author felt process yields needed to be improved to make [the process] practical. My 1970 article noted that the process had advanced to the point where a central processor of sufficiently small size could be done as a single chip. A real issue for Hyatt's patent would be, "Was it an enabling disclosure?"

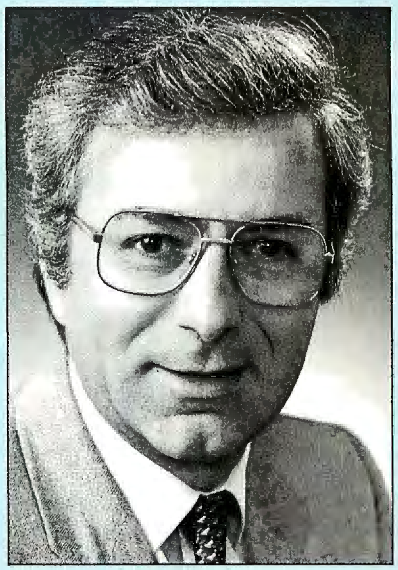
BYTE: ***An enabling disclosure?***

Hoff: A patent is supposed to tell one who is of ordinary skill in the art how to duplicate the invention without undue experimentation. If the invention is a computer on a chip, the patent must tell how to do that using available technology. As recently as 1988, the U.S. Court of Appeals turned down Hyatt's application for not being enabling.

Hyatt's main argument was that he was able to build his computer on two-sided printed circuit boards and that this fact was sufficient proof that the computer could be built as a single integrated circuit. The differences between integrated circuits and printed circuit boards were totally overlooked. As examples, there is no mention of process choice, or the effects of interconnection resistances, which are higher on integrated circuits by orders of magnitude. Coupling between elements of an integrated circuit can be a much more significant problem than on printed circuit boards.



Ted Hoff



Federico Faggin

At one point, Hyatt claimed he would use discretionary wiring, a technique promoted by Texas Instruments in the late 1960s. Discretionary wiring was based on fatally flawed assumptions, which even a few authors of that era recognized. Over the years, Hyatt made changes in the specifications of his patent. The 1970 application was for something he called a "factored computer."

BYTE: ***What was that?***

continued on page 310

Hello, Mr. Chips?

with some company, unnamed at this point, concerning licensing the rights.

Hyatt: Right now, there's a joint-venture relationship with a manufacturing company. It proposes to take a license on my patent, then to assist with financing, and, with its licensing capability, to license my patent to others.

BYTE: ***What impact do you believe the granting of your patent and its issuance will have on technology? Do you believe that as a result, technology will speed up, slow down, or keep the same pace?***

Hyatt: I think it will have a profound impact on the technology, because as a royalty flow is generated, I will turn those funds back into the technology for the next-generation products. Inconsequential royalty percentages won't have any significant impact on the current products but will have a significant effect on speeding up the introduction of the new-generation technologies.

As the excellent patent environment continues and patents are shown to be a good protection for intellectual properties, you will find a lot more people putting a lot more money into R&D. Now they can protect their R&D better, and they may even be better able to let the R&D pay for itself by licensing it. The whole industry will benefit.

BYTE: ***Can you explain to us briefly what your DRAM-performance-enhancement technology is all about?***

Hyatt: As you know, DRAMs are the backbone of the computer industry. They're dense, they're low in cost, and they support memory-intensive types of applications. However, they are slow. There are two ways that have been used to adapt to them. One is typically to slow down the microprocessor with wait states, and the other is to use cache memories to provide a higher-speed interface. Both of these are undesirable solutions. The ideal situation is to get a faster main memory.

Depending on the application, the DRAMs using my architecture can run approximately three times as fast as they would in conventional memory architectures. Most of the row addresses (the slow portion of the cycle) are unnecessary. I developed a circuit to detect when a row access cycle is redundant. Because I'm minimizing the number of row address cycles, we are not as row address insensitive and therefore can relax the design constraints on row addressing and take a little more care speeding up the chip select and the column addressing.

BYTE: ***Tell us about the work you are doing on your "twenty-first-century computer."***

Hyatt: My work gets into the physiovisual aspects of the human mind, what the mind responds to, how best to communicate large amounts of information to an operator, and how to implement systems that can facilitate that type of communication.

For example, productivity of operators increases as their systems approach real time, and when you reach full real-time operation, you have significant improvements in operator productivity. That situation has to do with the operator's mind being able to concentrate better and interact better with the machine.

Vista has nothing to do with OSes and application programs. It's a hardware implementation that taps the inherent visual capabilities of the mind and implements systems that facilitate that type of communication.

. . . This Is Intel on the Line

Hoff: It appeared to be a form of distributed computer. There is no mention in the specifications of a single-chip implementation, and just one of 80 claims mentioned a single chip. That claim was amended in 1972, deleting the single-chip reference. His 1973 filing, however, restored that single-chip computer claim. In 1974, he amended the specifications, changing the title to "Monolithic Computer."

Even with the changes of 1974, the specifications of his application still did not say anything about a one-chip implementation. It wasn't until 1978 that Hyatt added a single-chip reference to the specifications. Even then, there was still no information about what considerations needed to be made for one-chip implementation. His writings, even to the present, give no consideration to most of the factors that went into designing a complex integrated circuit.

For example, Hyatt's patent calls for an 8-MHz clock. Our 4004 target specification called for a 1-MHz clock. Federico Faggin was an outstanding designer—if anyone could have gotten the speed up to 1 MHz, he could have. But he ended up with only about 800 kHz.

In addition, Hyatt's system needed to handle paper tape at 1000 characters per second, plus maintain a multiplexed display. It is not at all clear, especially because his was a serial processor, not parallel like the 4004, that his system would have been functional if it had had to be slowed by a factor of eight or more.

The processor that's described in his patent uses 512 bits of shift-register scratch-pad memory. Implementing that scratch-pad memory and his processor logic would have taken about 10,000 transistors. Adding the amount of main memory he specifies would require at least 35,000 more. Using favorable yield models and assuming defect densities that would have made a 4004 die cost $5, the average cost of one of his chips would have been about $1 million. These are some of the reasons I don't believe his chip was feasible in 1970.

BYTE: ***Did you know him at the time? When you and Faggin were working on your microprocessor, had you ever heard of him?***

Hoff: No, I didn't. I had never heard of him.

BYTE (*to Federico Faggin, currently president of Synaptics, Inc.*)**:** ***What do you think about Gilbert Hyatt's patent for the microprocessor?***

Faggin: A patent is supposed to teach people skilled in the art how to do something novel. Hyatt's patent is more like a prophesy. You need more than a prophesy to patent something. You have to show something that is possible to do with the existing technology—a model has to be realizable. His patent shows integration into a single chip of ROM, RAM, and CPU. The technology to do that was not around at that time.

Our patent patented certain novel aspects of the 4004 so that Intel would have something to protect. This whole thing starts with the thought that the microprocessor was an invention. The microprocessor is not an invention. It is an implementation, a realization. Like going to the moon isn't an invention—it's a realization. To speak of the inventor of the microprocessor is absolutely wrong. This whole thing seems preposterous to me. There is no way that that patent could stand up if challenged.

Nobody heard of him for 20 years and then after all the industry had been created by other people, he comes up with this patent. I never heard of him.

Hyatt, however, states unequivocally that his patent will be upheld, saying, "There is no challenge to my patent right now, just a lot of discussion in the media, to a large degree by people who are not professionals. The Patent Office and Court of Appeals have addressed every conceivable issue that could possibly arise, and we've survived them."

In fact, says Hyatt, his patent may be used to help smaller companies fend off patent suits from larger semiconductor companies. TI, which received a patent for microprocessor work done by its engineer Gary W. Boone, has been aggressively pursuing royalty payments from a number of companies, including Zenith Data Systems. "My patent is probably the best 'prior art' against the Boone patent. I recently announced that I have agreed to be a technical expert and, in fact, witness for Zenith against TI."

Questions That Beget Questions

Many people think that Hyatt's patent has a good chance of standing up to any challenges that are levied against it. But others are posing significant questions and concerns about the validity of his claim.

To be granted a patent, you do not have to turn an idea into an actual product. However, you must describe how to build your creation accurately and clearly enough that others can do so.

Hyatt says that his company did produce some devices as a result of his early work. "There was a whole range of computers. The first one was the breadboard, a fully operating hardware developmental model. I built that in 1968." Hyatt says that starting in 1969, his company began building prototypes that used printed circuit wiring and continued with prototype development and pilot production through 1971, when the company went out of business.

Still, some are asking whether Hyatt revealed enough information in the patent for "one ordinarily skilled in the art" to be able to produce a microprocessor.

Michael Slater comments on this issue, "His patent doesn't describe how to reduce his invention to practice. Furthermore, I believe that an aggressive search will turn up extensive prior art. Hyatt had some fairly straightforward ideas that many other people were working on at the same time. He spent his time and energy writing patent applications and fighting with the Patent Office, while others made the microprocessor a commercial reality."

Another issue is that of allowable changes to the patent. According to Gregory Roth, at the time of the patent's effective filing, its title was "Factored Data Processing System for Dedicated Applications." Hyatt says the title "Data Processing System" preceded this title, but the Patent Office asked that he change it to a more specific description. The title of the granted patent is quite different: "Single Chip Integrated Circuit Computer Architecture."

How much change can you make in a patent application from beginning to end? "Only minor corrections," says Roth. A patent's title is different, however, states Hyatt. "A patent can be amended as long as there is no new matter entered. But changing the title does not make it new matter if the new title finds a basis in the rest of the application.

"The Patent Office restricts patents to a single invention and requires the filing of continuation patent applications on the different inventions. It also requires a descriptive title on each. In addition, the title and the abstract have no legal significance—they are only descriptive to generally show what the claims are directed to."

There also are requests for clarification concerning the extent of Hyatt's changes to his original patent application, to cover new technology that might not have been available when he made his original filing. Hyatt says, "My objectives were to solve LSI [large-scale integration] problems, including chip customization, gate-to-pin ratio limitations, monolithic interconnections on the chip, quantity of transistors on the chip, and number of pin-outs. I also wanted to better apply LSI in computers and in systems. The solution was my microcomputer—a fully integrated circuit computer."

Trevor Marshall, owner and president of YARC Systems, notes, "The U.S. Patent Office doesn't, and can't, do due diligence on patents—only internationally do they do it. A patent in the U.S. doesn't mean anything until it has been defended in court—unless you've got the money to enforce it."

"My prediction about the outcome," says Slater, "is that if Hyatt asks for any significant royalties, the patent will be challenged and overturned."

The Next Round

The busy southern California engineer has a number of projects under way. In fact, he is the owner of some 50 patents. Hyatt's newest patent is for a DRAM-performance-enhancement technology he has developed. According to Hyatt, his method would let DRAM chips run about three times faster than they can in conventional memory architectures.

Another of Hyatt's current projects is something he calls a "personal computer for the twenty-first century." Although he will reveal little information concerning his new type of computer, he says that it will address the issues of presenting large amounts of information to users, with technology based on current understanding of the mind and visual ability.

"It's the tip of the iceberg of some of the technologies that I've been working on," says Hyatt. "There are many disciplines, and they all have to operate in concert to give the performance and the special features that I feel are necessary for the next-generation PC."

A look at Hyatt's previous work may provide some clues to his forthcoming project. In recent years, he has been carrying out research in the area of display technology, and he has a number of patents to show for it. Some theorize that Hyatt is creating a type of new display that lets the user communicate directly with the computer in real time.

What Does It Mean to Me?

Hyatt would not reveal details of his pending agreement with the unnamed U.S. electronics firm, which could involve licensing his patent to chip manufacturers. However, typical royalty rates range from as little as 0.5 percent to 2 percent of revenues. That could add up to several million dollars of royalties for companies like Intel, Motorola, and others, if they decide to pay rather than fight. Those costs would undoubtedly be passed on to consumers, although the bottom line for computer buyers might not be that noticeable.

Hyatt says the royalties will help the computer industry rather than harm it, since the money will finance new ventures that will expand the U.S. technology base. Only time will tell whether patent #4,942,516 will yield enough money to fund Hyatt's new projects. But after 20 years, Gilbert Hyatt has proved that he is, above all else, a very patient—and persistent—man. ■

Contributors to this article include Janet J. Barron, Jeffrey Bertolucci, Howard Eglowstein, Owen Linderholm, Kenneth M. Sheldon, and Tom Thompson. You can reach them on BIX as "neural," "bertolucci," "heglowstein," "owenl," "ksheldon," and "tom_thompson," respectively.

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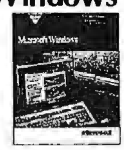

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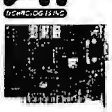

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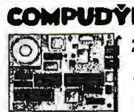

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ETHERNET: TEN YEARS AFTER

The popular DEC/Intel/Xerox standard celebrates a decade of data sharing

Rich Seifert

Imagine a world without networks: no Novell/3Com/TOPS, no clients, no servers. No Token Ring, Ethernet, or LocalTalk. No transceivers, wiring hubs, bridges, or routers. No TCP/IP, no Open Systems Interconnection.

That's the way it was back in 1980. Networks involved either proprietary point-to-point connections or leased lines from the telephone company, and 300-bps modems were standard. This was the environment in which DEC, Intel, and Xerox formed a partnership to develop a network standard, an effort in which I took part. We had to go where no LAN had gone before.

A blank sheet of paper is a scary proposition, but most engineers and product marketers rarely have to work with one. You're usually designing a product that is second- or third-generation—an incremental improvement on an existing concept, a logical extension of existing ideas.

Working on an established field of play can have its drawbacks, too, especially for established players. As Enzo Torresi (president of NetFrame Systems) has said, "The only reason God could create the world in six days was because He didn't have to worry about the installed base." Backward compatibility is the bane of the systems designer. You can't (or shouldn't) ship new products that don't interoperate with the products you shipped last year. It's a great way to lose customers.

We had no such problems with Ethernet in 1980. It was more than a clean sheet of paper—it was an empty book.

An Ethereal History

In the early to mid-1970s, Robert Metcalfe and his group at Xerox's Palo Alto Research Center invented and implemented an early Ethernet system. The system was widely used within Xerox and became a key part of the company's Alto computer system (which was never sold commercially). The Alto was the basis for the later commercial Xerox Star and, in many ways, the Apple Macintosh. During 1979, Xerox, together with DEC and Intel, worked to transform the core Ethernet work done at PARC into a network standard, implementable in silicon and suitable for volume use and manufacture by a wide variety of companies.

Employees from each of the three companies worked together from 1979 through to the publication of the version 1.0 specification in September 1980. Version 2.0 was published in November 1982. The major change in version 2.0 was the inclusion of standard network management capabilities. (For more details, see the text box "Ethernet Basics" on page 316.)

While the original technology was functional, it was not a complete design. The DEC/Intel/Xerox team solved the problems of building large networks, algorithm stability, electrical and system performance, installability, reliability, cost, and so on. The resulting design used the same basic principles as Metcalfe's prototype (it was still a CSMA/CD [carrier sense multiple access with collision detection] bus), but it bore few other similarities. The changes included electrical signaling, cable types, connectors, packet formats, CSMA/CD and back-off algorithm, cyclic-redundancy-check (CRC) calculation, system timing, and network management primitives. The result was a well-specified system (i.e., anyone could build a compatible product from the specifications) that could support all those applications that we thought about but that didn't yet exist.

It Didn't Come Easy

It would be nice if a group of smart people could look at a problem, figure out the solution, write it down, and tell everyone about it. It would also be nice to win the lottery, but the probabilities of the two events are roughly equal.

The Ethernet *Blue Book* published in 1980 contained just the results of all the discussions, tests, mistakes, and negotiations that went on for more than a year before the release. There were more variations than you can imagine. At various stages in its development, Ethernet had preambles from 1 to 64 bits long, a variety of different collision-detection methods, 16-bit CRC, high-level data-link control (HDLC) framing (i.e., flag characters and bit stuffing), and address lengths of from 32 to 64 bits.

This last item is especially interesting. With a 48-bit address

Ethernet Basics

Ben Smith

Is Ethernet that coaxial cable that connects the computers in a LAN, or is it what goes through the cable? Some of each: It is the *definition* of how the data is transferred, and also the definition of one of several possible physical media and connections: thick-wire Ethernet. Other variations, such as thin-wire Ethernet ("Cheapernet") and unshielded twisted-pair Ethernet (UTP—10 Base-T), are not really Ethernet. These are alternative IEEE 802.3 specifications for the physical layer.

However, networking is not so much about the wires (or fiber optics) that connect machines as it is about how the machines communicate—i.e., the protocol. The machines must be using the same set of rules to communicate.

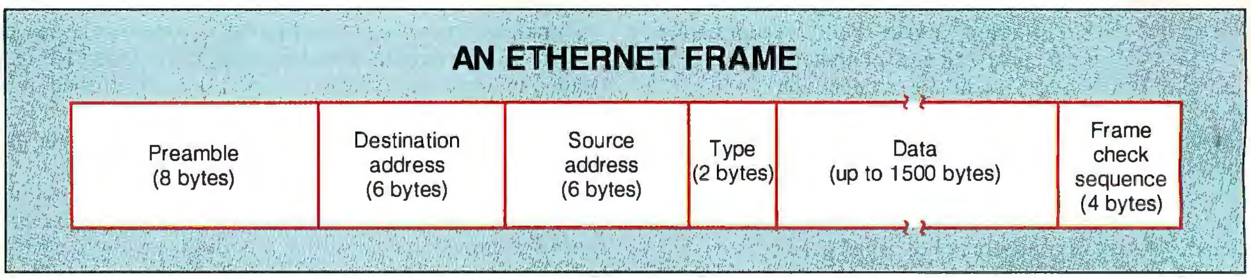
The issue of what "the rules" are can become an intermanufacturer political and marketing issue. To solve such issues, standards are developed by industry groups and committees such as the IEEE.

Ethernet is the former type of standard, made by industry groups. It specifies a CSMA/CD (carrier sense multiple access with collision detection) bus network. CSMA/CD is a technique of sharing a common medium (the cable) among several devices. It is based on the same etiquette that makes for a polite group conversation: "Listen before talking." Of course, even when people are trying not to interrupt each other, there are those embarrassing moments when two people accidentally start talking at the same time. That is essentially what happens in networks, where such a situation is called a *collision*.

If a node on the network detects a collision (by receiving too strong a signal), it alerts the other nodes by jamming the network. Then, after a random pause, the sending nodes try again. There is no aknowledgment of messages at this level of network communications.

The messages are technically called *frames* (see the figure). It is on the definition of a frame that IEEE 802.3 and Ethernet differ. This is also part of the MAC (media access control) layer of the network specification. A frame consists of an 8-byte preamble, a 6-byte destination address, a 6-byte source address, a 2-byte type field (used by higher-level protocols to identify a specific type of frame), a data field of up to 1500 bytes, and a 4-byte frame check sequence, which contains the CRC (cyclic redundancy check).

Ben Smith is a technical editor for BYTE. You can reach him on BIX as "bensmith."



length, you need some form of address administration to ensure that no two stations have the same address. Ethernet does this by allocating blocks of addresses to vendors, who are then individually responsible for assigning unique addresses to their products. If Ethernet had a 64-bit address space, a station could select an address at random, and the probability that two stations on the same network would have the same address would be insignificant. (We went through the mathematical analysis 10 years ago and proved it, at least to ourselves.) "But no one would have believed us," says Bob Printis, manager of systems architecture at PARC (and one of the few team members still with their original company). "We would have had to fight an endless battle on that one."

Ultimately, an Ethernet scheme of 48-bit universal addressing was accepted and adopted by the IEEE 802 and fiber-distributed data interface (FDDI) network standards. This was especially painful for Printis, who initially inherited the responsibility of assigning the vendor address blocks correctly.

The First Reviews

When the Ethernet technology was first exposed to the market, it drew lots of criticism. People said, "It's overkill. It costs too much. I don't understand it. It's too complicated."

Of course, all this was true. In the years 1980 through 1982, no one needed a network with a data rate of 10 megabits per second. There was hardly a computer around that could keep up with that, much less do anything useful with the information at that speed. (A common technology in use at the time was Corvus Systems' Omninet, a 1-Mbps twisted-pair bus, used primarily for disk sharing among Apple II computers.) Ethernet controller boards cost from $1000 to $4000, without software, transceivers, and so on. And, for the time, it *was* complicated.

However, we were planning for the future. We had to resist the temptation to develop merely what the market needed at the time. Ours was a vision of distributed databases, interoperability, and multivendor networks that exceeded the capabilities of simple technology. We wanted to build an infrastructure that could support the development of a wide variety of applications and have a long-enough product life to allow those applications to grow without having to tear out the underpinnings every few years. Not doing that would be like building a two-lane road to a new frontier; it will get you there now, but it will be obsolete by the time the frontier is developed. Better to build a superhighway and let it be empty for a while; there will be people to use it soon enough. (No surprise that two-thirds of the Ethernet triumvirate were in California.)

continued

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It's interesting that we aren't hearing the same complaints today about FDDI—other than cost, of course. That's because we've learned the Ethernet lesson of letting the market and applications develop to use the technology as it matures.

FDDI-based systems today do not take full advantage of the technology; neither the available silicon, the protocols we commonly use today, nor the attached systems can truly exploit the full capability of the channel. But the FDDI community is thinking and planning for the future. It learned from the Ethernet experience how fast one can go from overkill to underpowered.

Keeping an Open Mind-Set

The original Ether-thinking wasn't designed to give a competitive advantage to its developers. From the beginning, the design

We've learned the Ethernet lesson of letting the market and applications develop to use the technology as it matures.

and architecture were open. The developers thought that any disadvantage incurred by allowing competition to flourish would be offset by the increase in the size of the total market. Networking is only truly useful when everyone does it, and even a small piece of the pie is adequate if the pie is huge.

When designing Ethernet, we used a 20-year product life as our model, expecting that installations and quantities would ramp up over the first five to 10 years and then taper off as middle age set in and some new technology emerged. This was before there was even a complete system design: no silicon, no independent networking companies, no applications, nothing. We saw Ethernet as the UART of the 1990s. (UART, which stands for universal asynchronous receiver/transmitter, is the key component of a serial port.) In 1980, no reasonable manufacturer built a computer without an RS-232C port. Even if you didn't have an immediate use for it, you put one in anyway, because it gave your users flexibility. Our vision was that, in 1990, computer manufacturers would put networking into every machine, for the same reasons.

Virtually all of that vision has come true. Look at Sun workstations, DEC VAXes, and Macs. In each case, networking is an integral part of the product. Every Sun comes with an Ethernet port, and every Mac with a LocalTalk connection. The only way to connect terminals to (the larger) VAXes is through Ethernet, terminal servers, and local-area transport. The LAN business exploded during the 1980s, in parallel with PCs, to totally transform information technology. LAN hardware, LAN value-added resellers, third-party installers and support, thousands of software applications—none of these could have existed without the core technology and standards.

What may be more interesting are all the things we didn't foresee that have affected our business. For example, according to Bob Printis, no one predicted the emergence of twisted-pair

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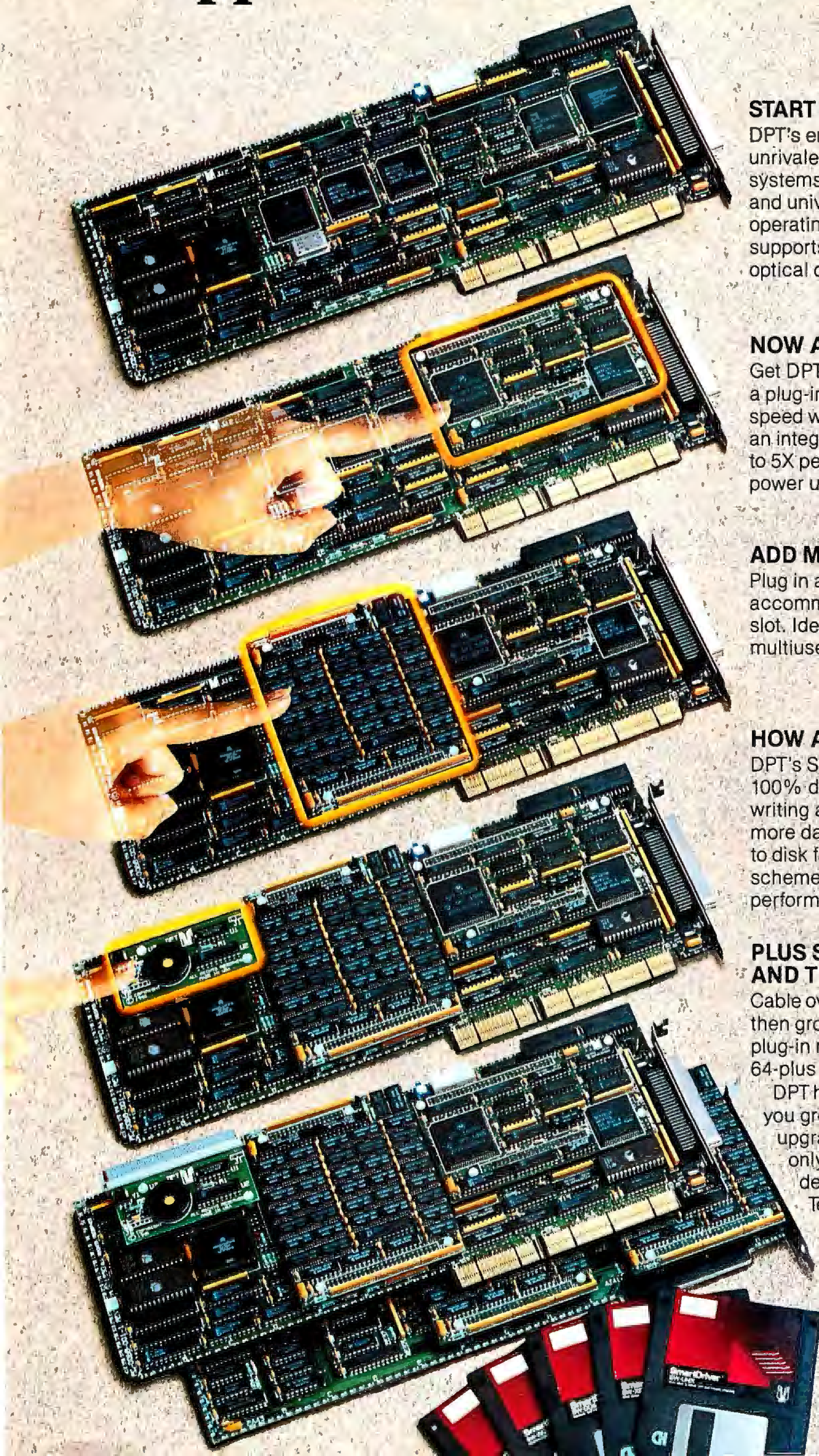

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As LANs became a commodity, people became more concerned with "mundane issues."

as the medium of choice. The original Ethernet was coaxial-cable based. This invariably required the installation of new cable to implement an Ethernet LAN.

As LANs became a commodity, people became more concerned with "mundane issues" such as wiring up one's building. Issues like these have become much more important than the communications system in use on that wire; you only get one chance to do it right. Today, twisted-pair wiring is popular, based not on data rates or electrical characteristics, but on ease of installation, reconfiguration, and cable management.

During the Ethernet design, we never realized the extent to which these issues would overshadow electrical performance. Compared to coaxial cable or fiber, twisted-pair has worse noise performance and higher bit error rates and can run at LAN data rates only over much shorter lengths. But users are willing to live with these restrictions in exchange for the administrative advantages it offers. As in many other facets of life, people are willing to give up a lot for convenience.

So Who Cares?

If you look at back issues of BYTE (or any publication covering the networking industry between 1980 and 1984), you will find articles touting the superiority of baseband over broadband (or broadband over baseband), or of Token Ring, Ethernet, Token Bus, Slotted Rings, and so on, over one another. There were arguments over such minutiae as preamble bits, frame formats, type and length fields, checksum algorithms, and address lengths. You don't see these anymore. The network wars are over, and everybody has won. (Well, almost everybody.)

When networking consisted solely of technology, technology was the subject of controversy. The basic building blocks of our business were just being cast, and everyone argued over the shape and color of the bricks. While all these things were ultimately decided, it turns out that it really didn't matter what the decisions were. The important thing today is that they were decided and we could get on with the business of networking.

Today, hardly anyone cares about the technology as long as it works. There are only three things users really care about:

1. What applications can I run on my network?
2. How should I wire my building?
3. How do I manage the network effectively?

Users are not concerned with the shape of the connector, the color of the cable, or the formats of the bits on the wire. It's not

Token Ring versus Ethernet; it's applications that run on Token Ring versus applications that run on Ethernet.

To the extent that applications, wiring systems, and network management are technology-independent, the underlying network characteristics become invisible and unimportant. The only vestige of their presence is performance. But there is rarely a perceptible performance difference once all the layers of software, server bottlenecks, and disk latencies are inserted between the user and the wire.

What Would We Change?

If the original Etherneters could change anything, what would they change?

Dave Redell, originally principal scientist with Xerox Business Systems and now a member of the research staff at DEC's Palo Alto Systems Research Laboratory, would have set the maximum packet size higher than the current 1500 bytes. "There was nothing magic about that number," said Dave. "It was a compromise. The main concern at the time was the cost of memory."

During the specification discussions, the packet size limit varied from around 600 bytes to as much as 10K bytes. Longer packets make for more efficient channel utilization, but they also increase the probability of an error in the packet and a collision on the next packet. However, the overriding concern at the time was that simple (read "cheap") controllers would allocate a fixed, maximum-size buffer for every received packet. With 1K-bit and 4K-bit RAMs the norm (this was 1979, remember?), that was a major concern. So, we compromised. The 1500 bytes allows for 1K bytes of user data, plus any reasonable protocol overhead. "If it were longer, large file transfers would be faster, and we might have avoided some of the Token Ring–to–Ethernet bridging hassles," laments Redell.

Bob Printis would have included a length field and avoided the Ethernet versus IEEE 802.3 wars. [Editor's note: *IEEE 802.3, while based on Ethernet, included some differences that made the two incompatible. Despite the well-intentioned efforts of the IEEE, the de facto Ethernet standard is far more widely used than the official standard.*] The only significant difference between Ethernet and IEEE 802.3 is the IEEE standard's use of the length field versus Ethernet's use of a type field. The two can be made to at least coexist by assigning all type field values to be numerically greater than the maximum length of 1500 bytes.

Personally, I would have saved every Ethernet user a lot of grief by not specifying the dreaded slide-latch connector (used on the cable between the station and the transceiver). We really had good intentions. I was fed up with RS-232C connectors that fell off because the tiny screwdriver necessary to tighten them down was never handy. I just didn't realize that the slide latch was so flimsy and unreliable until it was too late. Ethernet installers around the world must curse me every day. ■

Rich Seifert is president of Networks and Communications Consulting. Formerly with DEC and Industrial Networking, Inc., he is coauthor of the Ethernet specifications (versions 1.0 and 2.0) and the IEEE 802.3 and 802.4 standards. He can be reached on BIX c/o "editors" or on Usenet at seifert@asylum.sf.ca.us.

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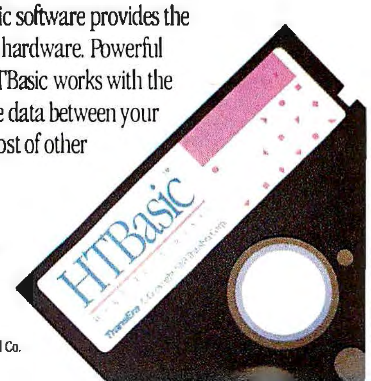

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FLEXOS'S MUSCLE

FlexOS may look like MS-DOS, but that is where the similarity ends

Ben Smith

PART Six

FlexOS, from Digital Research (remember CP/M?), is a real-time, multiuser, multitasking operating system particularly suited for point-of-sale applications. The basic utilities look and behave just like their MS-DOS counterparts (e.g., COPY, CHDIR or CD, and TREE), but the underlying functionality of the operating system is from an alternate reality.

FlexOS is rich with features for both applications developers and users (e.g., X/GEM, the multitasking version of the GEM graphical user environment). Concurrent processes can share the same program image. Files have read, write, execute, and delete privileges for three user classes: Owner, Group, and World. The list of advanced operations is far greater than the list of elements of DOS compatibility. FlexOS with all its options is a solid, attractive, and familiar world for any real-time application.

At the Core

Unlike MS-DOS, FlexOS is a protected-mode operating system that takes advantage of 286 and 386 processors. It uses DOS media for its files. It recognizes DOS file systems, making the exchange of DOS and FlexOS files totally transparent. The 386 version even has a DOS applications environment, allowing you to run DOS applications in protected mode under FlexOS. The core of FlexOS consists of the *supervisor* and the *resource managers*. The supervisor controls the flow of requests from application programs. It handles CPU and memory-related requests with its kernel and passes device-related requests on to the resource managers as appropriate (see the figure).

The resource managers provide the administrative glue between the supervisor and the device drivers. There are separate resource managers to control the disk drives, pipes (interprocess communications), network facilities, the console, and a collection of miscellany, including communications with serial terminals and parallel printers.

In some ways, the process management is similar to Unix: Each process has a process ID and a family ID. Spawned processes retain the family ID of their parent. Besides spawning a new process (which runs concurrently with the parent), you can create a subroutine process (running in series with the parent). In this latter case, a new process ID is not created, and the calling process sleeps until the subroutine is finished. FlexOS also allows you to chain processes together; in other words, the calling process becomes the called process. All child processes can share memory with their parent processes.

At the heart of the supervisor kernel is the event-driven *dispatcher*, which responds to interrupts and schedules processes in the following way:

- All asynchronous service routines are run to completion, one at a time.
- Each standard process is run for its slice of time. These are run in the order of the priority levels in the process table.

Unlike Unix, FlexOS yields both system and user processes to interrupts. This way, FlexOS supports real-time asynchronous I/O in its application programming and device driver interfaces. An interrupt service routine is allowed to take control once the CPU state has been saved.

Once the time-critical operations are complete, the interrupt service routine can pass its activities on to an asynchronous service routine, which has a priority like the user processes. At this point in interrupt handling, the control returns to the dispatcher. FlexOS also provides a polling mechanism for non-interrupt-driven device drivers.

Applications for FlexOS must be polite about memory usage, because the operating system does not swap user process space out to disk. If a program isn't using some of its allocated memory, it should free it so that other processes can use it.

The FlexOS memory model treats system processes differently from user processes. System processes (e.g., supervisor, resource managers, and drivers) run without parameter-bound checking and have direct access to system hardware; memory addressing is direct. A user process runs with full protection and is isolated from any direct access to hardware.

For the Developer

The primary applications development language for FlexOS is C—specifically, the MetaWare High C compilers. This is supplemented with Digital Research's RASM-86 relocatable code assembler and LINK86, its corresponding linker.

The kicker for the FlexOS development environment is the FlexView windowed symbolic/source code debugger. A good symbolic debugger can make the difference between painful applications development and fast, efficient applications development—particularly for programmers who are new to the operating system and libraries.

The basic programming interface to FlexOS is provided by supervisor calls, the counterpart to Unix system calls. (Table 1 is a summary of the SVCs.) For example, to change the priority of a process from 200 to 100 (a higher priority), you would SET the `prior` field of the process table entry for a process. (When the COMMAND SVC creates a user process, the default priority is 200.) Many of the fields in a system table (see table 2) are read-only. In fact, the `prior` element is the only field that you can change in the process table.

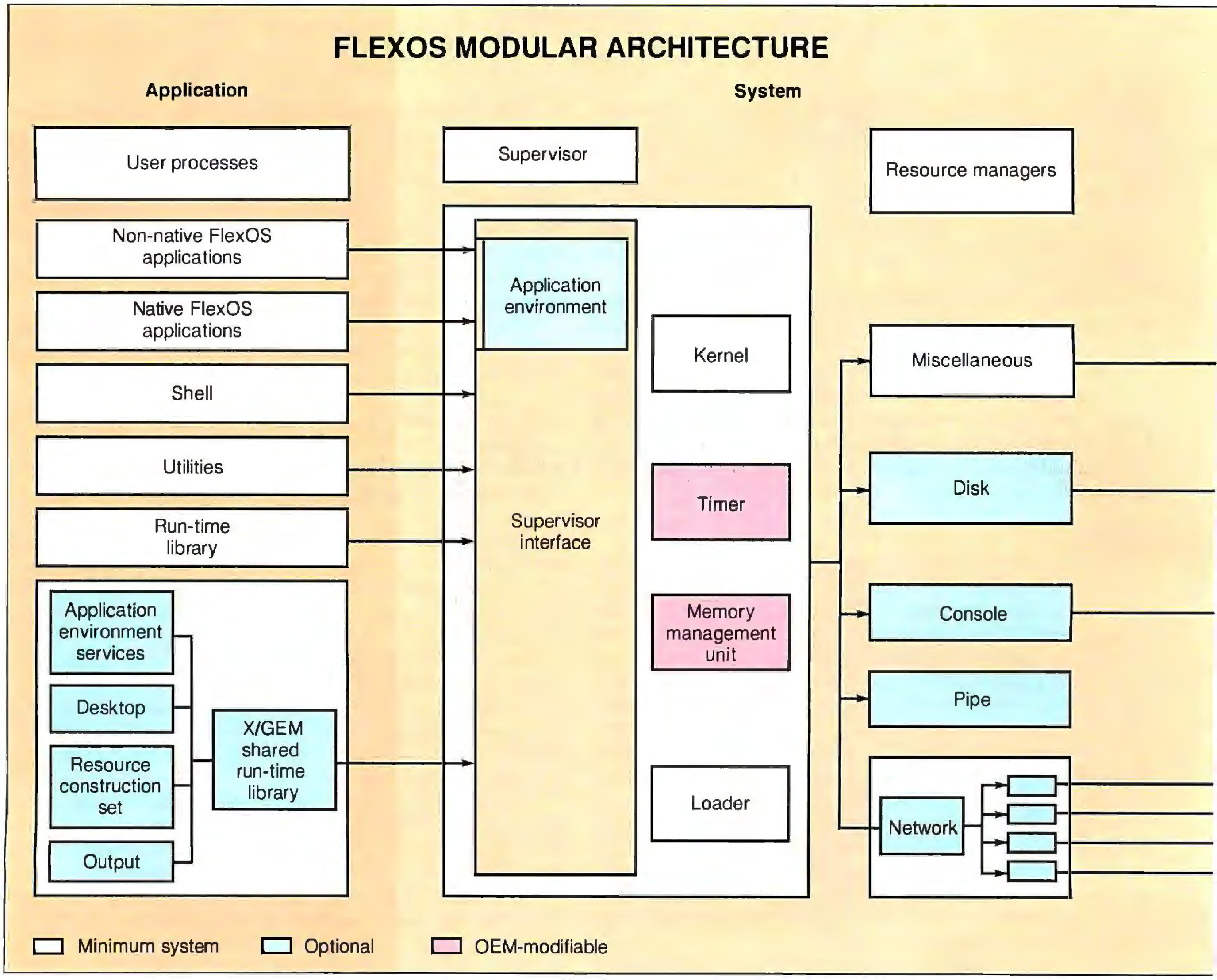
The system comprises application services, a supervisor, resource managers, and their associated drivers and subdrivers.

Control from the Command Line

Many of the facilities that are available to the programmer through SVCs are also available to the user through shell commands and utilities. For example, the information of the process table is available through the PROCESS command. Unfortunately, you can do little more than view entries in the process table and kill processes. There is no way at this level of FlexOS to change the priority of a process or to move a background process into the foreground.

Although there are far more commands available to the FlexOS user than there are for the MS-DOS user, the script language has the same flow control and syntax as DOS .BAT files, with one notable extension: BATCH. The BATCH command allows nested scripts, meaning a .BAT file can be used as a subroutine of another .BAT file.

The interactive command interpreter has a command his-



tory. You cycle through the history list using a search string. As any user of the Unix Korn shell will tell you, this is a great time saver when you are doing system administrative chores. Another convenience is the ability to load device drivers without rebooting the system.

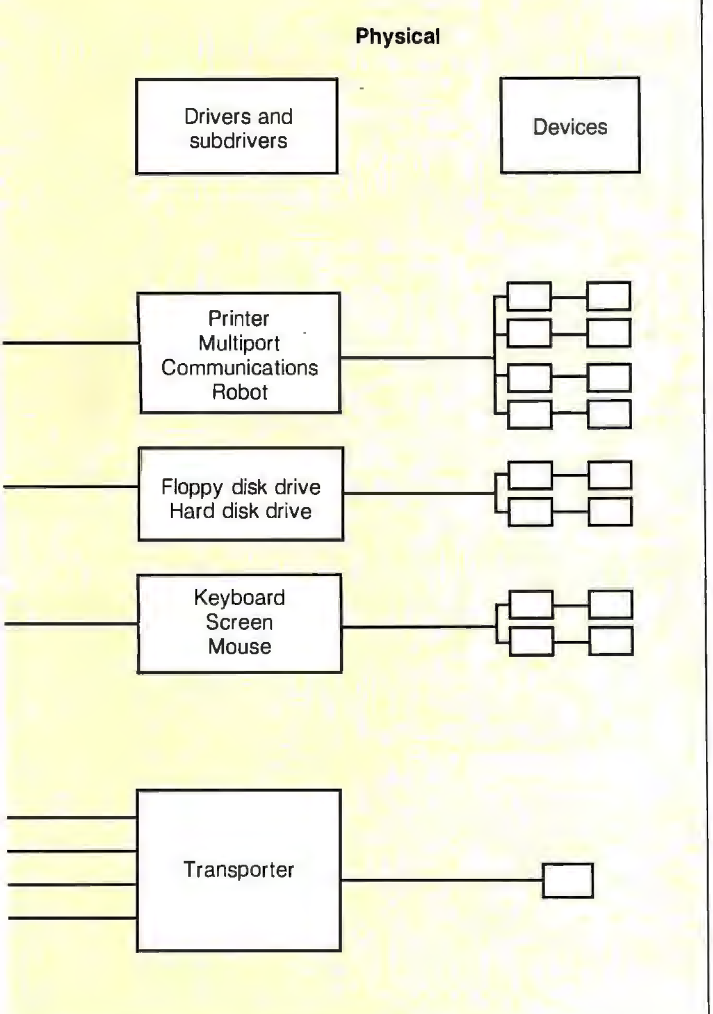
Several Unix utilities are part of FlexOS, including `pr`, `grep`, `split`, and `paste`. The impression you get at the command level is that FlexOS is MS-DOS with Unix extensions for multiuser, multitasking operation.

Valuable Modules

Most of the alternative operating systems that we have covered in this series have provided only functionality; they have left aesthetics as an exercise for the developer. This is not the case with FlexOS.

Digital Research has ported its valuable GEM graphical user interface (GUI) to FlexOS. This version is called X/GEM but still looks the same as the MS-DOS version, including a window manager, a file manager, and several utilities. (X/GEM requires more memory than your basic 640K-byte system.)

The value that X/GEM adds to the GEM of MS-DOS and the Atari ST comes from the use of the underlying multitasking of FlexOS and support for sophisticated intelligent graphical



FLEXOS SUPERVISOR CALLS

Table 1: *The basic programming interface for FlexOS is provided by supervisor calls.*

SVC	Purpose
	File management
CREATE	Create a file.
DELETE	Delete a file.
OPEN	Open a file.
CLOSE	Close a file.
READ	Read a file.
WRITE	Write to a file.
RENAME	Rename or move a file.
DEFINE	Define logical name for a path.
LOCK	Lock/unlock an area of a file.
SEEK	Modify or obtain current file pointer.
	Console file management
COPY	Copy one screen rectangle to another.
ALTER	Alter a screen rectangle.
XLAT	Specify keystroke translation.
	Event management
STATUS	Get status of an asynchronous event.
RETURN	Get return code of completed event.
WAIT	Wait for multiple events.
CANCEL	Cancel asynchronous event.
	Process management
COMMAND	Perform shell command.
CONTROL	Control a process for debugging.
OVERLAY	Load overlay from command file.
TIMER	Set and wait for timer interrupt.
ABORT	Abort specified process.
EXIT	Terminate with return code.
ENABLE	Enable software interrupts.
DISABLE	Disable software interrupts.
SWIRET	Return from software interrupts.
EXCEPTION	Set software interrupts on exceptions.
MALLOC	Allocate memory to heap.
MFREE	Free memory from heap.
	Device management
SPECIAL	Perform special device function.
DEVLOCK	Lock/unlock device for user/group.
INSTALL	Install, replace, and associate drivers.
	Table management
GET	Get table values.
SET	Set table values.
LOOKUP	Scan and retrieve tables.

ITEMS DISCUSSED

FlexOS ....(Contact vendor for pricing)
Digital Research, Inc.
OEM Sales
4401 Great America Pkwy., Suite 200
Santa Clara, CA 95054
(408) 982-0700
Inquiry 1008.

FLEXOS SYSTEM TABLES

Table 2: *The key to system control in FlexOS programs lies in system tables, data structures that contain information about the status of the system. To operate on system tables, you use the supervisor calls GET, SET, and LOOKUP (see table 1).*

Table	Contents
PROCESS	Process information
ENVIRON	Process environment
TIMEDATE	System time of day
MEMORY	System memory use
PIPE	Pipe information
SHMEM	Shared memory information
DISKFILE	Disk file information
DISK	Disk device information
VIRCON	Virtual console information
SYSTEM	Global system information
FILNUM	File numbers table
SYSDEF	System logical name table
PROCDEF	Process logical name table
CMDENV	Command environment
DEVICE	Device information
PATHNAME	Full path name
SRTL	Shared run-time libraries information
MOUSE DT	Mouse driver table information
VDIPRN	VDI printer device information
PORT	Port device information
SPECIAL	Special device information

hardware. It is compatible with existing GEM applications.

There is an optional network extension to FlexOS that allows several FlexOS systems to share disks, printers, and communications pipes. The underlying transport and low-level protocol is not defined. Digital Research distributes drivers for IBM Token Ring Adapter and TCP/IP on Ethernet.

Nearly everything in FlexOS is modular. Not only are the device drivers, networking, and the GUI and application programming interface modules, but the basic system is broken into submodules that can be installed as needed. The whole system can be stripped down to the point that it can be put into ROM, a requirement for factory-floor and point-of-sale devices. FlexOS data-entry devices and "cash registers" can boot and run entirely from ROM; the transactions are sent across the network to another device that has mass storage and appropriate administrative programs.

FlexOS was not designed as a DOS clone, nor is it marketed as one; it is for multitasking and multiuser applications. Nor is it designed as a simple Unix substitute; it is a real-time operating system that necessarily lacks much of the complexity of Unix. Digital Research has been in the business of making operating systems since the beginning of the microcomputer era, and in many ways it is responsible for early acceptance of the microcomputer. It has also been making multiuser operating systems from those early days. The company's experience is quite apparent in FlexOS. ■

Ben Smith is a technical editor at BYTE and the author of Unix Step by Step *(Howard Sams, 1990). He can be reached on BIX as "bensmith."*

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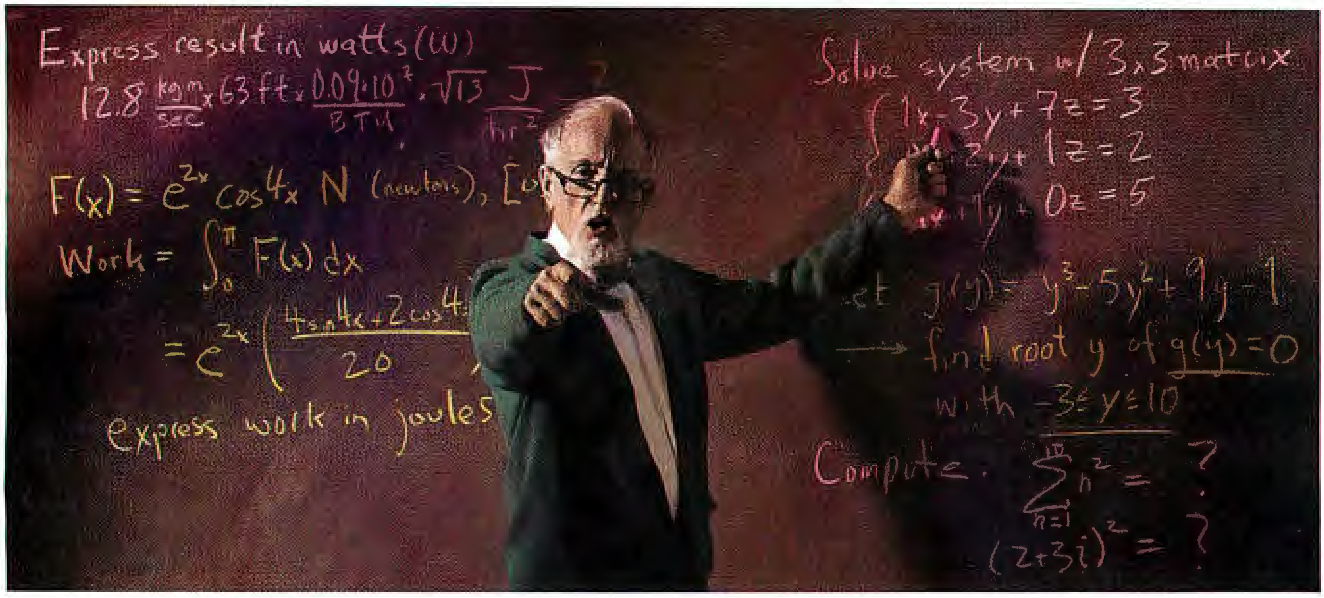

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THE OBJECT-ORIENTED AMIGA EXEC

A close look at the object-oriented core of the Amiga operating system

Tim Holloway

O*bject-oriented* is the computer buzzword for the early 1990s. It's the latest Holy Grail, which will let programmers leap tall buildings in a single bound, cure world hunger, and produce 100,000 lines of fully debugged code a day.

Well, maybe not. After all, AT&T invented one of the premier object-oriented programming languages, C++, and was unable to get release 2.0 out within a year of its predicted release date. Nevertheless, there is no question that OOP is a Good Thing, and producers of operating systems have been furiously recoding their products as object-oriented systems, generally using C++.

Yet there is one object-oriented operating system that has been in widespread use since 1985. It runs Commodore's Amiga, although, ironically, it was not written in an OOP language.

Amiga Exec—An "OOPS" Design

The Amiga's operating system is sometimes incorrectly referred to as AmigaDOS. Actually, the Amiga operating system has three major components: Exec, the multitasking kernel; AmigaDOS proper, which provides the high-level file systems and Command Line Interface; and Intuition, the basis for the graphical user interface (GUI). I'll be discussing only the Amiga Exec. Of the three, it is the most object-oriented and the most comparable to the C++ programming language.

That may seem surprising. Aren't GUI's what made OOP so famous? Well, yes, but there's more to OOP than simply dealing with data objects that correspond to graphical images. More on this later.

Although many Amiga features have a potentially unlimited number of elements, the absolute minimum RAM that the Amiga system software requires is a fraction of what many comparable systems require; even counting the ROM part of the operating system, the memory consumed is only about 512K bytes (although newer Amigas can support larger ROMs).

So what's missing from the Amiga operating system that makes it so small? How does the Amiga manage to provide multitasking and windowing services in less than one-half to one-fourth the memory that Apple and IBM computers need? The answer lies in *minimal redundancy*.

If you examine the internal structure of many popular operating systems, you'll discover that it's "OS versus them." That is, you have this somewhat monolithic block of stuff that is the core operating system, some additional voodoo acting as device drivers and the like, and applications code—and only an uneasy truce ever lets them meet. Even though the operating system may itself be composed of many components, its appearance to the applications programmer is still essentially as a rather mysterious edifice, beyond which only selected portions of applications software may go.

The Amiga operating system is different. Relatively few parts of it are totally opaque; in fact, with later revisions of the operating system, the trend has been to further open its internals for applications use. This is even more surprising considering that, unlike the Macintosh, the Amiga runs its applications in the nonprivileged state.

No Magic

Most present-day operating systems operate as if the operating-system code is "magic"; that is, it spends most of its time running in privileged states, inhibiting interrupts, executing arcane instructions that are incomprehensible to mere mortal applications programmers, and otherwise doing things that are completely outside the scope of applications programming. That isn't really true.

Very little operating-system code is truly magic; most of it deals with managing tables, lists, queues, and other such mundane tasks. However, since these are operating-system tables, lists, queues, and so forth, they are generally managed with special routines that run in privileged, noninterruptible, memory-managed, or otherwise arcane environments.

What tends to be overlooked is that it is often possible to take all the "magical" parts of code and separate them from the "nonmagical" parts, resulting in a set of controlling routines to switch modes, and a lot of data-handling routines that look suspiciously similar.

This situation means that, first, there exists the possibility that general-purpose versions of some of these routines can be created to replace all these similar-but-not-identical functions; and second, since these routines are no longer magic, they can be accessible to application programs as well, reducing their overall size and complexity, to say nothing of the time saved by using pre-debugged code.

Using general-purpose code for critical operating-system functions might seem like heresy to some—after all, aren't "general-purpose" and "efficient" mutually exclusive? The answer appears to be no, or more accurately, "If it's general-purpose and it's not efficient, perhaps it's not general-purpose enough." What usually wastes time in general-purpose code is all the testing and branching that it has to do to handle the variations of data structures it processes.

Where does OOP come into all this? The answer lies in the principle of inheritance. By arranging the system data structures much as we did for system code in traditional systems and by placing related data items in a common sequence, we gain two advantages: a reduction in the amount of special-case processing that was so offensive, and the creation of a hierarchy of data object classes. As a side effect, the system becomes easier to understand—there are fewer unique functions.

An Inside View

Exec, as mentioned earlier, is the nucleus (or kernel) of the Amiga operating system, and it is realized in just such a manner. Exec consists of a collection of increasingly complex object classes, as can be seen in figure 1. When a new Exec object class is defined based on a simpler class, it contains all the data objects of the simpler class and also is (usually) valid for not only operations defined for that class, but for all operations pertaining to the simpler class, as well. This is known as function *inheritance.*

Exec's heavy reliance on inheritance is what makes it so compact. It does not contain separate sets of routines to manipulate tasks, I/O devices, intertask messages, and so on; instead, it contains basic routines to handle collections of objects—be they task objects, device objects, or whatever—and adds functions only where additional support is required. In contrast, many operating systems contain a collection of task routines (including those required to manage the task table) and a collection of device routines (including those required to manage the device table), and so forth.

There are many ways to represent collections of data internally, each with its own advantages and disadvantages. Exec is based on the doubly linked list. The list elements are allocated dynamically from anywhere in RAM that's convenient (see the section on memory management); therefore, there are no tables to fill up. On the other hand, access speed is highly dependent on the number of nodes in the list, but there are ways to reduce that problem, as I'll explain later.

The Amiga operating system distinguishes itself in that the operating system itself provides support for doubly linked lists. Exec supports two levels of lists: lists and MinLists. (The Lattice C++ implementation adds two more that are similar to the standard Exec lists, but without automatic initialization.) These are used to define items that the Amiga system software initializes.

The MinList is the anchor to a doubly linked list of MinNodes. MinNodes contain next and previous MinNode pointers. The MinList structure contains a pair of dummy MinNodes to simplify processing by reducing special-case logic required to process items at the ends of the list. An empty MinList always consists of two MinNodes—the dummy nodes at the front and the end of the MinList—both of which are contained *within* the MinList data structure itself. The dummy front node's next-node pointer points to the actual first node of the list. Its previous-node pointer is always NULL.

A similar situation exists in regard to the dummy end node. Since the dummy front node's previous-node pointer is always NULL and the dummy end node's next-node pointer is also always NULL, it was possible to save a small amount of memory by making them overlap by sharing the same NULL pointer. Dummy MinNodes do add one complication: The last actual item of the list is not the one with the NULL next-node pointer: That honor belongs to the dummy node.

A complete set of functions exists to support insertion and deletion of MinNodes at either end—or points in between—of a MinList. By using the proper functions, therefore, a MinList can be used as a first-in/first-out (FIFO) (also known as a queue) or as a last-in/first-out (LIFO) (also known as a stack), as well as a general-purpose list.

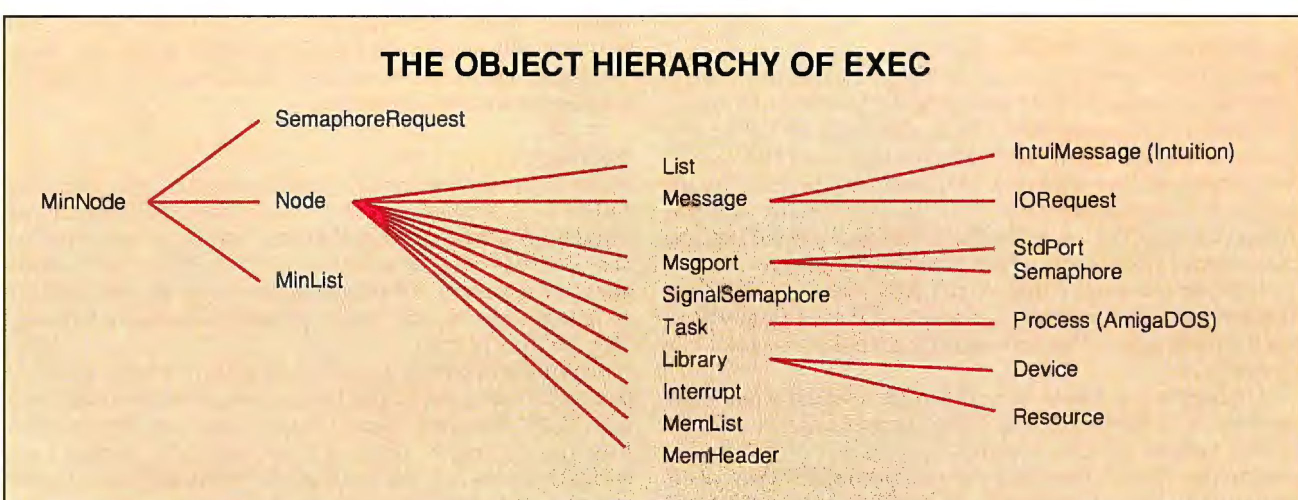

Figure 1: *The nucleus of the Amiga's operating system consists of a collection of increasingly complex object classes.*

Once again, note that there is nothing magical about MinLists, MinNodes, or any of the functions that act on them. Although they are extensively used by the Amiga operating system, they can be used just as freely in any application program.

Friends and Members

A note about C++ *friend* and *member* functions. When a class is defined in C++, its internal components are (unless otherwise specified) protected from casual access. This is a strong selling point; it makes it harder for an object's innards to be corrupted and easier to locate the responsible function. To make practical use of (and to alter) the information within a class object, therefore, some sort of access mechanism is required. C++ provides two: a friend function, which is like a traditional C function, except that by having been declared a friend of one or more classes, it is allowed to directly access the data stored within that class or classes; and a member function, which is actually owned by a specific class and therefore has an "invisible" extra parameter passed to it: "this," which is a pointer to the class object being acted on.

Exec was designed to be used by non-OOP languages; thus, the Exec functions are, in effect, friend functions. The `#include` files made up by MTS Associates to support C++ on the Amiga generally define them as such. However, to better support Exec in its capacity as an object-oriented system, a number of member functions were also defined. For example, virtually every object in the Amiga is in some sort of list, so most objects have a member function named `next()`. No matter what it is, no matter how it's linked, and no matter what the name or relative location of the object's next-item pointer, you are thus always guaranteed that you can get a pointer to the next one in the list by using the `next()` function.

Lists: MinLists and Then Some

A list is an extended MinList, made up of nodes. The nodes are MinNodes plus a 1-byte type field, a 1-byte priority, and a pointer to the node's name, which is a C-format string. Figure 2 shows the structure of a node. A node incorporates the structure of a MinNode, and thus automatically inherits the properties of a MinList to form a list.

Subsequently, a list can use all the MinList functions. A list can be maintained as a FIFO or LIFO, just like a MinList. However, a list can also be maintained in priority sequence, courtesy of the list friend function `Enqueue()`. If the nodes in the list are given names, it is also possible to search the list for the first/next node of that name. This can be very useful, as it's how Exec locates a number of public objects.

Signals

Signals are represented by a 32-bit word containing a pattern of signal flags. There are 16 that are allocatable to the user and 16 reserved by the operating system. When a task signals another task and the other task is in a signal wait state, the receiving task's incoming signal information has the incoming signal bits logically ORed in. This is then ANDed with the recipient task's pattern of signals that it is waiting on. A nonzero result causes the task to become dispatchable.

This is an extremely efficient way to activate a sleeping task, and it can be done at any system level, including in interrupt routines, which are denied many of the more sophisticated system services.

Messages

Figure 3 shows how a message is constructed from a node. Messages are extremely important in the operation of the Amiga. They are used to pass information from task to task, as the basis for I/O requests, and as the medium of transfer for Intuition's mouse and window events. Unlike a signal, which can merely give an "I'm here!" indication, a message can have complex information piggybacked on it.

A message is an extended node and is usually transmitted to a message port (MsgPort), another type of node that contains a list of incoming messages to be serviced, in priority order (see figure 4). MsgPorts can be private and anonymous, or they can be added to the system message port list. Frequently, they occur in pairs (one of each), since after a message is serviced, it is common to forward it to a reply MsgPort, where it is generally recycled or discarded—although it is possible to bounce a message through a whole series of ports. There are several different ways to implement a MsgPort, but the most common way is sup-

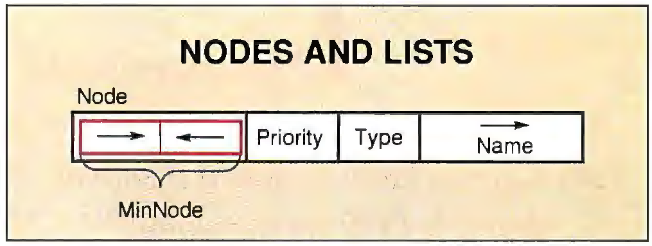

Figure 2: *Nodes can be located by name and arranged in priority order. Nodes are anchored by lists. Since a node incorporates a MinNode, it inherits all the list properties and functions.*

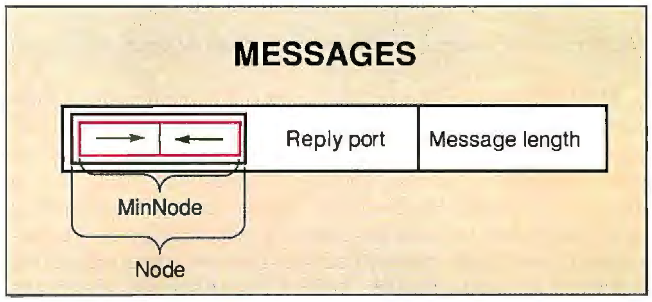

Figure 3: *The Amiga operating system uses "messages" to pass information from task to task, as the basis for I/O requests, and as the medium of transfer for Intuition's mouse and window events. A message incorporates a node and therefore inherits all its properties and functions.*

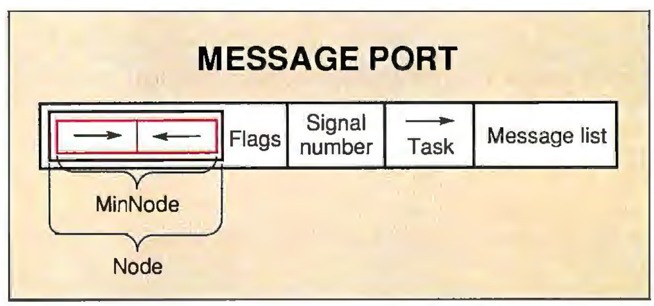

Figure 4: *A message is transmitted to a message port, which contains a list of incoming messages to be serviced, in priority order. Like messages, message ports incorporate a node and therefore inherit all the properties and functions of a node.*

If you examine the internal structure of many popular operating systems, you'll discover that it's "OS versus them."

ported by a special C++ class named the StdPort—or standard message port—which can be created and initialized by coding

```
StdPort *listener = new StdPort ( "I hear you" ) ;
```

The StdPort constructor takes care of all the details of standard MsgPort initialization. Memory is allocated and initialized, and a signal is acquired on which the listening task can wait. Using the AddPort function, the MsgPort can be put on the system's public MsgPort list, where it can be found by any task that wishes to send it a message. Because Exec was designed in an object-oriented manner, the new operating-system functions are quite simple. A C++ reconstruction shows the following:

```
void AddPort ( MsgPort *mport )
{
 Forbid() ;// disable task-switching
 Enqueue ( AbsExecBase->PortList , mport ) ;
 Enable() ;// re-enable task-switching
}
```

Here's a reconstruction of another system function:

```
MsgPort *
FindPort ( const char *portname )
{
 return ( MsgPort *)
   AbsExecBase->PortList.find ( portname );
}
```

FindPort illustrates another important design feature. If you searched a system list every time you wanted to access an element in that list, system performance would suffer. Instead, the convention is to search and return the object's address. Thereafter, the object's address can be used directly (the Amiga does not use Macintosh-style handles, which cause objects to shift about in memory). The downside of that is that you must never move or remove an object that other tasks may be using. Libraries and devices ensure this by maintaining a user count. For simple message ports, the application should either enforce a log-in/log-out facility or else require that all messages be sent on a one-shot basis (i.e., FindPort/ PutMsg).

Each task is limited to a maximum of 32 distinct signals but can have an unlimited number of MsgPorts. The same signal can be used by more than one MsgPort, which is what keeps Intuition tasks from being limited to a finite number of open windows.

IORequests

IORequests are extended messages that include I/O control and transfer information sent to devices. A basic set of commands (read, write, control, and so on) is common to all IORequests; for a given device, additional extensions can be added as needed. A number of special-purpose device IORequest classes have been derived; any device implementer is at liberty to derive his or her own extensions as needed. It's fairly common to end up with something like the following:

```
MyDeviceRequest is based on:
 StdIORequest is based on:
 IORequest is based on:
 Message is based on:
  Node is based on:
    MinNode
```

With each level of inheritance, you gain additional properties and functions. The only new code required is that which supports your own unique class of object.

Libraries

Another important type of node is the library. It consists of a base structure, preceded by function vectors and followed by optional private storage. There is a set of basic functions (e.g., open, close, and expunge) common to all libraries. Beyond that, the designer is free to add functionality at will.

Unlike most operating systems, the Amiga operating system does not use software interrupts or illegal instruction traps to provide operating-system services. Instead, there is a master library, named exec.library, located in the ROM kernel. All the fundamental system functions—the list primitives, memory management, functions to load and open libraries (the libraries' own internal initialization and open routines are called from this)—are defined here. The only immutable part of the operating system is absolute memory location 4, which points to the Exec library structure (ExecBase). The data portion of ExecBase contains the fundamental Exec structures, including the list definitions for the system message ports, libraries, devices, and tasks.

It's interesting to compare Exec libraries with the dynamic link libraries used by OS/2 and Microsoft Windows. DLLs support sets of functions, but they provide additional services as well. The Intel 286 and subsequent chips support the concepts of different levels (rings) of security. If you don't hold the requisite minimum security level, a request will fail. DLL function dispatching can cause security-level switching. The Motorola 68000-series equivalent of this is the Module Call facility. It, however, requires at least a 68020 microprocessor unit and preferably a paged memory management unit. AmigaDOS runs on all 68000s, so the only security levels inherently available are due to the fact that AmigaDOS programs run by the default user state, whereas the operating system runs in supervisor state, as required.

There are pros and cons to both approaches. Since Exec libraries are essentially simple vector tables, the overhead of calling library functions is barely higher than when the function is resident in the calling program (much less than a software interrupt), instead of being shared system code. On the other hand, a carefully designed DLL, while incurring a small speed penalty, is more immune to damage from programs that have run amok.

Note that DLLs are extensions to the Microsoft operating systems; the basic system functions are still software-interrupt driven. Hence, there has to be logic for both kinds of library interfaces. Amiga libraries, however, not only provide a single interface, but they are immune to the problem inherent to all software interrupts—there's only a finite number of them,

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The Amiga operating system is unusual in that it doesn't partition memory for applications.

which never seems to be enough for practical purposes. Libraries, on the other hand, are not only "infinitely" expandable, but it is a straightforward task to create new ones that are indistinguishable from the built-in ones—or even to completely override a built-in one by inserting a new library of the same name at a higher priority on the system library list.

The library concept is itself extended; it forms the basis for an I/O device by adding a few standard functions. Most devices work via extended messages, called IORequests. There are also extensions to these extensions (such as the StdIORequest), as well as customized extensions for specific devices. Devices typically also possess one or more tasks so that I/O can be done asynchronously, although this is not mandatory.

There is another, less-understood extension to the library, called the resource. A resource essentially acts as a coordinator for shared resources (generally hardware), such as the different drives on a disk controller, or the serial and parallel I/O ports (which are implemented on the same chips).

Tasks

The task structure is yet another node. This one contains all the definitions required to make Exec a fully functional, preemptive, priority-driven, multitasking operating system. A task is roughly equivalent to an OS/2 thread. An extended task, known as a process, provides additional information to permit use of the AmigaDOS functions defined in the library named dos.library—chiefly such things as Unix-like I/O services, program loading capabilities, and the like.

Exec's task scheduler is not as elaborate as OS/2's, which is rumored to have been lifted bodily from IBM's VM/370 mainframe operating system. The OS/2 dispatcher dynamically adjusts task priorities based on certain algorithms that are in the "magic" part of the operating system. While this is impressive, it's doubtful that a single-user operating system needs it. No matter; you're stuck with it. About the best you can do is turn it off, but it still eats up real memory.

Exec gives good performance with a simple time-slice dispatching algorithm. More complex custom algorithms can be attached in a straightforward manner, if required. This can be done safely (and in a release-independent manner) on the Amiga, because both the dispatcher functions and task lists are accessible via well-defined interfaces.

Nothing in the basic design of Exec actually requires only a single CPU to be present in the system. Exec could be implemented in a multiprocessor system if access to system lists were properly serialized. Amiga 2500 systems contain a 68000 and a 68020 (or 68030). At present, one or the other is put to sleep at boot time, but there are possibilities here.

Semaphores

Originally, serialization in Exec was done either by the `Forbid()` function, which prevents other tasks from being dispatched, or `Disable()`, which switches off interrupts. However, this serializes the entire system. For serializing access to a specific resource, semaphores are better.

There are two kinds of semaphores in Exec. A SignalSemaphore is based on a MinNode. It provides high-performance serialization but has restrictions on use. A semaphore is based on the message system and can be used in more general situations. Either type of semaphore is preferable to the cruder `Forbid()`/`Permit()` or `Disable()`/`Enable()` functions, both of which reduce the amount of multitasking that can be done while serialized on the resource.

Interrupts

An interrupt is a data structure that points to interrupt-handling code, plus any working storage it might require. To allow for more than one task to handle an interrupt event, interrupts are nodes. The exact handling of interrupts varies, depending on the type of interrupt.

Memory Management

The Amiga operating system is unusual in that it doesn't partition memory for applications, or even the operating system itself. Instead, it maintains a free memory list where each chunk of free memory has certain attributes, and requests are matched against them. Thus, no application runs out of memory until the system itself runs out of memory, and there is no requirement to juggle segments or, as with the Macintosh, compact memory.

A set of low-level functions can be used to acquire and free memory, but Exec also provides a set of functions to manage memory within pools acquired by the application. This has several advantages: less overall memory fragmentation, lower overhead (since the entire pool can be released as a unit, instead of piecemeal), and the ability to preallocate enough memory for applications that have a lot of dynamic memory usage.

There is no system-memory-in-use list. If an application fails and doesn't have a cleanup routine, or if the programmer neglects to free all acquired memory, it's lost until the system is rebooted.

Exec memory management supports both bank-switched memory and virtual memory. Memory allocated with the MEMF_PUBLIC attribute is guaranteed to always be visible to all tasks, interrupt routines, and the system supervisor. Memory on the application's stack or allocated without this flag has no such guarantee. With a minimum of 8.5 megabytes of RAM, neither virtual memory nor switched memory cards are in widespread use, so it's likely that many applications will fail should this situation change.

All the other components of the Amiga's operating system—AmigaDOS, Intuition, the WorkBench, the system's unique built-in animation routines, and so on—all ultimately depend on the services of Exec. Exec is compact, efficient, flexible, reliable, and expandable. And no other system I've ever worked with has been so easy to work with. I like that. ■

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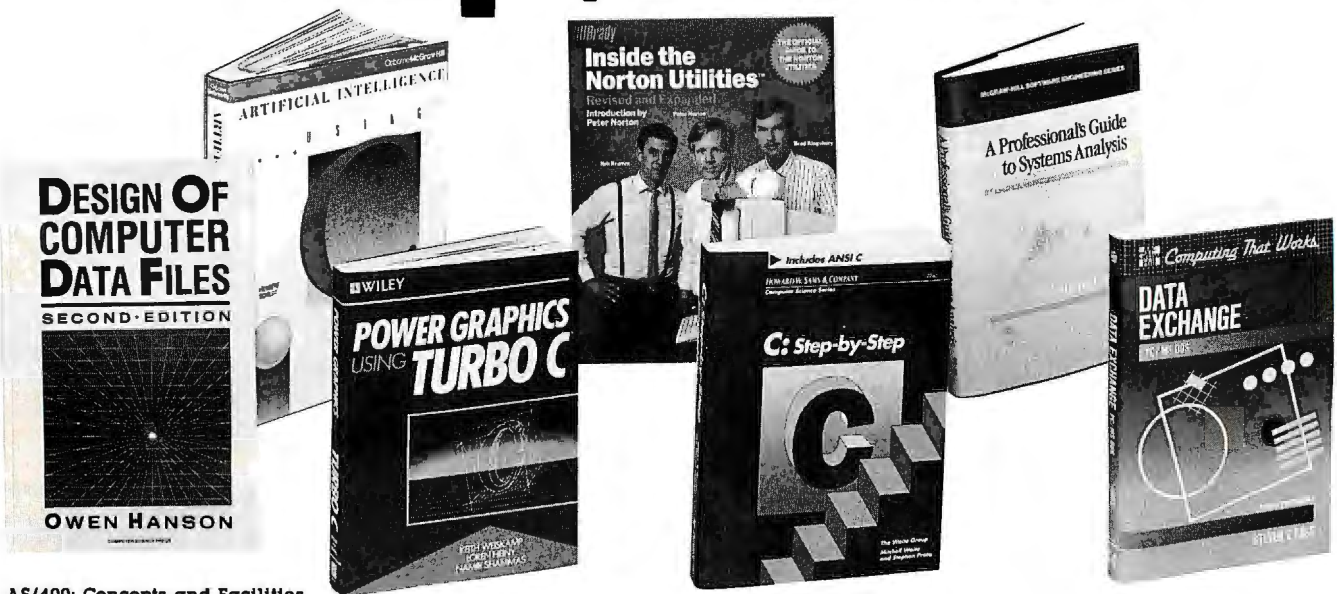

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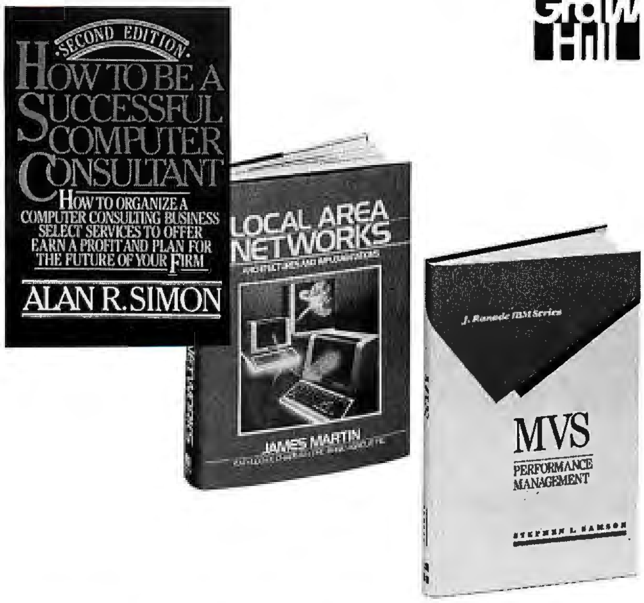

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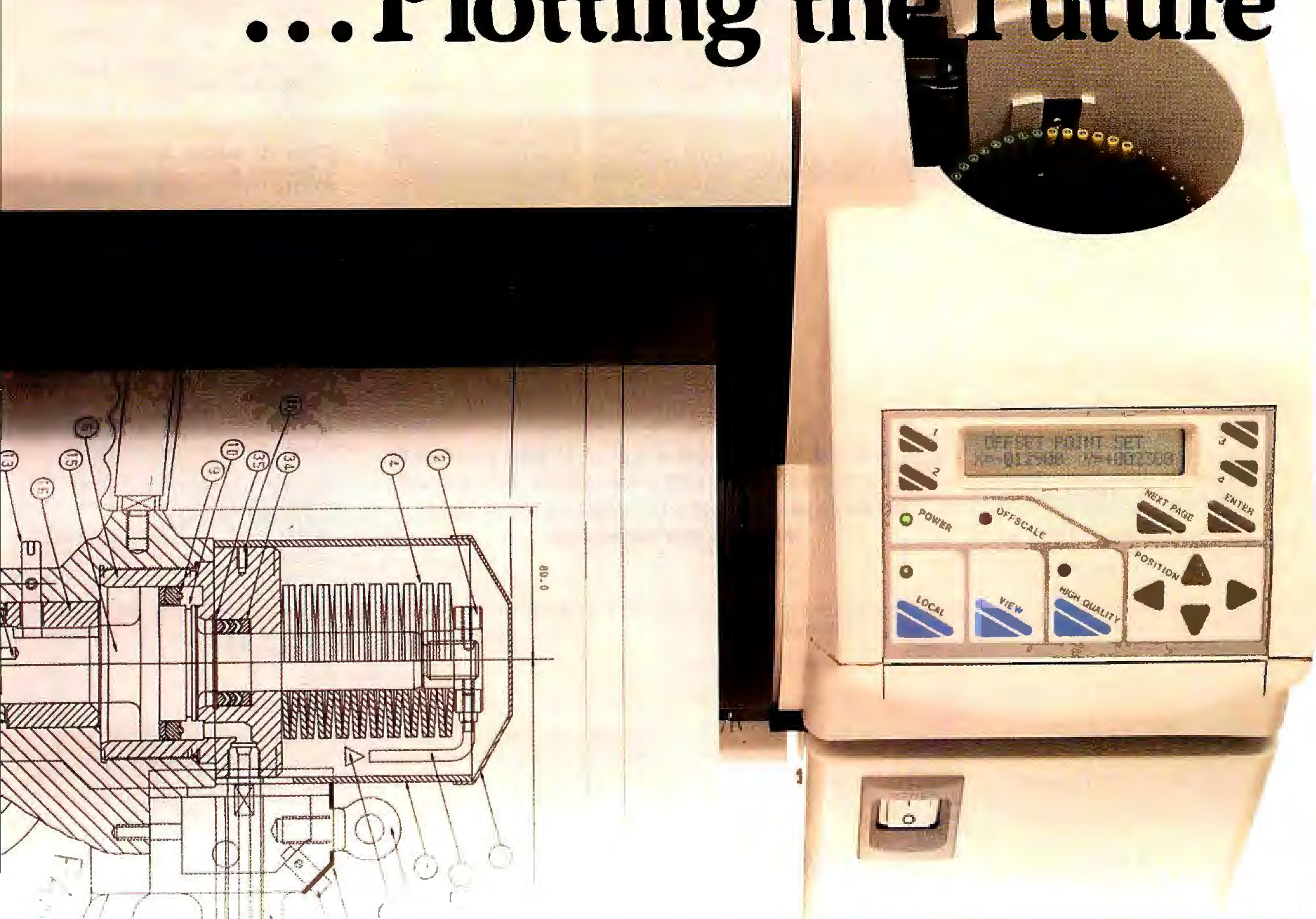

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Circle 124 on Reader Service Card

FEATURE ■ Peter K. Stys, M.D.

PUTTING WAVEFORMS TO PAPER

Want to capture displayed data on a Mac into a file? Here's how.

In the past decade, microcomputers have invaded engineering and scientific laboratories. What's more, with the introduction of ever-more-sophisticated interface and data acquisition cards, micros (in this case, Mac IIs) have become serious tools for controlling lab instruments and acquiring their data. A Mac II can store volumes of this data, crunch it into meaningful results, and display it.

However, a stumbling block that has arisen is the conversion of the displayed data into something that Mac graphics applications could use. What has been needed is a way to produce high-resolution hard-copy output of the data for publication.

Using Symantec's Think Pascal compiler in my laboratory research at Yale, I implemented a solution that translates digitized waveform information into standard Macintosh graphics objects. As Mac graphics objects, the information can then be either pasted into other applications via the Clipboard or saved to disk as PICT files. Although my data was mainly digitized voltage samples, the examples shown here can be just as easily applied to any data pairs displayed as a two-dimensional curve.

A Little Nerve

Work in my laboratory centers around the study of electrical responses of nerve tissue. The nerves are stimulated with a short current pulse, and an oscilloscope digitizes the evoked responses (called *action potentials*). I use a Mac II that is equipped with an IOtech IEEE-488 general-purpose interface bus (GPIB) interface card that transfers the digitized samples from the oscilloscope. A multifunction A/D, D/A, digital I/O, and timer board from GW Instruments generates digital and analog signals that I use for precise control of experimental parameters.

I store the digitized waveforms as compressed text fields in HyperCard 1.2.5. HyperCard is assisted by a healthy assortment of XCMDs, written in Think Pascal, that handle computation-intensive tasks such as data compression/decompression, fast waveform plotting, and digital filtering.

The entire system worked extremely well until it came time to publish my results and include real waveforms on paper. A little browsing through the volumes of *Inside Macintosh* (the official Mac bible, with a detailed description of the Mac OS) revealed that it would not be difficult to write a short procedure that converts a digitized waveform into a graphics object. To explain how I accomplished this, I'll start with a brief background of how the Mac generates and handles graphics.

QuickDraw Basics

The Mac relies heavily on graphics procedures to draw its Desktop, windows, icons, and so forth. To handle these computationally intensive operations, the Mac ROM contains a set of powerful and highly optimized graphics primitives that are collectively called QuickDraw. All graphics are constructed on a 2-D grid whose x and y coordinates are 16-bit integers with values that range from −32,768 to 32,767. Note that QuickDraw locations are defined as integral positions on this grid, unlike in PostScript, whose coordinate system uses floating-point values.

At the programmer's disposition is a set of ROM Toolbox calls that create basic geometric shapes, such as lines, rectangles, ovals, and polygons. In turn, you can fill each of these shapes or objects with a certain pattern or draw its outline with a particular pen width or pen pattern. It quickly becomes apparent that a series of calls to different QuickDraw procedures can result in a complex image. The stunning graphics, created by QuickDraw calls, that can be displayed on Mac screens certainly attest to this.

QuickDraw further simplifies things by defining a data structure called a *picture*. A picture is nothing more than a series of recorded QuickDraw calls. Pictures are typically stored in compressed form and are accessed through a variable-length handle. These pictures can be written to disk files with a file type of PICT. A PICT file is a standard file type that's recognized by most graphics applications. You can record images by using a standard QuickDraw call (`OpenPicture`), and you can reconstruct them on the screen by "playing back" the picture with the `DrawPicture` QuickDraw procedure.

Creating the Waveform

It really doesn't matter how digitized signals are stored. Some applications might save the x-y values (in my application, these correspond to time-voltage pairs from the oscilloscope) as an ASCII table or as 1-D or 2-D integer or real arrays. As I noted above, QuickDraw expects points on a grid with integer coordinates, so your data ultimately has to be converted to integers.

How you do this is important, since it influences the final resolution of your image. Here's an example: I use a setting of ±100 millivolts full-scale on my oscilloscope when sampling my signals. If you take each sample and map these voltage readings into an integer array by rounding (e.g., −44.7 mV becomes −45 mV, +58.3 mV becomes +58 mV, etc.), the maximum resolution you can ever attain is one part in 200. However, the A/D converter in the oscilloscope digitizes signals with a 12-bit dynamic range, equivalent to a resolution of one part in 2^{12} (4096). I am better off taking the raw data from the converter and using the actual 12-bit values as the coordinates of my graphics object. This way, full resolution is maintained and no information is lost.

But there is one problem with this approach. When it's displaying graphics, QuickDraw maps each point to a pixel on the screen. At an average display resolution of 72 dots per inch, my waveform *y*-axis might be as large as 4096 dots, or 57 inches. Even using a 21-inch monitor, I would never be able to see more than a small part of the waveform at any one time. Printing is even worse: Nothing short of a poster-size page would hold the entire image.

As it turns out, this is not as big a hurdle as it seems; I can choose the appropriate graphics application to scale the waveform. This way, I still can use the full range of 4096 points to produce the best-looking waveforms.

You should also give careful consideration to the *x*-axis. In the example shown in listing 1, every point is simply mapped onto the coordinate plane. With 4000 points per waveform, it won't take many waveforms pasted into the same document to choke most existing graphics applications. Even if the application is robust enough to handle the data, screen redraws will be painfully slow, even on a Mac II.

For display purposes, showing only every tenth data point should be adequate. This depends on your signal and how many high-frequency components that it contains. (Nyquist sampling theory applies to graphics, as well—faster-changing signals require more points for faithful reproduction.) In my laboratory, I reached a compromise that uses an adaptive approach. An algorithm analyzes the waveform, and the faster it changes, the more points are sent to the grid to better render these rapidly changing segments.

With 4000 points per waveform, it won't take many waveforms pasted into the same document to choke most existing graphics applications.

Trial-and-error tests will help you find values that yield the best results. Assuming you have an integer array of *x* and *y* values that you can deal with, examine the code in listing 1 to see how a picture structure is created and used.

Creating a Picture

You must first allocate a handle before it can accept the QuickDraw calls that define the picture; you accomplish this by calling `OpenPicture`. A waveform is best represented as a *polygon*, a related collection of straight-line segments. In a polygon, these segments move together and can be scaled together in a graphics application—no manual grouping of hundreds of scattered lines is necessary. In addition, you can split a polygon into two or more polygons, or you can bind two polygons into a single one. Finally, you can smooth a polygon to reduce the jaggies and yield beautiful results on a laser printer.

As an aside, a limitation of the latest version of the LaserWriter driver (6.0 as of this writing) will not allow printing of polygons with more than about 400 vertices. You must either manually split a large polygon after importing it into your graphics application or initially build it as a contiguous series of smaller polygons.

In QuickDraw, you create a polygon in much the same way as you create a picture: You open it (using `OpenPoly`), record a series of straight lines (using `MoveTo` and `LineTo`), and conclude the definition (using `ClosePoly`). The lines are actually "drawn" in the current pen width and pattern by `FramePoly`. Once the vertices have been saved in the picture, the handle is finally deallocated. In my application, the *y*-coordinates that are passed to the `MoveTo` and `LineTo` calls must be negated, because in QuickDraw the positive *y*-axis points downward. Otherwise, your picture will appear upside down.

I always draw a baseline as the last line segment of the polygon, so it always moves with the rest of the waveform. In the figure it is drawn at 0 volt, but in practice you will draw it at whatever level your oscilloscope's offset happens to be set to. This gives an excellent frame of reference (to let you know if the waveform is floating on some DC voltage level).

continued

Listing 1: *A Pascal procedure to record data points into a QuickDraw polygon. The polygon is saved onto the Clipboard and into a file.*

```
{Pascal code demonstrating how to convert an integer}
{array into a Macintosh graphics structure, which is then pasted}
{onto the Clipboard and written to a 'PICT'-type disk file.}
{'nPoints' is the number of elements in the wave, which is passed}
{in the integer array 'theWave', of type 'waveType'.}
procedure WaveToPICT (nPoints: integer; theWave: waveType);

  var
   sysFlag: boolean;
   j, vRefNum, refNum: integer;
   longZero, longCount, count, scrapResult: longint;
   drawRect, picFrame: rect;
   fName, prompt, origName, nullStr: str255;
   myPic: picHandle;
   myPoly: polyHandle;
   scrapType: ResType;
   OSResult: OSErr;
   creator, fileType: OSType;
   reply: SFReply;
   where: point;
   dlgHook: ProcPtr;

 begin
{allocate handle for picture, define big picture frame}
  setRect(picFrame, 0, -5000, 10000, 5000);
  myPic := OpenPicture(picFrame);  {start recording QuickDraw calls}
```

continued

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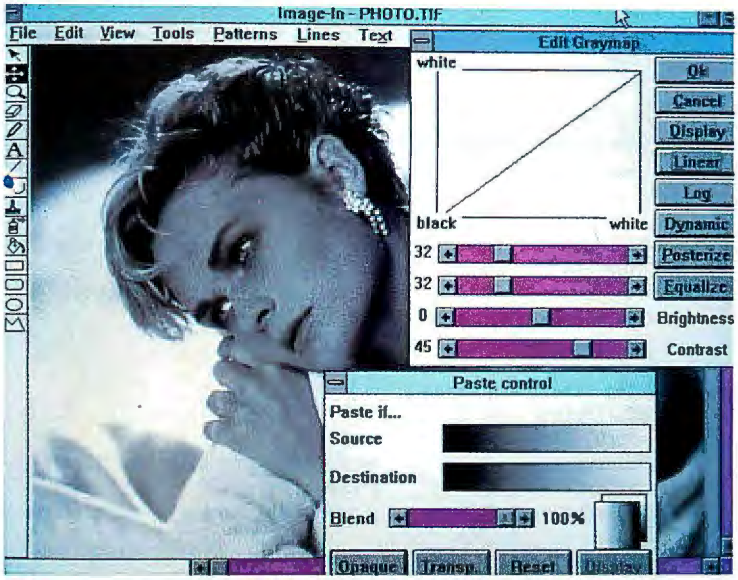

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```
{now draw the polygon - it will be recorded in myPic}
  myPoly := OpenPoly;  {allocate handle, start recording poly }
                       {coordinates}
{y-values must be negated because positive y-axis points down }
{in QuickDraw}
  MoveTo(1, -theWave[1]);      {move pen to first coordinate}
  for j := 2 to nPoints do     {record the rest}
   LineTo(j, -theWave[j]);

{draw the baseline at zero volts}
  LineTo(nPoints, 0);
  LineTo(0, 0);
  ClosePoly;                   {stop recording poly coordinates}
  FramePoly(myPoly);           {'draw' the poly in the picture}
  KillPoly(myPoly);            {dispose of the poly - it's stored in myPic}

{now draw calibration marks as a second poly}
  myPoly := OpenPoly;          {create a new poly}
  MoveTo(npoints + 100, 0);    {start 100 points to the right of wave}
  LineTo(npoints + 100 + 200, 0); {make horizontal limb 200 points long}
  LineTo(npoints + 100 + 200, -150);{make vertical limb 150 points high}
  ClosePoly;
  FramePoly(myPoly);
  KillPoly(myPoly);

  ClosePicture;                {stop recording picture}

{*** put the picture on the Clipboard ***}
  scrapResult := ZeroScrap;    {clear/initialize the Clipboard}
  scrapType := 'PICT';         {we're putting a picture there}
  count := myPic^^.picSize;    {size of picture in bytes}
  if odd(count) then
   count := count + 1;         {must be even}
{place the picture on the Clipboard - if scrapResult=0 then no error}
  scrapResult := PutScrap(count, scrapType, ptr(myPic^));

{alert MultiFinder to update other scraps}
  sysFlag := SystemEdit(3);    {3 is a 'Copy' command}

{*** write the picture to a disk file ***}
{prompt for a filename}
  where.h := 100;
  where.v := 100;
  dlgHook := nil;
  origName := 'Wave.PICT';
  prompt := 'Save graphics to:';
  SFPutFile(where, prompt, origName, dlgHook, reply);
{create the file}
  creator := '????';
  fileType := 'PICT';
  OSResult := Create(reply.fName, reply.vRefNum, creator, fileType);
{open the file}
  OSResult := FSOpen(reply.fName, reply.vRefNum, refNum);
{write 512-byte header first}
  longZero := 0;
  longCount := 4;
  for j := 1 to 512 div 4 do
   OSResult := FSWrite(refNum, longCount, @longZero);
{write picture to file}
  count := myPic^^.picSize;
  OSResult := FSWrite(refNum, count, ptr(myPic^));
{close file}
  OSResult := FSClose(refNum);
{update volume info}
  nullStr := '';
  OSResult := FlushVol(@nullStr, reply.vRefNum);

  KillPicture(myPic);  {we're done, release the picture handle}

 end;
```

Finally, it is frequently necessary to convey to the reader the absolute magnitude of the waveform by printing calibration marks along with it. In the example, an arbitrary pair of marks measuring 200 (x) by 150 (y) is drawn separately as an L-shaped polygon. In reality, you would read your oscilloscope's horizontal sweep speed and vertical sensitivity (e.g., μs/sample and μV/count, respectively) and calculate the appropriate size of the calibration marks. You now have a complete description of your waveform and can instruct QuickDraw to conclude the picture definition with a call to `ClosePicture`.

You then copy the picture that's now in the handle `myPic` to the Clipboard with a standard Toolbox call (`PutScrap`). An important point to note here when running under MultiFinder is the call to `SystemEdit`. This instructs MultiFinder to update all other scraps (a separate scrap is maintained for each application) with the new information. Otherwise, when you paste the Clipboard's contents into another application, it might not contain your most recent picture.

Finally, you save the picture to a PICT file. The calls to `SFPutFile`, `Create`, `FSOpen`, `FSWrite`, and `FSClose` are Mac Toolbox calls that first put up a dialog box that lets the user select a destination filename, open the file, write to the file, and close the file when the application is done. A 512-byte header must precede the picture definition. This header contains information specific to each graphics application, but it can contain all zeros in the generic case.

Importing the Picture

Your picture now exists as a standard QuickDraw graphics object—albeit a giant one—residing either on the Clipboard or in a disk file. By choosing a good graphics application, you can manage this large object quite easily.

The application I use for most of my graphics work is Deneba Software's Canvas 2.1. I can paste my waveform directly into a Canvas document, and it will also recognize generic PICT files. Either way, you end up with a large waveform spanning several pages.

However, Canvas allows you to manipulate objects even though they extend well beyond the size of your drawing. As a matter of fact, you don't even have to see the entire picture in order to reduce it; you simply paste it, group all the parts (they are all selected automatically after the paste), and go to the Scale menu to reduce both x and y dimensions by any percentage (10 percent fits the example

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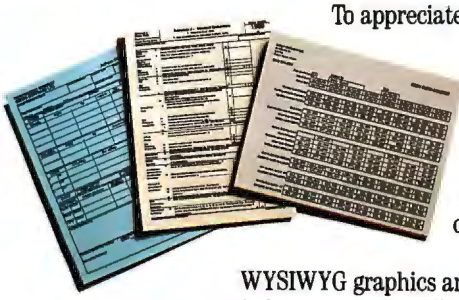

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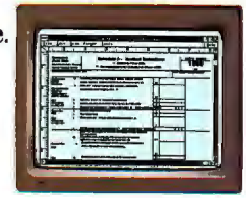

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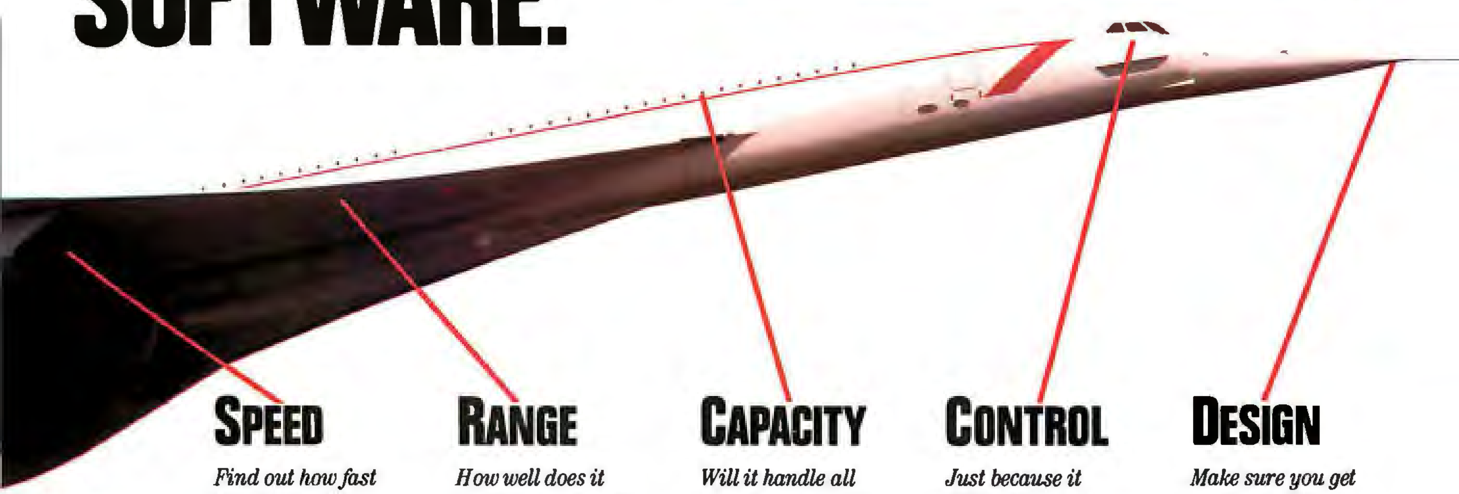

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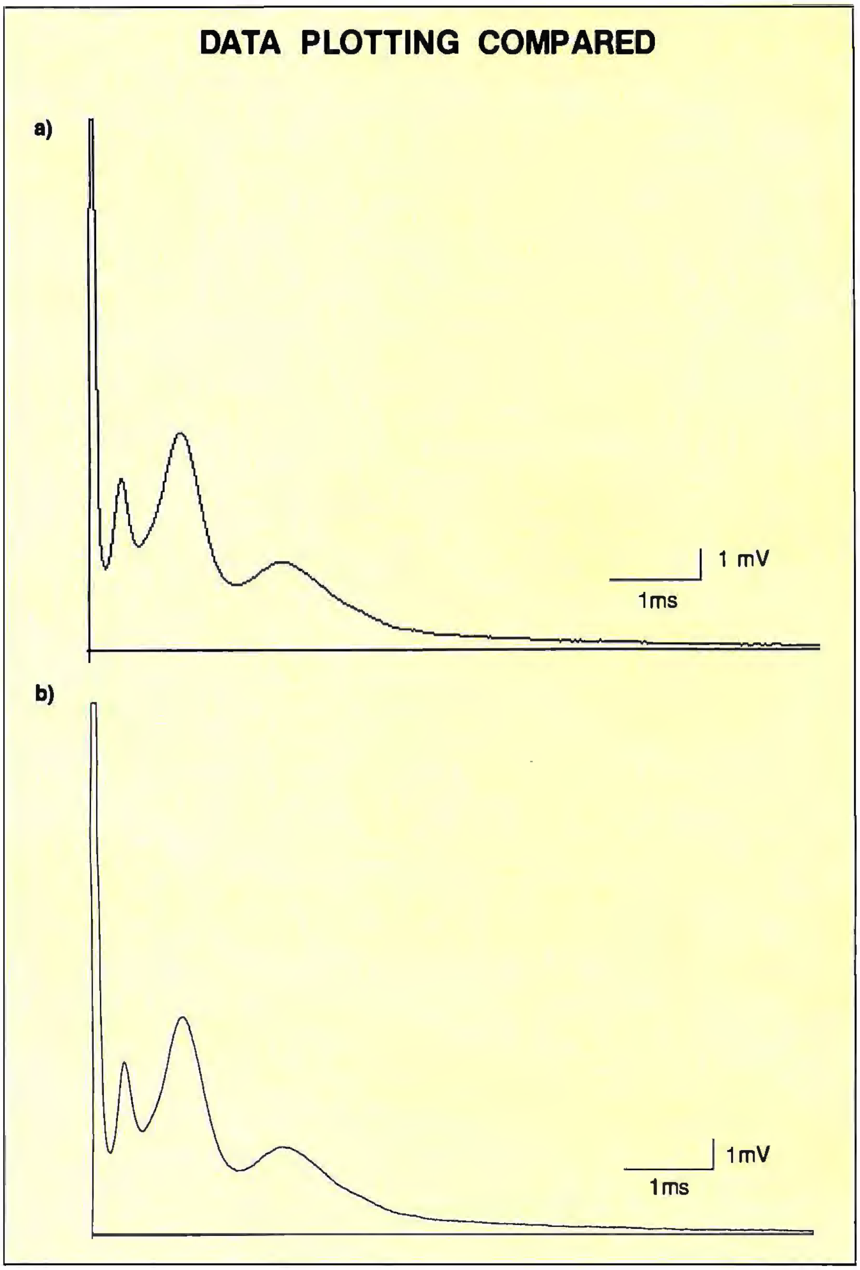

Digitized electrical response recorded from an optic nerve.
The top tracing **(a)** *was drawn as a bit map in HyperCard and then pasted into Canvas 2.1. The printing resolution is limited to 72 dpi, even though the waveform contains many more sampled points. In* **(b)**, *the sampled data was converted into a PICT file (using the technique described in the article), pasted into Canvas, and reduced. Note the markedly improved resolution with the latter method. Calibration marks are included as a reference and will automatically scale with the waveform.*

on a single page).

By scaling a large object in Canvas, you maintain full resolution because, in contrast to QuickDraw, Canvas graphics are not limited to the screen's pixel resolution. Furthermore, the calibration marks scale down precisely with the rest of the waveform, maintaining the original proportions.

Picture Perfect

The figure shows an example of a typical waveform recorded in my laboratory, demonstrating the superior resolution and flexibility of object-oriented graphics compared to bit-mapped images. The top part of the figure was drawn as a bit map within HyperCard and then pasted into Canvas. My HyperCard stack contains an XCMD that automatically decompresses a previously stored waveform and places it on the Clipboard for pasting into any object-oriented graphics application.

The bottom part shows the same signal converted to a polygon object. Notice the smooth output that results, because by using a polygon to represent the waveform I can obtain a higher resolution. Scaling by different percentages in the x or y directions will always be reflected in the calibration marks as long as they are grouped along with the waveform. Ungrouping the curve and marks allows you to manipulate the two as totally separate graphics entities.

All operations pertaining to polygons (e.g., coloring, smoothing, splitting, editing individual vertices, and setting the line width) can be applied to my imported waveforms as if they were created within Canvas in the first place. You can add labels, axes, or other embellishments from within the graphics application. Alternatively, if these labels and axes are used routinely, they can be easily generated by the original translator XCMD with a few extra lines of code.

As you can see, once you understand the basic principles of Macintosh graphics, it's easy to write a short Pascal (or C, if you prefer) procedure that converts digitized waveforms (or any other 2-D data that you wish to display) into standard Macintosh QuickDraw graphics objects. As QuickDraw objects, your graphics can be pasted into any Mac application that accepts picture data: graphics, page layout, or word processing programs.

In addition, as a QuickDraw object, your graphic is not limited to screen resolution; it will reproduce properly on a high-resolution laser printer. I find this to be the best way of transferring my signals to paper for reports or publications. With your own data and a little effort, you too will be impressed by the quality of your printed results. ■

Editor's note: *The source code for listing 1 is available for the Mac in electronic format. See page 5 for details.*

Peter K. Stys is an associate research scientist at Yale University. In addition to lab work, he divides his time between seeing patients at Yale's Neurology Clinic and Mac programming. He also builds hardware and writes software for real-time laboratory data acquisition. You can reach him on BIX c/o "editors."

EEF
ELEX ELECTRONIC FILING

The ELEX Electronic Filing System (EEF) is a hardware/software system designed to reduce the frightening volumes of paperwork that burden businesses on a daily basis. As paper is eliminated, transactions are made in a fraction of the time required by traditional means, costly storage facilities are reduced, data security and integrity is enhanced, and work quality and quantity is increased. These factors all give companies and individuals the competitive advantage they need to excel in the business environment of the 90's.

Filing vs. Archiving

Document image processing is a new technology which has just begun to evolve. The myriad of hardware devices on the market, and the lack of an industry standard protocol for communicating between them, make the integration of an electronic filing system a formidable task. And without intelligent software to control all aspects of the storage, management, and retrieval of documents, the filing system will be nothing more than a micro-fiche machine in disguise.

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- A single user workstation under the **DOS** or the **OS/2** operating system.
- A local area network - **Novell NetWare** 286 and higher or any DOS 3.1 compatible **network**.
- A **host computer** under the **UNIX, VAX/VMS** or **IBM AS/400** system with a PC connection.

Input
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Processing
Document Manager, Retrieval Engine, Hyper-Media, Database Application Generator, Turn-key Solution.
Output
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The EEF system opens a vast new world of opportunities for you. The possible applications are limitless, and to name a few:

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Any application in these fields that requires maps, charts, logs, sketches, etc.

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The kind of visual information which is so essential for medical applications is handled by EEF in a natural, straightforward manner.

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For prospective clients wishing to enter the field, we have prepared a pilot system, enclosing in one package the full range of functions necessary for electronic filing. The system components are:

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386 base micro-computer at 33MHz with 64K cache, 8 MB RAM, 1.2GB with access time of 0.8MS (disk caching), proprietary scanner and printer interfaces, high resolution (1660 x 1200) CRT display, laser printer 300 dpi at 8 ppm, scanner 300 dpi with 100 page feeder.

Software

The EEF software package, including the document manager, the retrieval engine, the hypermedia interface, and 20 hours of customization services.

Total cost for the pilot system is 30,000 US$.

For further details and literature, please contact:

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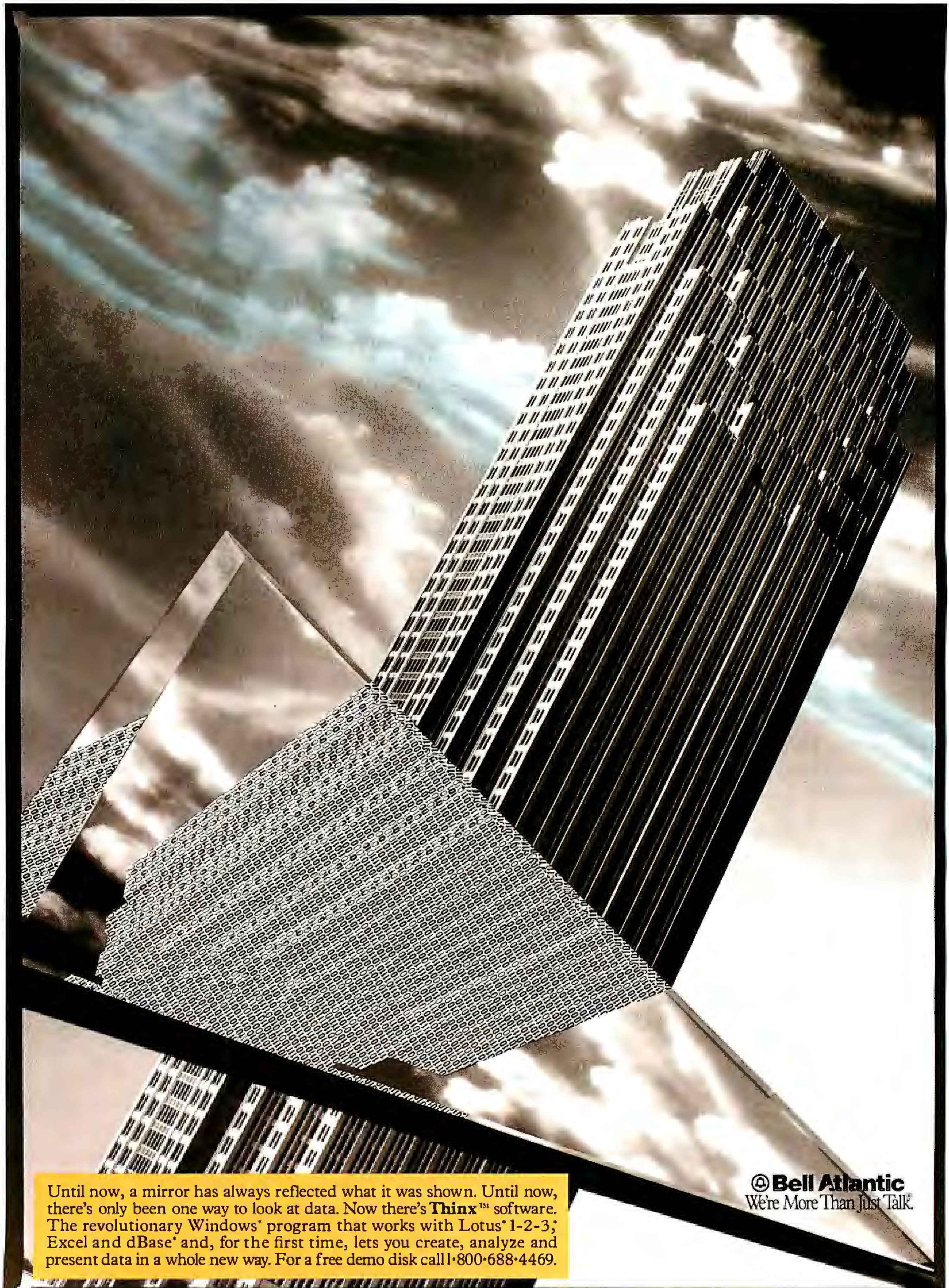

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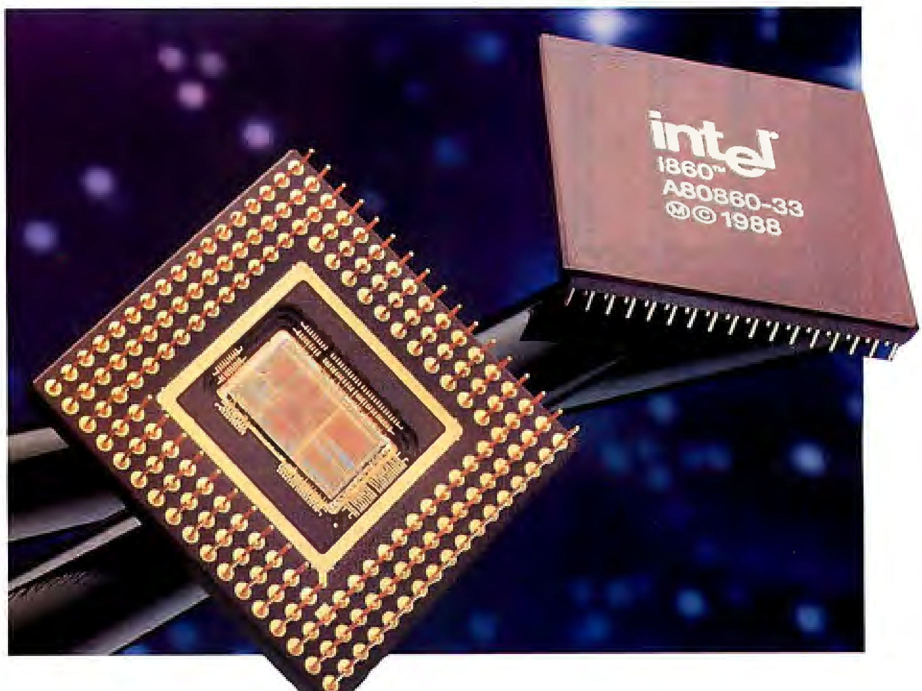
Circle 380 on Reader Service Card

Personal Supercomputing with the Intel i860

A close look at Intel's RISC-based "Cray on a chip"



You've heard the old adage: Most people use only 15 percent of their brainpower. Geniuses, however, tap into the 85 percent reserve. Well, I don't know if that's really true for humans, but it certainly applies to computers.

The key to great performance is a CPU architecture that keeps transistors in constant and productive use. The i860 has that ability. Master its memory systems and integer and floating-point processors, then make all these pipelined units run in parallel, and you're well on the way to PC supercomputing.

Who needs personal MFLOPS (millions of floating-point operations per second)? The scientists and engineers who (like me) grew up on the IBM 7094s of the sixties and 370s of the seventies, and who today use VAXes, Crays, and IBM 3090s—that's who. In particular, anyone who studies three-dimensional physical systems develops an insatiable lust for numeric horsepower. Of course, all sorts of nontechnical professionals—bankers, architects, economists, filmmakers, brokerage firms, meteorologists—also benefit from supercomputers more than most people suspect.

Before the arrival of supercomputers, you had to use simplifying assumptions to reduce 3-D problems to two dimensions. But when it comes to analyzing something like the precise flow of air over an airplane in flight, there's no substitute for true 3-D analysis. And the payoff can be dramatic. Shaving even a fraction of a point off the drag coefficient of a new airliner will result in immense fuel savings over the lifetime of a fleet of 500 planes.

The most popular technique for studying real-world objects is called finite-element analysis. In FEA, you "mesh" an object with a polygon grid to create an armature of elements. Then you solve for some property while applying constraints to each element.

Whether the property under investigation is an electrical, thermal, fluid-flow, or stress field, the problem always boils down to the same thing: solving a linear equation that contains a matrix of coefficients. These matrices often have dimensions in excess of 10,000 by 10,000 elements and can consume hundreds of megabytes of disk storage. Of course, matrix math also plays a key role in 3-D graphics. Zooming, rotating, translating, and clipping all rely on matrix operations.

These are just the operations at which the i860 can excel. But it doesn't happen automatically. In scalar mode, as you'll see, the i860 doesn't do much better than an i486/80487 or a Weitek WTL4167.

To attain peak performance, you have to exploit the chip's pipelining and parallel-processing capabilities. Figure 1 shows the i860 with its recommended memory subsystem. The architecture is of the Harvard type, with separate instruction and data caches. Instructions feed out of a 4K-byte, 64-bit-wide cache that can drive both the CPU ("RISC core") and FPU simultaneously through independent 32-bit instruction buses—that's one flavor of i860 parallelism.

Data feeds out of an 8K-byte, 128-bit-wide cache that can drive two long real arguments at a time at the adder, multiplier, or graphics unit. (The processor also has 32 integer registers and 32 floating-point registers, each 32 bits wide.) The adder is a three-stage pipeline, as is the multiplier, and these two units can hook together in a variety of ways. That's another form of parallelism.

To make the i860 hit full stride on a

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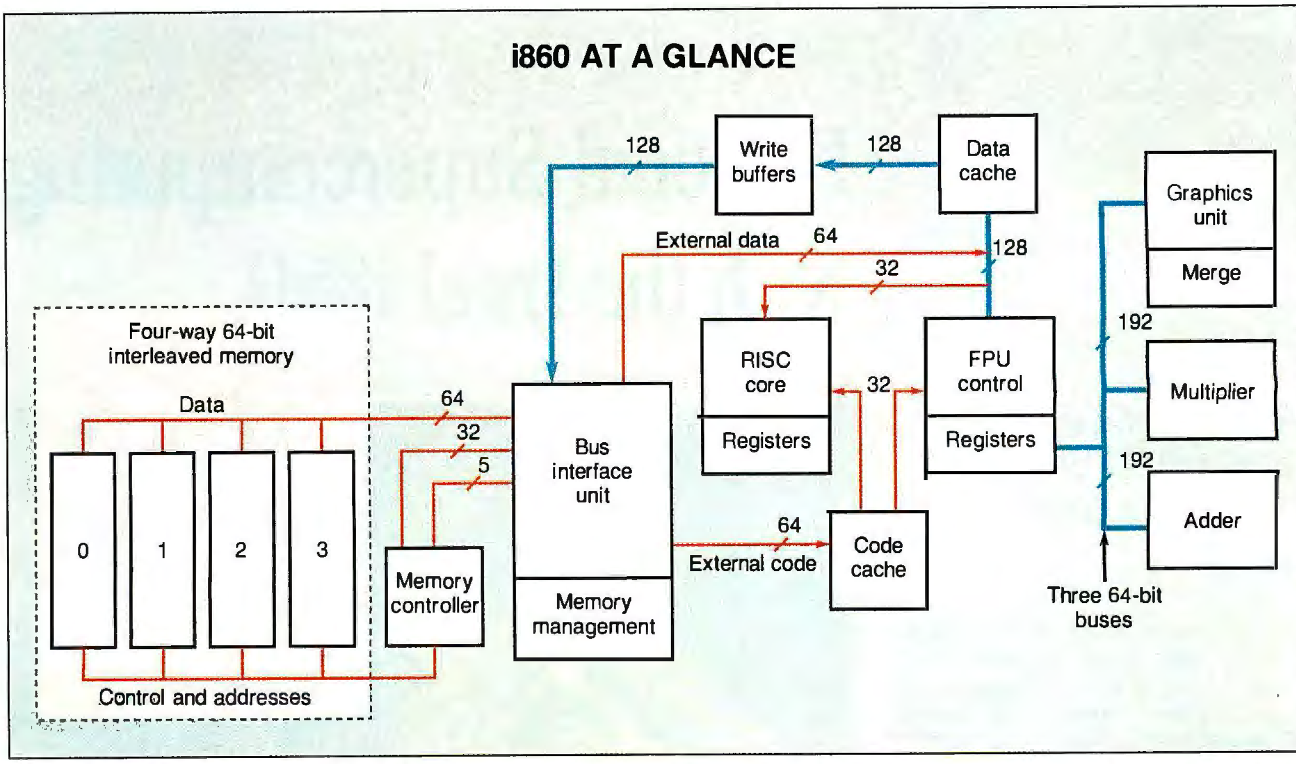

Figure 1: *The i860 features a Harvard architecture, wide internal data paths, pipelined arithmetic units, and a graphics unit.*

numeric problem, as you'll see, you have to get the CPU and FPU working at the same time, feed and flush the adder and multiplier pipelines efficiently, and exploit the adder/multiplier synergy. Once you see how that's done, you'll understand better why the i860 has the architecture that it does. (For a more complete review of the i860 architecture, see "The Intel 80860," December 1989 BYTE.)

The i860 in Scalar Mode

I normally use a benchmark that I call the "Whetscale" (a variation of the Whetstone) to compare scalar numeric devices. Because scalar operations aren't repetitive and can't be pipelined, the Whetscale doesn't give the i860 a chance to really stretch its legs.

The i860's raw speed is impressive. Table 1 shows the Whetscale results for a variety of numeric devices. The improvement in scalar performance over the last eight years has been stunning—roughly a factor of 250 from the 80287 to the i860. This correlates nicely with Moore's law, which states that semiconductor performance has been doubling annually.

Notice, however, that the i860 is not dramatically faster than the Weitek 4167 at single-precision scalar operations. That shouldn't be a surprise. The state of the art in fast FPUs has been at or below the 100-nanosecond mark for the last several years.

A number of chip companies, including Weitek, Analog Devices, and Texas Instruments, have made a business of selling special floating-point data paths for minicomputers to companies such as Sun Microsystems and Alliant. The challenge now is not simply to build faster data paths (i.e., the parts of the device that carry out the arithmetic), but to organize the remainder of the system so that it is able to feed the data paths as fast as they consume numeric data.

It brings to mind the hot-rod speed-shop business. The first solution to building faster cars is bigger engines. Soon everyone has huge engines running in cars that can't make corners. The speed problem then becomes one of cornering and, after that's mastered, of reducing aerodynamic drag.

Weitek was the first of the "engine" companies. It started out building 16-bit flash multipliers and expanded into a complete line of FPUs.

Intel, recognizing that none of its OEMs was likely to take the Sun approach to incorporating Weitek support, contracted with Weitek for a chip that glued Weitek engines to a 386 using a memory-mapped interface. That worked as a stopgap measure: Intel could claim Weitek performance for its 386 line and compete with RISC machines while maintaining DOS compatibility.

WHETSCALES

Table 1: *These are the "Whetscales" for Intel and Weitek numeric devices, in MFLOPS. Note the 250-fold speedup from the 80287 to the i860.*

	80287 10 MHz	80287 20 MHz	80387SX 20 MHz	80387DX 20 MHz	3167 20 MHz	80387 33 MHz	3167 33 MHz	i486 25 MHz	4167 25 MHz	i860 33 MHz
Single-precision	0.061	0.185	0.612	0.615	2.27	1.61	4.05	3.31	9.95	12.36
Double-precision	0.051	0.133	0.554	0.560	2.00	1.43	3.57	2.94	7.71	12.36

WHETMATS

Table 2: *These are the "Whetmats" for Intel and Weitek numeric devices, in MFLOPS. Even in scalar mode, the i860's raw speed gives it an edge over the Weitek 4167.*

	80287 10 MHz	80287 20 MHz	80387SX 20 MHz	80387DX 20 MHz	3167 20 MHz	80387 33 MHz	3167 33 MHz	i486 25 MHz	4167 25 MHz	i860 33 MHz
Single-precision	0.028	0.181	0.282	0.378	1.32	0.866	2.56	1.87	4.55	5.88
Double-precision	0.024	0.059	0.204	0.328	0.62	0.672	1.12	1.70	1.93	4.91

WHETMAT/WHETSCALE RATIO

Table 3: *The Whetmat/Whetscale ratio describes how well a processor copes with the addressing overhead associated with vector operations. For single-precision work, the 4167 and the i860 have comparable vector efficiencies, but in double-precision the i860's 64-bit external data bus pulls it significantly ahead of the 4167.*

	80287 10 MHz	80287 20 MHz	80387SX 20 MHz	80387DX 20 MHz	3167 20 MHz	80387 33 MHz	3167 33 MHz	i486 25 MHz	4167 25 MHz	i860 33 MHz
Single-precision	0.460	0.441	0.469	0.614	0.581	0.537	0.632	0.565	0.457	0.475
Double-precision	0.470	0.440	0.368	0.585	0.307	0.469	0.313	0.578	0.250	0.397

Intel got busy back in the "frame" shop building a device that could properly take advantage of today's wide numeric data paths. Think of the Whetscale as a drag race. Both the 4167 and the i860 have plenty of what it takes to post a good mark: good compilers and brute force. But when it comes to the Le Mans of the numerics business—double-precision vector operations (as exemplified by the LINPACK benchmark)—the i860, with its 160-MB-per-second memory interface, runs the course as much as 10 times faster than a 4167-equipped i486.

Jacking into the Matrix

I use a second benchmark, called the "Whetmat," to evaluate performance on a typical vector operation—a matrix multiplication. The Whetmat, in conjunction with the Whetscale, gives you a way to measure the relative efficiencies of scalar and vector operations.

On scalar processors, vector operations run slower than scalars for two reasons: They have to access operands from memory instead of registers, and they have to compute the address of each operand as it is used. Table 2 shows raw Whetscale results, and table 3 displays "vector efficiency"—that is, Whetmats divided by Whetscales, which I take as a measure of how effectively a scalar processor copes with the addressing overhead of vector problems.

I'm still restricting the i860 to scalar mode, but even without the advantages of pipelining and parallelism, notice how the i860 begins to distinguish itself from the i486 and 4167. The i860 continues to perform well on the double-precision Whetmat, while the i486 and the 4167 are hardly better than an i486 running on its internal FPU. Moreover, the i860 outdoes the Weitek devices in terms of double-precision vector efficiency.

The problem with the 4167 is that, for large matrices, it's bound by the data bus. (You see the same thing happening with the 80387SX, which keeps up with its DX cousin on the Whetscale but falls behind on the Whetmat.) What turns out to be the biggest asset of the i860 for vector operations performed in scalar mode is its 64-bit-wide external data bus.

If the 4167 were attached to the i486 with a 64-bit-wide bus, you could drive a double-precision, memory-accessing operation with two lines of i486 code (instead of the four that it actually requires) and thereby double the 4167's performance for certain vector operations.

Even in scalar mode, then, the i860's raw speed and wide external data bus give it a significant edge over competing numeric devices. But 4.91 double-precision MFLOPS falls far short of the chip's rated maximum: 66 MFLOPS (at 33 MHz). How do you get the i860 to live up to its full potential?

Henry Ford Had the Right Idea

A pipelined processor works just like one of Ford's assembly lines. The i860 has four of them, and you can use them or not, depending on the problem and how you decide to code it. The four pipelines are the external memory loader, the adder, the multiplier, and the graphics unit.

The adder and multiplier can load from registers, the data cache, or external memory. The ability to pipeline loads from external memory is crucial for vector operations on large matrices.

The adder and the multiplier, both of which are three-stage pipelines, are available to both scalar and pipelined instructions. In scalar mode, these units produce a result every three cycles. But pipelined instructions can control the units on a cycle-by-cycle basis, producing new results each cycle.

The amount of work you can get out of the i860 pipes is simply the speed of the pipes times the number of pipes in operation. At 33 MHz, with both the adder and multiplier yielding new results each cycle, that's 66 MFLOPS!

Of course, the problem that is being solved must require some sequence of additions and multiplications that alternate, so the adder and multiplier can work together. But that's not as artificial as it may seem. Vector dot products, which are the core of other vector operations, such as matrix multiplication, have exactly this sort of interleaved add/multiply behavior.

Given the right sort of problem, you've got to arrange to keep your numeric factory fed with numbers, and to get rid of the results as fast as they come out the back end. Here, the i860's Harvard architecture comes into play.

The 64-bit external data bus can shuffle 8 bytes of data to or from memory every other cycle—that's 4 bytes per cycle, or 160 MBps. To start a single-precision dot product on every cycle—and thereby keep the load and numeric pipelines fed—you will have to read one operand from memory while grabbing the second operand from a register or out of the cache.

The i860's 8K-byte data cache can hold entire rows when multiplying matrices as large as 2000 elements. As a matter of fact, the i860 is said to be operating in "Cray" mode when its cache emulates the vector registers of a Cray. That's feasible because the i860 can move data between its cache and the FPU's register file at a whopping 640 MBps. Moreover, the two kinds of loads—pipelined loads from external memory straight into registers, and cached loads that fill the "vector register"—can proceed in parallel.

REGISTER SETUP

Table 4a: *Floating-point registers f4 to f11 hold the first array, and registers f12 to f19 hold the second array. Results appear in registers f12 to f19 after a three-cycle delay.*

src1	src2	Destination
f4	f12	f12
f5	f13	f13
f6	f14	f14
f7	f15	f15
f8	f16	f16
f9	f17	f17
f10	f18	f18
f11	f19	f19

Wiring for Dual-Operation Mode

I've said that the i860 supports two forms of parallelism. In *dual-operation mode*, the adder and multiplier work in concert. In *dual-instruction mode*, the RISC core loads floating-point registers while the FPU runs in parallel. The two modes are complementary; I'll tackle dual-operation mode first.

Before you can understand "dual-ops," though, let me review basic pipelining. Tables 4a and b show the pipelined multiplication of two arrays of single-precision floating-point numbers. As you can see, it's a series of instructions of the form

```
pfmul.ss src1, src2, dest
```

where the `p` in `pfmul` selects pipelined mode, and the `.ss` specifies single-precision operands and a single-precision result. The special register `f0` acts as a dummy destination for the first three instructions, while the pipeline fills. Thereafter, each instruction yields a result that began its trip through the pipeline three instructions ago. At the end, register `f0` acts as a placeholder again, this time supplying dummy operands to flush the last three results out of the pipeline.

Now, a vector dot product boils down to a sequence of operations like this:

PIPELINED MULTIPLICATION IN ACTION

Table 4b: *Once you prime the multiplier, it produces a new result each cycle (G=garbage).*

	Multiplier			
Instruction	**Stage 1**	**Stage 2**	**Stage 3**	**Result**
pfmul.ss f4,f12,f0	f4×f12	G	G	None
pfmul.ss f5,f13,f0	f5×f13	f4×f12	G	None
pfmul.ss f6,f14,f0	f6×f14	f5×f13	f4×f12	None
pfmul.ss f7,f15,f12	f7×f15	f6×f14	f5×f13	f12<—f4×f12
pfmul.ss f8,f16,f13	f8×f16	f7×f15	f6×f14	f13<—f5×f13
pfmul.ss f9,f17,f14	f9×f17	f8×f16	f7×f15	f14<—f6×f14
pfmul.ss f10,f18,f15	f10×f18	f9×f17	f8×f16	f15<—f7×f15
pfmul.ss f11,f19,f16	f11×f19	f10×f18	f9×f17	f16<—f8×f16
pfmul.ss f0,f0,f17	G	f11×f19	f10×f18	f17<—f9×f17
pfmul.ss f0,f0,f18	G	G	f11×f19	f18<—f10×f18
pfmul.ss f0,f0,f19	G	G	G	f19<—f11×f19

(1×2)+(3×4)+(5×6)+...

For this job, you'd need to interleave addition and multiplication. There are 62 ways to chain together the i860's adder and multiplier. Figure 2a shows the full set of possibilities. The adder, for example, can receive operands from floating-point registers, the special T (temporary) register, the multiplier, or itself.

To perform the dot product, combine the adder and multiplier to create a "multiply-accumulate" instruction, which, as shown in figure 2b, recirculates the adder's results back through the adder.

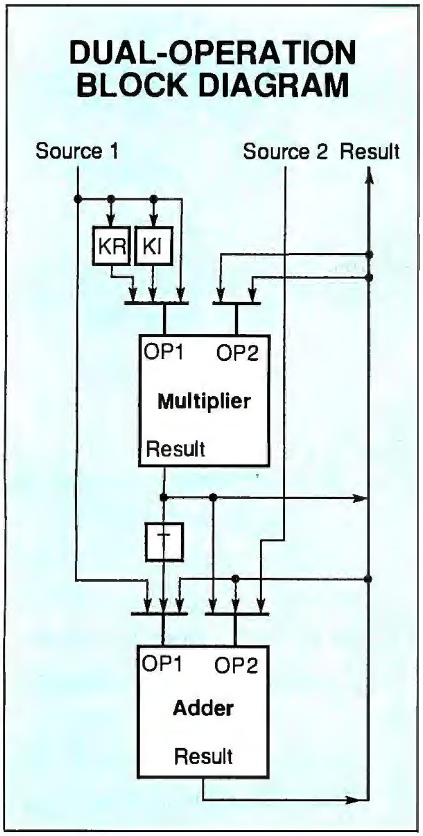

Figure 2a: *The multiplier and adder can receive inputs from registers, their own outputs, or each other's outputs. They can be wired 62 different ways to create special-purpose instructions, such as "multiply-accumulate."*

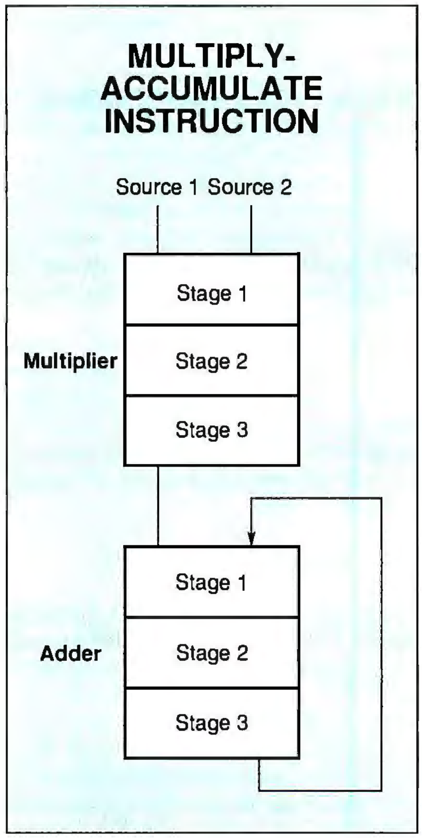

Figure 2b: *The multiply-accumulate instruction is formed by combining the adder and the multiplier. The multiplier feeds the adder, while the adder's results recirculate back through the adder.*

STATE DIAGRAM OF DUAL-OPERATION MODE

	Multiplier			Adder		
Stages	1	2	3	1	2	3
Cycles						
4	4 *12	3 *11	20	9 + 0	0	0
5	5 *13	4 *12	33	20 + 0	9 + 0	0
6	6 *14	5 *13	48	33 + 0	20 + 0	9
7	7 *18	6 *14	65	48 + 9	33 + 0	20
8	8 *19	7 *18	84	65 +20	48 + 9	33

Figure 3: *After seven cycles, partial sums begin to accumulate as the adder's results recirculate back through the adder.*

Take a look at the dot product example in tables 5a and b. In table 5b, the cryptic `m12apm.ss` is the multiply-accumulate instruction. It wires the FPU so that the multiplier gets two operands from registers, and so that the adder's two operands are the multiplier's result and its own prior result. During the priming phase, you fill up the multiplier with the first three product terms: 1×9, 2×10, and 3×11. When terms reach stage 3, you start referring to them by their value.

By the fourth instruction, you have a problem. The third stage of the adder is about to feed back into the adder's first stage and get added to the garbage value there. Instructions 4 through 6 therefore prime the adder with 0s using pipelined additions involving the dummy register f0. Since `pfadd.ss` is a pipelined operation, it will take three cycles to complete. The `pfadd.ss` instructions affect only the adder; the values in the multiplier are untouched.

Now you can enter the steady-state part of the algorithm. After another three-cycle latency, during which the adder combines multiplier results with the 0s in its pipeline, the adder begins its real work: accumulating partial sums in each of its stages.

Figure 3 shows what's happening in a more graphical way. For the first six cycles of the journey through the pipeline's stages, all terms progress from left to right, just like on an assembly line. Then the pattern abruptly reverses, as adder results feed back to the first stage of the adder. In a real program, the steady-state part would be a loop with dozens or hundreds of operand pairs.

When all the product pairs have been fed in from their registers, start harvesting the sums. First, flush the multiplier with 0s. You use the same multiply-accumulate instruction, since, while you're flushing the multiplier, you want the adder to keep accumulating sums.

After three cycles, the multiplier's job is done. The adder contains partial sums in each of its stages; once you combine these, you'll have the answer. You could load them off to three registers and then use scalar operations to combine them, but this would cost at least three cycles to unload the pipes plus nine cycles to perform the three additions. Instead, use a series of pipelined additions with a single scalar addition, for a total of eight cycles.

The final code sequence in table 5b is worth a close look. Begin by taking what was in the adder pipe at the end of the last

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Accredited Member, National Home Study Council 170 - 031 multiply-accumulate, 117, and put it in register f20. The next instruction should strike you as bizarre. It appears to place f20 and f21 into the pipeline, while putting the stage 3 adder result into f21. But this is the first use of f21. How can the result you're about to place in f21 also be the same operation's input value?

Simple: The i860 works backward. Its internal clock breaks pipelined operations into three parts. On cycle 1 of the internal clock, the last stage of the adder gets stored to the destination. On cycle 2, stages 1 and 2 advance to stages 2 and 3. On cycle 3, the inputs latch into stage 1.

This backward way of doing things actually makes a lot of sense, as it starts off the most time-consuming part of the process (storing results) early. It's also what makes it possible for results to recirculate back through the adder with a single instruction.

Prepare for Lift-off: Entering Dual-Instruction Mode

Until now, the assumption has been that operands are simply available in registers. To load those registers without stalling the pipeline, you'll have to tackle the second form of i860 parallelism: dual-instruction mode.

In that mode you will be doing pipelined loads and pipelined computation at the same time. But, again, let's start by looking at a simple pipelined load. The memory subsystem uses a three-stage

REGISTER SETUP

Table 5a: *Registers f4 to f11 contain the first array, and f12 to f14 contain the second.*

src1	Value	src2	Value
f4	1.0	f12	9.0
f5	2.0	f13	10.0
f6	3.0	f14	11.0
f7	4.0	f15	12.0
f8	5.0	f16	13.0
f9	6.0	f17	14.0
f10	7.0	f18	15.0
f11	8.0	f19	16.0

MULTIPLY-ACCUMULATE IN ACTION

Table 5b: *During the steady-state part of the algorithm, each instruction drives the three stages of the multiplier and the three stages of the adder in parallel (G=garbage).*

	Multiplier stages			Adder stages			Result
Priming: Fill multiplier with first three products							
m12apm.ss f4,f12,f0	1×9	G	G	G	G	G	Ignore
m12apm.ss f5,f13,f0	2×10	1×9	G	G	G	G	Ignore
m12apm.ss f6,f14,f0	3×11	2×10	1×9	G	G	G	Ignore
Priming: Prepare adder for first product							
pfadd.ss f0,f0,f0	3×11	2×10	1×9	0	G	G	Ignore
pfadd.ss f0,f0,f0	3×11	2×10	1×9	0	0	G	Ignore
pfadd.ss f0,f0,f0	3×11	2×10	1×9	0	0	0	Ignore
Steady state							
m12apm.ss f7,f15,f0	4×12	3×11	20	9+0	0	0	Ignore
m12apm.ss f8,f16,f0	5×13	4×12	33	20+0	9+0	0	Ignore
m12apm.ss f9,f17,f0	6×14	5×13	48	33+0	20+0	9	Ignore
Now the first product term feeds back to the adder							
m12apm.ss f10,f18,f0	7×18	6×14	65	48+9	33+0	20	Ignore
m12apm.ss f11,f19,f0	8×19	7×18	84	65+20	48+9	33	Ignore
We've multiplied all terms, now flush the multiplier							
m12apm.ss f0,f0,f0	0×0	8×18	126	84+33	65+20	57	Ignore
m12apm.ss f0,f0,f0	0×0	0×0	152	126+57	84+33	85	Ignore
m12apm.ss f0,f0,f0	0×0	0×0	0×0	152+85	126+57	117	Ignore
Combine adder stages and store result							
pfadd.ss f0,f0,f20	G	G	G	0+0	152+85	183	f20<—117
pfadd.ss f20,f21,f21	G	G	G	183+117	0+0	237	f21<—183
pfadd.ss f0,f0,f20	G	G	G	0+0	183+117	0	f20<—237
pfadd.ss f0,f0,f0	G	G	G	0+0	0+0	300	f0<—0
pfadd.ss f0,f0,f21	G	G	G	0+0	0+0	0+0	f21<—300
fadd.ss f20,f21,f20	G	G	G	G	G	G	f20<—537

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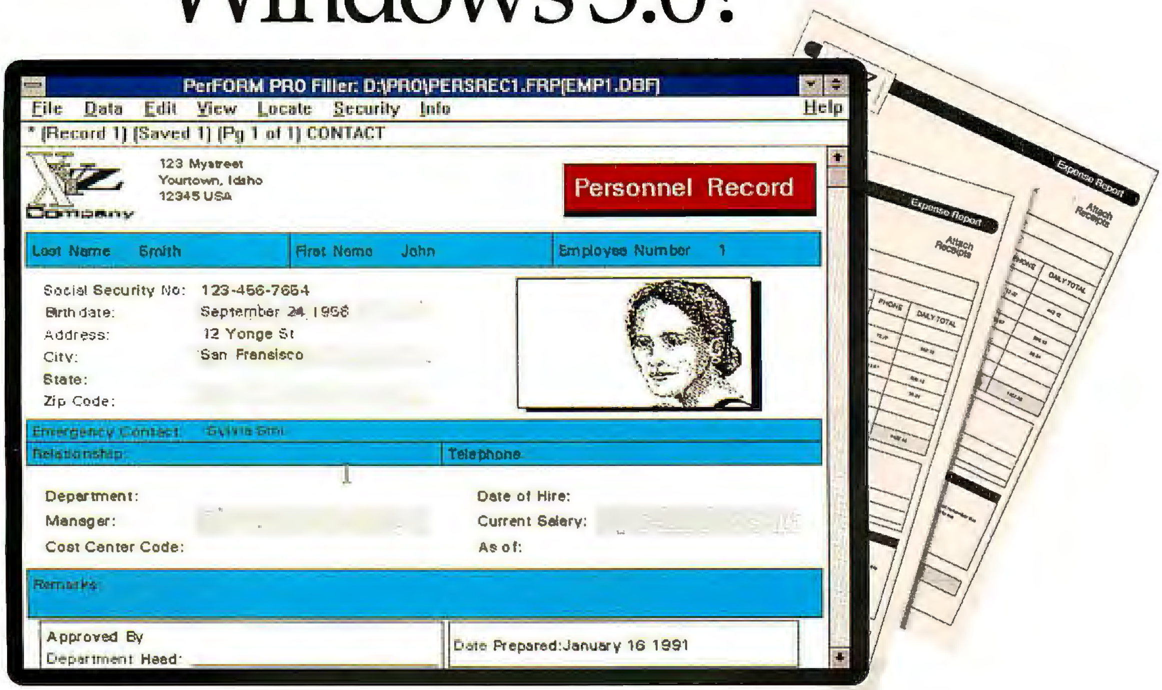

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Listing 1: *Note the use of both pipelined* (`pfld`) *and scalar* (`fld`) *load instructions. Pipelined loads are appropriate when you're going to use an operand once and then throw it away. Use scalar loads when you want operands to get stored in the cache.*

```
// Multiply eight elements of row A by column B.
// Row A is contained in registers f4..f11.
// Row B is contained in registers f12..f19.

inner::
d.m12apm.ss    f4,f12,f0      //Start f4*f12 into multiply-accumulate pipe.
        fld.q  16(r29)++,f8   //Load 4 elements of A into f8..f11
                              //from cache, and increment r29 by 16.
d.m12apm.ss    f5,f13,f0      //Start f5*f13 into multiply-accumulate pipe.
        pfld.d 8(r24)++,f16   //Load third stage of pipe into f16,f17
                              //and increment f24 by 8.
d.m12apm.ss    f6,f14,f0      //Continue with multiply-accumulate pipe.
        pfld.d 8(r24)++,f18   //Load and service B pipeline.
d.m12apm.ss    f7,f15,f0      //Continue with multiply-accumulate pipe.
        fld.q  16(r29)++,f4   //Load A now for use at top of loop!
d.m12apm.ss    f8,f16,f0      //Continue with multiply-accumulate pipe.
        nop                   //Dual-instruction mode always requires pairs.
d.m12apm.ss    f9,f17,f0      //Continue with multiply-accumulate pipe.
        pfld.d 8(r24)++,f12   //Load B now for use at top of loop!
d.m12apm.ss    f10,f18,f0     //Continue with multiply-accumulate pipe.
        bla    r27,r28,inner  //Start branching to the label now!
d.m12apm.ss    f11,f19,f0     //Last multiply-accumulate in inner loop.
        pfld.d 8(r24)++,f14   //Load B for next loop now!
```

pipeline that is controlled by the instructions of the form:

```
pfld.z src1(src2), freg
```

or

```
pfld.z src1(src2)++, freg
    //autoincrement
```

In both forms, src2 provides a base address to which src1 gets added. In the auto-increment mode, each instruction increments src2 by src1; that makes it possible to load arrays with constant stride factors stored in src1.

The z stands for the number of bytes to load into memory: 4 or 8. Because you're working with a three-stage pipeline, the destination register, `freg`, receives the data specified in the third prior `pfld` instruction, not the current one. As you can imagine, it's just about impossible to write pipelined code for the i860 without drawing stage diagrams to visualize what is happening in the pipelines.

In dual-instruction mode, you execute pipelined loads and pipelined add/multiply operations simultaneously. To

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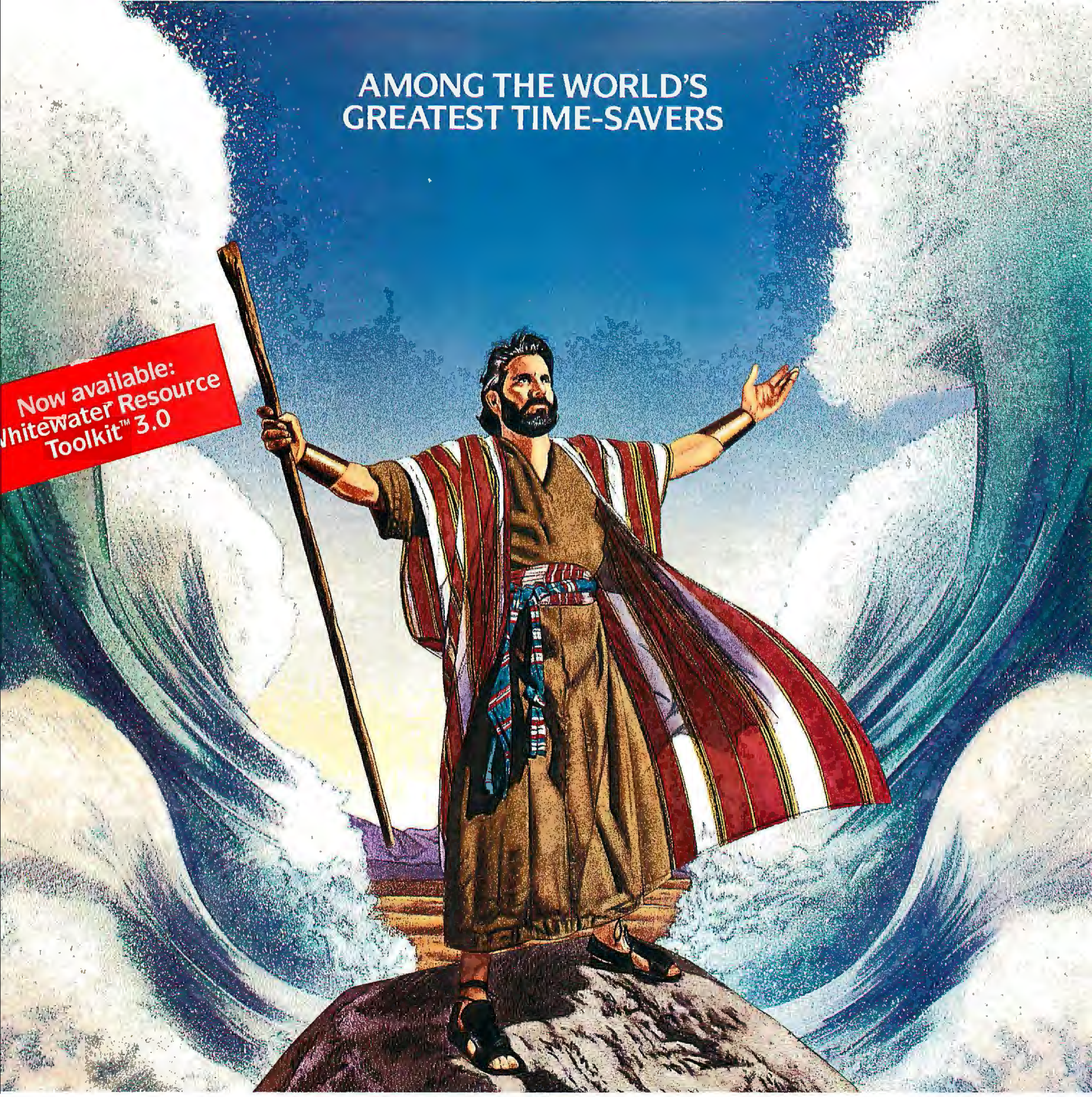

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accomplish this feat, you exploit the i860's ability to fetch two instructions at once from the instruction cache.

Listing 1 shows the inner loop of a matrix multiplication in dual-instruction mode. The `d.` prefix that precedes each multiply-accumulate instruction tells the processor to execute this floating-point instruction and the following core instruction simultaneously.

Note the use of both pipelined (`pfld`) and scalar (`fld`) load instructions. With pipelined loads, you bypass the cache; that's appropriate for large arrays that you're going to touch just once. Scalar loads fill the cache; that's useful for small matrices that will fit entirely in the cache, or for larger matrices whose rows can be cached.

There are many points of interest in this short piece of code, which takes just eight cycles (200 ns) to execute at 40 MHz. On every cycle, the i860 schedules four or five processor activities. For example, the third and fourth lines of code start the multiplier (and adder) pipes, store the third previous pipelined load to f16 and f17, and increment r24 by a constant stride factor of 8. That means the i860 performs five tasks every 25 ns, or one every 5 ns, which is the equivalent of 200 million operations per second on a conventional system. That's what transistor productivity is all about.

The code has a unique rhythm. The pipelined loads at the head of the loop deliver their goods at the bottom half of the loop, while the loads at the bottom are arranged to feed the top of the loop. The whole loop has the feel of the antique push-pull amplifiers used to power radio transmitters back in the old days.

After rewriting the Whetmat to call a hand-coded matrix multiply like the one that is shown in listing 1, the i860 hit 62 MFLOPS. That's quite close to the theoretical limit of66 MFLOPS (at 33 MHz), and much faster than the 4.9 MFLOPS the i860 achieves in scalar mode.

The i860 can make your dreams of personal supercomputing come true. My i860-powered Compaq 386/20 portable computer turns in over 10 LINPACK MFLOPS. How good is that? The top-of-the-line VAX 8800 produces 1.2 LINPACK MFLOPS; an IBM 3081K does only slightly better at 2.1. Of course, a Cray X cranks out over 60 LINPACK MFLOPS, but I can't carry one home. ■

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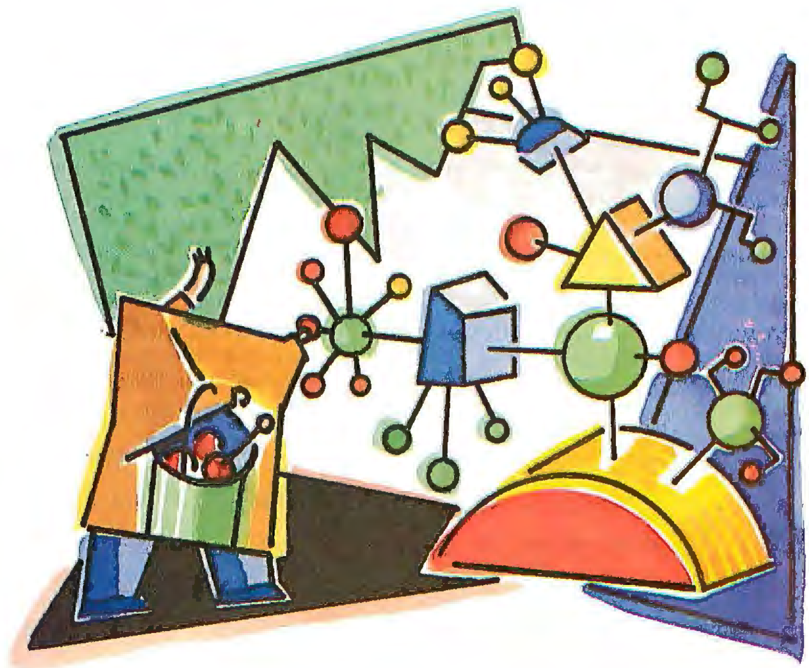
GENETIC ALGORITHMS

Programming takes a valuable tip from nature



In 1618, Johannes Kepler discovered that a planet's distance from the sun was related to the length of its year. He discovered the correct equation through a certain amount of intelligent guesswork and some experimentation. How could you begin to get a computer to solve this problem intelligently? You could try equation after equation until you found one that fit the data, or you could get your computer to do the work.

Another scenario: You are trying to program a robot to move around a complex and changing realm. The robot needs to adapt quickly to unanticipated problems without being reprogrammed. How can a computer find solutions to problems where the problems are not clearly spelled out?

Finding answers to these real-world problems is hardly easy. A solution to the first problem could be a formula composed of any number of sines, cosines, distances, and year lengths that is the best model of planetary motion. Not only are the combinations of rules that govern the movement of robots without number, but the rules themselves need to change. Rules that might work in one realm need adjustment to work in another realm.

One technique for solving these kinds of problems, called *breeding*, comes from nature. This genetic metaphor encompasses a wide range of search strategies and is proving to be a very flexible way to get computers to learn how to solve problems for themselves.

Mean Genes

Programming a computer to maintain its own "gene pool" of solutions and search for the best one requires you to first answer a few questions. What do potential solutions look like? How will the different solutions vary? What range of possible solutions might be in the pool? What is the difference between the good answers and the bad ones? What is a good way to quantify this? How will breeding take place? How can solutions be crossbred with each other?

The best place to begin is with an example from algebra: Find a way to solve two simultaneous equations, ax+by=c and dx+ey=f, where x and y are unknowns and a, b, c, d, e, and f are constants. You can easily show that x= (ec−bf)/(ae−bd). To simply the example (without reducing its generality), let's say that ae−bd=1.

You want to make the computer "learn" the solution to this problem. To do this, you must come up with a basic plan for describing what a solution for x looks like: It must be some arithmetic combination of a, b, c, d, e, and f. Why give the computer any more hints than this? Let the solution domain be the set of ({ }) equations, made up of either the addition, subtraction, or multiplication of the six constants a, b, c, d, e, and f. This is represented in the computer as a binary tree with an a, b, c, d, e, or f in the leaves and an operation at each of the interior nodes joining two leaves. Figure 1 shows the tree that represents the correct solution. You can call these potential solutions *genes*.

You can easily generate genes by randomly choosing arithmetic operations or constants; if it is an operation, you recursively call the same procedure on itself to find the two subtrees below it. This will generate plenty of solutions, almost all of them incorrect. It would be possible to check them all and eventually find a correct one, but it is unnecessary to take this exhaustive approach. Surprisingly, breeding better solutions from genetic algorithms is much faster.

continued

Gene Gym

If you are going to apply some Darwinian test of fitness, you need to develop a function that quantifies "best." You can create an appropriate function for the example of two simultaneous equations from a set of 15 samples. For instance, if a=1, b=2, c=4, d=0.5, e=2, and f=3, then $x=2$. Why not test a random tree with these particular values of a through f and see how closely it comes to the correct answer of 2? If your program selects 15 random tests and can find the correct answer in all cases, there is a pretty good chance it is the correct answer for all possible values of a through f. So let the *fitness* of a solution be the sum of the squares of the differences between the correct answer and the current attempt. The best answer will have a fitness of 0, and the worst will be a large number.

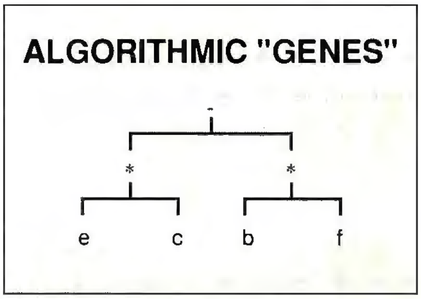


Figure 1: *To solve the two simultaneous equations $ax+by=c$ and $dx+ey=f$ (where x and y are unknowns and a, b, c, d, e, and f are constants), you can set up a binary tree with the constants as "leaves" in the tree, and mathematical operations at the branches. Solving for x gives $x=(ec-bf)/(ae-bd)$. If you assume that $ae-bd=1$, then $(ec-bf)$ is the correct answer. This tree shows how this "gene" is represented in the computer.*

You need to answer two final questions. How do two solutions "breed?" What is a sensible way to mimic the effects of recombination of DNA? In the example above, you would have the computer perform two steps: *reproduction* and *crossover breeding*. The reproduction step will consist of creating a new generation in which the more "fit" solutions are more highly represented that the unfit ones. This can be done by randomly selecting answers that are weighted by the value of the fitness equation. More of the fitter solutions tend to survive into the next generation.

The actual mixing takes place in the crossover breeding. You accomplish this by taking two potential solution trees, selecting a random interior node from each of them, and then swapping the subtrees below them. (Figure 2 shows how this can be done with two solution trees.) This is applied to random pairs in the generation. Usually the process of reproduction is followed by crossover breeding of a fraction of the genes. The two operations of reproduction and crossover breeding are interwoven until the solution is found.

Some researchers have extended this genetic metaphor to include a form of random mutation: For each batch of reproduction and crossover breeding, a small number of random nodes are selected and changed. The genes with these small differences will often shake a population out of a static configuration.

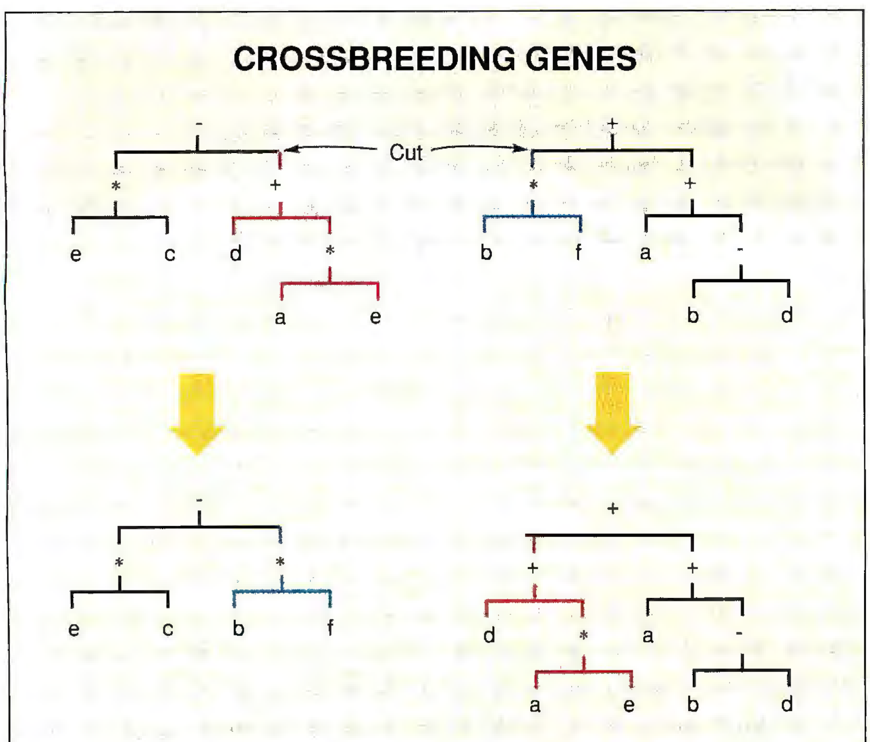


Figure 2: *To "breed" two possible solutions and come up with a still better solution, you can perform "crossover breeding." Here, two solutions (top) are cut at the points indicated, and the subtrees below those points are swapped, resulting in two new solutions (bottom). Note that one of the new genes is the correct solution shown in figure 1.*

Actual Behavior

A complete listing of a genetic algorithm is available as GENE.PAS in electronic format (see page 5 for details). See the text box "A Sample Genetic Algorithm" at right for the pseudocode of the software.

The program was written in Pascal, and its structure is complete enough to allow modification to any other problem. It is only necessary to rewrite `EvaluateGene` and the random `Gene Creation` code at the beginning. Most of the other code does not need to be modified to suit the individual problem. The software also includes other parameters, such as the number of potential solutions in each generation and the maximum size of the tree.

If you experiment with this example of genetic problem-solving software, you'll notice that the default parameters aren't necessarily more useful than others, but it is possible to come up with some rules of thumb. For example, more genes in each generation means that the simulation will take longer to run, but it will also maintain a wider range of diversity. The number of times that you test cases is a trade-off between speed and a vague notion of accuracy. More test cases means that the computation of the fitness function takes longer, but it also means that the computation will do a better job of screening out mistakes. If only one test case is used, then random functions that just happen to get that one case right would be selected far too often, and the fitness function would provide little guidance. On the other hand, testing 40 or 50 cases would be overkill.

A Sample Genetic Algorithm

The pseudocode example in listing A uses three parameters: the size of the gene pool; MaxGenes, the number of generations to simulate; and MaxGeneration, the number of genes to cross, which is some value that is less than or equal to MaxGenes and the mutation probability.

Data Structures

Variables. A list of values that make up the realm that the genetic algorithm is trying to model. In the case of the two simultaneous equations, it is the set {a, b, c, d, e,f}.

Listing A: *The main loop.*

```
for i:=1 to MaxGenes do
   OldGenePool[i]:=
     CreateRandomGene
for Generation:=
     1 to MaxGeneration do
   for i:=1 to MaxGenes do
        FitnessValue[i]:=
          EvaluateGene
            [OldGenePool[i]];
   NormalizeFitnessValues;
   Reproduce; {Creates new genes
                in NewGenePool}
   CrossOver[CrossOverNumber];
   Mutation[MutationProbability];
end;
```

Operations. The set of possible operations applied to the variables. In the case of the two simultaneous equations, it would be {*,+,−} but may include functions of one operand, such as sine, or user-defined functions of many operands.

Gene. A tree with operations on its interior nodes and variables on its leaves.

OldGenePool,NewGenePool. The old and new gene pools.

Test Cases. A set of values for the variables and a correct answer. For instance, if {a=8, b=5, c=2, d=3, e=2, f=1}, then $x=-1$. The potential Genes are checked against these Test Cases to determine their fitness.

Functions

CreateRandomGene. This returns a random tree filled with operations at the interior nodes and variables on the leaves. Used at the beginning only.

EvaluateGene[x:Gene]:Fitness Value. EvaluateGene takes a gene, compares it against the test cases, and produces a number that measures how good the gene is in matching the correct results. One function that works well uses the sum of the squares of the difference between the value using the gene and the correct value: Σ (gene-result − correct value)^2. This is usually inverted so that the best genes have a fitness value approaching 1, and the worst a value approaching 0:

$$\frac{1}{1 + \Sigma(\text{gene-result} - \text{correct value})^2}$$

NormalizeFitnessValues. This takes the fitness values from the evaluating gene and normalizes them so the total adds up to 1. This produces a relative fitness number. The best genes have a much higher rating than the others.

Reproduce. This takes an old generation and creates a new generation using NormalizeFitnessValues. To create each new gene in the pool, Reproduce copies an old one selected with a randomized process weighted by the normalized fitness values (i.e., the genes with the highest fitness values are more likely to make it into the NewGenePool). The weighting ensures that the new set of genes will contain the better genes.

CrossOver[i]. This function takes *i* different genes from NewGenePool in pairs and "breeds" them by crossover. That is, it selects a random interior node of each gene and swaps the subtrees under these nodes. This creates the different types of functions.

Mutation[p.]. This selects nodes at random from the genes in NewGenePool and with probability *p* and mutates them into something different.

Setting the number of genes that are mated with each other through crossover (CrossoverNumber in the pseudocode) involves a more subtle trade-off. Consider the extremes: If there was no crossover, then the program would never create any new structures from the initial random population; the population would tend toward a stable selection of the best initial guesses. On the other hand, if every gene was crossed with another after reproduction, then many superior genes would quickly be crossed out of existence. Crossbreeding 90 percent of the population seems to work reasonably well, because good functions will often have a high-enough fitness value to make their way into the noncrossed 10 percent. Choosing a mutation rate involves weighing the same trade-off.

The fitness function is another important detail that needs to be tuned carefully. If the function is too steeply graduated, the moderately successful genes will still enjoy a vastly superior fitness value, and the next population will be almost completely homogeneous. Suddenly, any hope for good combinations produced from crossover will be gone. On the other hand, if there is not enough difference in the fitness functions, then there will be little guidance to the function and the whole process will be no better than a random walk. The fitness function uses the square of the sum of the differences. (Other functions may be better for different applications.)

The entire process of developing genetic algorithms is, by nature, empirical. The best results always come if you stop the program frequently and watch the way the functions change. I've found that I need to tune the fitness function several times before success. When I was first running the software and trying to find a solution for two simultaneous equations, I was generating random genes with 31 nodes, while the correct function only had seven. Since the random process of crossover and mutation conserved the number of nodes in the system, I usually encountered trees that were larger than optimum. I solved this problem by generating genes with a wide range of sizes. The important part was rolling up my sleeves and watching the gene pool change.

At first, you may be disappointed. Using genetic algorithms often does not yield a correct solution because the process has evolved itself into a "genetic corner," or niche. The system can reach a stable state in which the remaining genes will often combine to make further instances of themselves. The result is that no amount of crossing or mixing will generate substantially different forms. To an extent, this effect is unavoidable.

The fitness function drives the system toward better solutions, and sometimes it takes a wrong turn. The system will often converge after running and rerunning the fitness function several times. A mutation process can help move the process

There have been several programs that have learned to navigate and plan.

out of a niche, but mutations aren't as successful as just having the breeding start over with new values. If the mutation rate is too high, the system starts mutating backward because it overwhelms the force of reproduction. As an alternative to mutation, you can run several different gene pools in parallel and then occasionally cross the different pools together.

Real-World Examples

For many years, there has been experimentation with genetic algorithms that solve real-world problems. In 1980, S. F. Smith created a poker-playing set of rules using genetic breeding for his doctoral dissertation from the University of Pittsburgh. The program was not forced to choose which cards to discard, but it did have to control the betting. In a set of runs against a fairly good poker algorithm, the software quickly learned how to exploit a bug in the algorithm and trounce it. Even when the bug was fixed, the genetic algorithm still continued to learn to win consistently.

There have been several programs that have learned to navigate and plan. For his Ph.D. dissertation from the University of Michigan, L. B. Booker created a system where a simulated animal learned how to find its way around a machine "world." John Koza and Martin Keane of Stanford University have adapted genetic techniques to keep a broom balanced, an application that is important not only to the circus but to a wide range of robots. Their technical report also contained examples from Kepler's work, as well as a way of solving two simultaneous equations.

John Koza has also written on the genetic approach to economic modeling. He has been especially interested in having genetic algorithms discover scientific equations.

At Xerox's Palo Alto Research Center (PARC), Tadd Hogg and Bernardo Huberman have been using genetic algorithms to stabilize some of the chaos in networks. They've found that if there is chaos caused by having many agents on a

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network competing for a resource (e.g., a file server), then rewarding the best predictive agents will stabilize the network.

David Goldberg, now at the University of Alabama, wrote a genetic system for his Ph.D. that learned how to control a gas pipeline. The important problems are determining correct flow rates and pressures to meet demand, and detecting leaks. His program can learn how to successfully handle the changes in demand.

A Short Theoretical Explanation

At this point, you may be wondering what is really going on in this big primordial soup of bits. Is it just random coincidence that is mating the correct subexpressions? Even though fitness functions control the reproduction, crossover and mutation quickly destroy whatever coherence there is. Is it more luck than science? One of the founders of the field, John Holland, introduced the notion of a schema to provide an abstract way of understanding the process.

To explain this, I'll use a simple example of a genetic algorithm from David Goldberg's book (see the Further Reading section at the end of this article). Consider a problem where the genes are 5-bit-long binary strings of 0s or 1s and the goal is to find the largest possible string (11111). You do the crossover by taking two strings, choosing a cutting position, and then switching. For instance, if the cut comes after the first bit, 10010 and 00111 yield 00010 and 10111. The fitness function is just the value of the string when taken as a binary number. The value of 10010 is 18. It should be easy to see how a small population will eventually evolve the right answer.

A schema in this instance is a string made up of three different characters—0, 1, or *, where the asterisk stands for "don't care." Each string in the population could correspond to a number of different schemata. For instance, the gene 10010 would correspond to the schemata 1****, 10*10, and 10010, among others.

In a similar way, each schema might have several corresponding genes, which are members of the population. For instance, 10*** would correspond to both 10010 and 10111. The value of a schema is related to the fitness function, and it is easy to see that schemata like 11*** are better than ones like 00*1*.

When reproduction occurs in the gene pool, the results are mirrored in schemata, and the better schemata find themselves with more corresponding genes than the less-fit schemata. In this example, the schema 1**** will probably find

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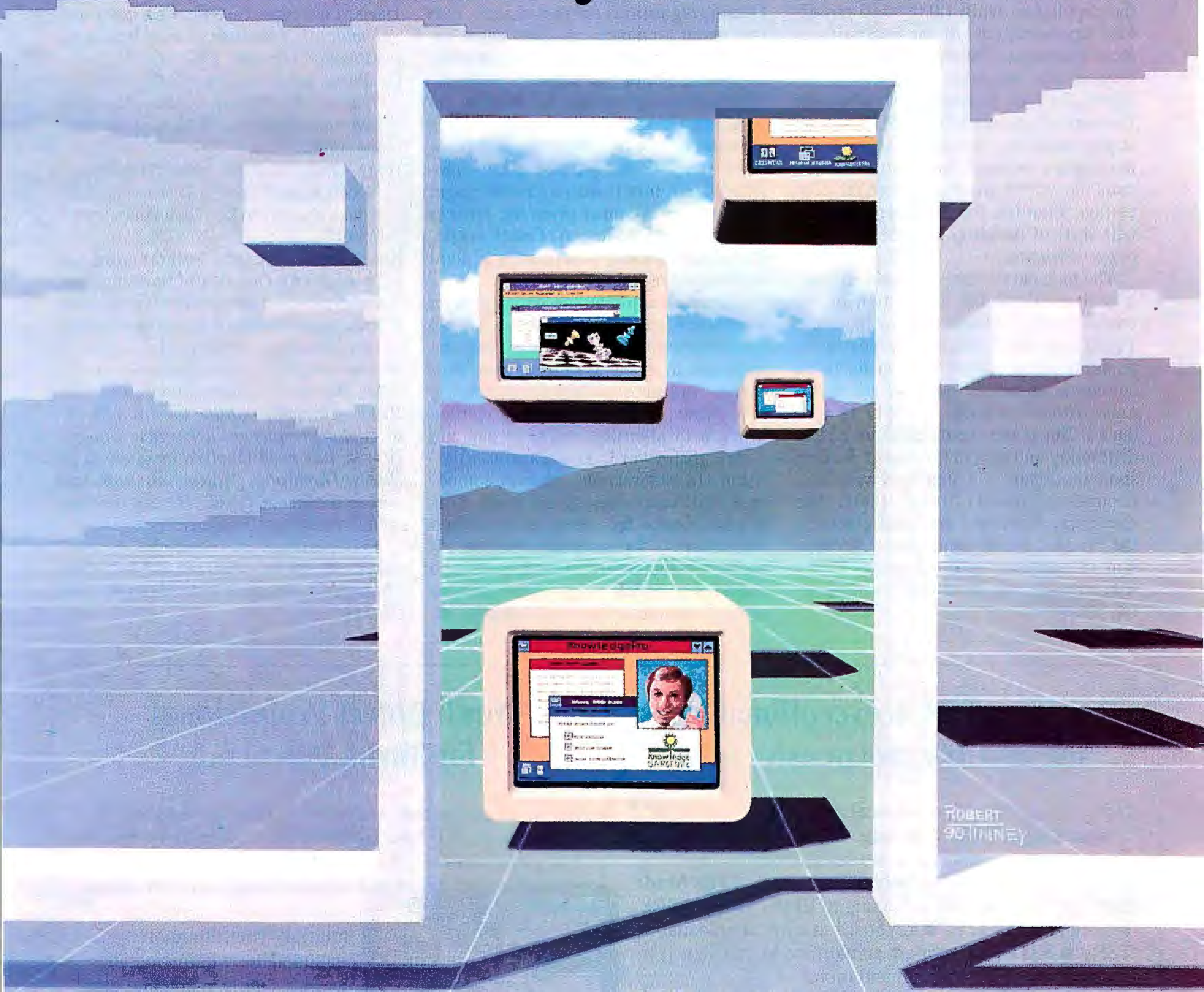

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itself with more corresponding genes in the population, while 00*** will rapidly lose representation. At the beginning of these operations, the main battles will be between the schemata representing the high-order bits, such as 1****, while the fortunes of schemata like ***10 will be largely random. When the average fitness values increase and the unfit schemata like 00*** are driven from the population, then the forces of reproduction will shift to deciding the fate of lower-order schemata.

The nice part of the schemata analysis is that it allows the abstraction of the complexities of crossover. For instance, 11110 and 00001 might be genes in the population that are set up to mate. If the cut comes at the last position, the maximum fitness possible (11111) is produced. But if the winds of chance blow differently and the cut is made at the first spot, the result is a step backward to a population with 01110 and 10001. The schemata, however, are unaffected by the random choice, and after reproduction of whatever pair emerges, 1**** will probably still have more corresponding genes than 0****.

Problems, Caveats, and Conclusions

Genetic algorithms are part chance, part intelligent guidance, and part eager experimentation. In a sense, they are like an abstraction of the scientific method. Their advantage is that the endless recombination and reproduction provide a certain amount of robustness and flexibility that are not part of many algorithms. But this is also a disadvantage, since the randomness gives the process an undeserved reputation of black magic. The analysis using schemata is a good explanation of what is happening.

Although applications using genetic algorithms are still new, many people are experimenting with applying the technique to problems ranging from Wall Street trading simulations to robotic movements. Often, the lessons learned by a genetic algorithm can be turned into a straightforward, nonadaptive algorithm. In other cases, genetic components will keep adapting the work. This is what Kepler did when he discovered the equation for planetary motion. If adaptive solutions are needed, there's no reason why genetic algorithms can't be reused to fine-tune existing solutions. ■

FOR FURTHER READING

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Peter Wayner is a consulting editor for BYTE. Currently reading toward a Ph.D. in computer science at Cornell University, he has been involved in research at IBM's Thomas J. Watson research lab and at the Xerox PARC. He can be contacted on BIX as "pwayner."

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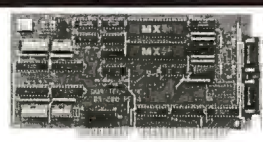

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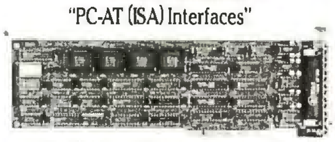

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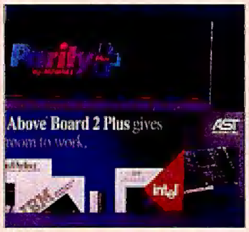

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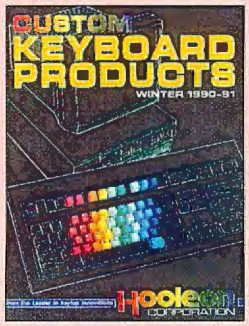

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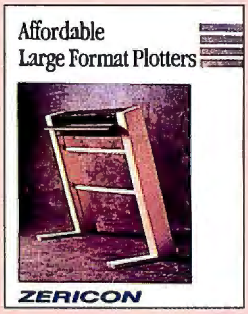

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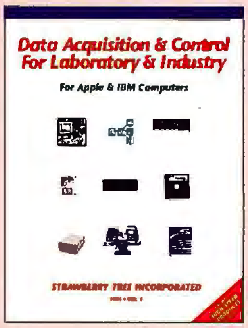

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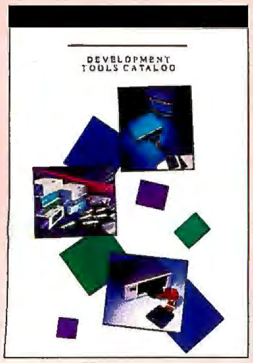

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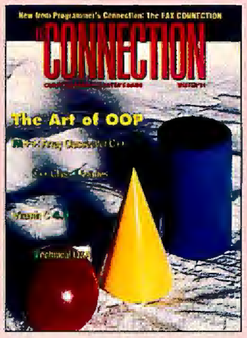

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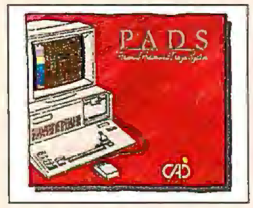

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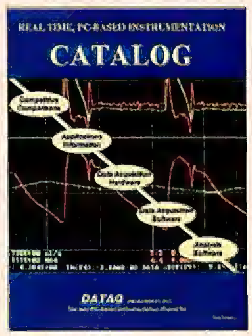

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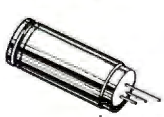

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- Wavelength: 820nm
- Collimation: .18mrad (typ.)
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STOCK #	PRICE
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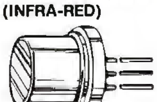

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- Current: 90-150 mA
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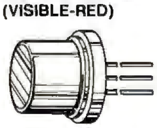

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- Current: 65-100 mA
- Operating Voltage: 1.75-2.2V
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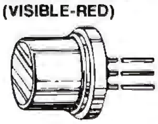

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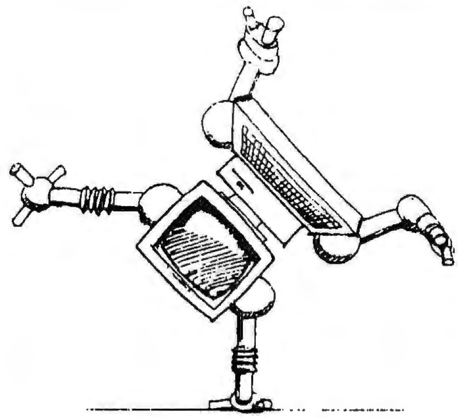

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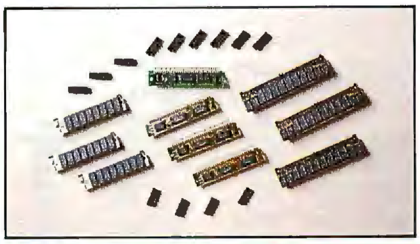
EVEREX		TREND	
Internal 1200 BAUD	$ 69	Internal 1200 BAUD	$ 59
Internal 2400 BAUD	129	External 1200 BAUD	99
Internal 2400 BAUD w/MNP 5	169	Internal 2400 BAUD	69
External 2400 BAUD w/MNP 5	199	External 2400 BAUD	129

Laptop Memory

2MG Card-Toshiba Portable T1200e	$435
2MG Card-Toshiba Portable T1600	259
2MG Card-Toshiba Portable T3100SX	265
4MG Card-Toshiba Portable T3100SX	615
512K Card-Toshiba Portable T3100e	149
2MG Card-Toshiba Portable T3100e	259
2MG Card-Toshiba Portable T3200SX	289
4MG Card-Toshiba Portable T3200SX	689
3MG Card-Toshiba Portable T3200	419
2MG Card-Toshiba Portable T5100	265
2MG T5200	265
2MG Module-Toshiba Portable	265
2MG Module-Toshiba Desktop T8500	345

Memory Products



SIMM/SIPP MODULES

	150ns	120ns	100ns	80ns	70ns	60ns
4MG X 9	—	—	—	$415	$385	—
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INTEL (80287)	$120	$183	$208	$280	—	—

8088 MATH CO-PROCESSORS

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INTEL (8087)	$88	$115	$165

386 MATH CO-PROCESSORS

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CYRIX (83D87)	$305	$350	$450	$549	—
IIT (3C87)	$305	$350	$450	$549	—
INTEL (80387)	$305	$350	$450	$549	$290

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1 MB	$109	1 MB	$ 62
2 MB	$179	2 MB	$ 94
4 MB	$309	4 MB	$289
TONER	$ 74	TONER	$ 70

IBM PS-2

34F2933 - 4MG Memory Module for 55SX; 65SX Memory Option IBM P/N 34F3077; 34F3011	$599
6450375 - 1MG Memory Bd for 80-041	149
6450379 - 2MG Memory Bd for 80-111;311-121; 321	320
6450603 - 1MG Module for 70-E61; -121, Adaptor Board IBM P/N 6450605, 6450609, 34F3011 & 34F3077	95
6450604 - 2MG Module for 70-061, E61; -121, 50Z; 55SX 65SX; P70	165
Adaptor Board IBM P/N 6450605, 6450609, 34F3011 & 34F3077	185
6450608 for Model 70A21	185
30F5360 (Kit-2 ea)	190
30F5348 (Kit-2 ea)	72

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MITSUBISHI 60MB, 5.25HH, RLL, 28ms	849
CONNER 3204 200MB, 3.5HH, RLL/IDE, 16ms	900

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	1MB Module	113646-001	138.00
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DESKPRO 386/20, 25 286E	1MB Module	113131-001	130.00
	4MB Module	113132-001	295.00
DESKPRO 386/20e	1MB Board	113644-001	248.00
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DESKPRO 386/33, 486/25 SYSTEMPRO	2MB Module	115144-001	218.00
	8MB Module	116561-001	999.00
	32MB Module	116568-001	5990.00
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PORTABLE III	512K Kit	107331-001	89.00
	INTFC BD	107808-001	99.00
	EXP BD	107811-001	249.00
	2MB Kit	107332-001	179.00
SLT/286	1MB Module	110235-001	249.00
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LTE/286	512K Board	117077-001	199.00
	1MB Board	117081-001	179.00
	2MB Board	117081-002	249.00
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	INTFC BD	107707-001	99.00
	4MB Board	107653-001	799.00
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SLT/386S	1MB Module	108303-001	349.00
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	2MB Module	N/A	224.00
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	4MB Kit	500510-008	359.00
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PREMIUM 386/25, 16sx, 586/33	1MB SIMM	500718-001-2	79.00
	1-16MB	500722-004	495.00
PREMIUM 486/ 2ST, 25TE, 25, 25E & 33	1MB SIMM	500718-002	89.00
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PORTABLE T3100SX	2MB BD	PC15-PA8308U	259.00
	4MB BD	PC15-PA8310U	589.00
PORTABLE T3200	3MB BD	PC6-PA7137U	399.00
PORTABLE T3200SX	2MB Kit	PC12-PA8307U	249.00
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PORTABLE T5100	2MB BD	PC7-PA8301U	259.00
PORTABLE T5200	2MB Kit	PC10-PA8304U	259.00
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30-286, 50 & 60	2MB Kit	30F5360	174.00
PS/2 50Z & 55-SX, 65SX	1MB SIMM	6450603	98.00
	2MB SIMM	6450604	139.00
55SX & 65SX	4MB Module	34F2933	399.00
50, 50Z, 55 & 60, 65SX	2-8MB Board	1497259	499.00
PS/2 70-E61, 061, 121	1MB SIMM	6450603	98.00
	2MB SIMM	6450604	139.00
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PS/2 80-041	1MB Module	6450375	135.00
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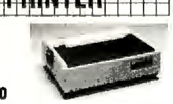

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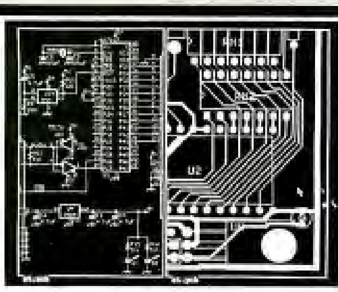

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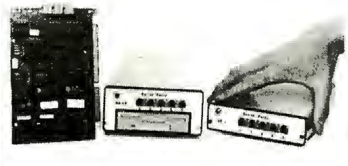

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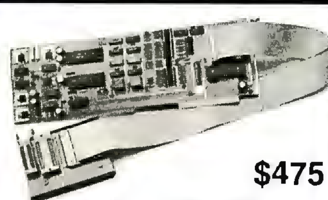

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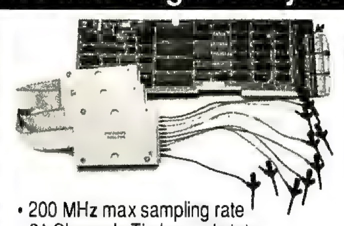

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Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

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Index to Advertisers by Product Category

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Title ______________________

( ) Phone ______________ ( ) Fax ______________

Company ______________________

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City ______________ State ________ Zip ________

A. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level 9 ☐ Professional
8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS 15 ☐ UNIX
13 ☐ DOS + Windows 16 ☐ MacOS
14 ☐ OS/2 17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1–25 20 ☐ 51–99
19 ☐ 26–50 21 ☐ 100 or more

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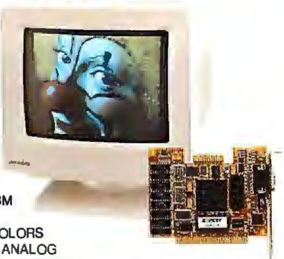

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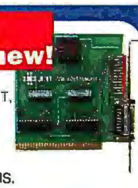

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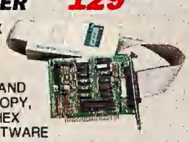

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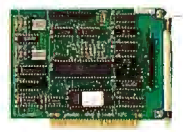

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Zenith Orphan

Dear Jerry,

I would be grateful if I could enlist your help in looking after an orphan computer for which I am the guardian.

The computer in question is a four-year-old Zenith ZP-151, which was an early diskless laptop with Microsoft Word, Multiplan, and Project stored in ROM in an early version of Microsoft Works. It is sturdy and reliable.

The machine came with a cable and a software package (called ZPXFER) that allows you to upload and download programs via the RS-232C ports of Zenith computers, such as the Z-150 series. Unfortunately, the program doesn't seem to let you do the same through the ports of non-Zenith computers, which seems strangely arbitrary and is now frustrating, because I would love to use it with my AT and 386 clones.

Would you or your readers have any suggestions as to how I can use ZPXFER with my AT and 386 clones? Quite a few Zenith Z-150 series machines were sold, so the question may have some general interest. Zenith and the Zenith community that I have tried to contact have not been able to help.

The same machine had a port for a cassette recorder interface, but no specifications for this are provided. I would be interested to know if anyone has ever successfully interfaced this machine with any storage device.

I use the AT and 386 clones mainly for word processing and data analysis. For the latter task, I use SPSS-PC and a nice new logistic regression/survival analysis package called Egret, developed at the University of Washington in Seattle. I also use a package called NCSS, which has nice graphics, including Chernoff's faces. I would love to see implementations of sophisticated statistical graphics programs at affordable prices on MS-DOS machines (I am totally naive about Unix).

I really enjoyed your recent comments on the decisions about whether to update, change, or stick with old versions of software. I don't have any uninterruptible power supplies, and I dread the time when my equipment gets zapped!

I am a pediatrician working in developmental pediatrics, with an emphasis on epidemiology. My first degree and first love was psychology, so we share some interests. I am mainly interested in whether epidemiology can help us understand the causes of conditions such as cerebral palsy and undiagnosed mental handicaps.

Have you ever read any of the novels of Nigel Balchin? He was a distinguished British psychologist who also wrote successfully. His novel *Mine Own Executioner* introduced me to psychology. Balchin also wrote some good novels that often examined responses to fear in astronauts (*Kings of Infinite Space*) and bomb disposal experts (*The Small Back Room*).

Andrew J. Brunskill
Iowa City, IA

I had a Z-150, but I fear we gave it away. I don't know how to port things from it; apparently Zenith did a few things in a nonstandard way in those days. I recall, vaguely, that we had to get a new programmable array logic chip for the Z-150 to make it work properly.

I did my undergraduate work at the University of Iowa. Do the students still stand at the bottom of the hill to push tourists' cars at first snowfall?

I haven't read the novel in question, but if I see it in a bookstore, I'll grab it.

—Jerry

Changing Configurations

Dear Jerry,

I am writing in response to the letter from Norm C. Peterson (March 1990).

Peterson seems to want to be able to install certain device drivers that are furnished only in the .SYS form from the command line. I am unaware of any way of translating a .SYS file to a .COM file, but I have automated the change from one configuration to another. A quick and easy way to change configuration seems to be Peterson's fundamental, underlying need.

I keep all the various configurations that I would like to use in a series of files (e.g., CONFIG.001, CONFIG.002, and CONFIG.003). Then when I want to change configuration, I type `COPY CONFIG.003 CONFIG.SYS` and reboot. (I also keep a set of AUTOEXEC.BAT files in a similar format and change them at will.) While I don't do it, you can automate the COPY process with a batch file to shorten the typing and help prevent errors. For example, C.BAT would be a single line—`COPY CONFIG.%1 CONFIG.SYS`—or you could get fancier, with a menu to remind you what the individual configurations are.

At a second level of sophistication, I keep all the CONFIG.*nnn* files listed sequentially in a single ASCII file, CONFIG.DOC, so I can create a new CONFIG file by selecting portions of the old ones as needed. I don't have to look up the syntax of something I am already using; it is there in the .DOC file. When I have the new CONFIG.*nnn* ready in the CONFIG.DOC file, I mark it with a block and use the block-write-to-disk file function of my word processor (Control-K-W in WordStar nondocument mode) to create the actual CONFIG.*nnn* file. A similar process is used to keep an AUTOEXEC.DOC file.

This procedure also has the advantage of letting me return immediately to the original/desired configuration after an installation program has decided to change CONFIG.SYS or AUTOEXEC.BAT for me. This is an annoyance that you have written about from time to time.

Frederick S. Holmes Jr.
Annandale, VA

Please see my column in the July 1990 issue for a review of BOOTCON, which solves this problem once and for all.

—Jerry

College on Tape

Dear Jerry,

I liked the idea of having the entire Library of Congress on CD-ROM (Computing at Chaos Manor, June 1990), and I wonder just how to go about doing that—write another letter to my congressperson?

I see ads for boards that allow you to back up a hard disk onto VHS videotape. That should mean that a VHS videotape with an entire hard disk's load of stuff on it could load about as much information on just about any subject as a person could want. It's a little change in the idea of how to use a hard disk drive—not as a permanent file, but as a big temporary file.

A college course—including a textbook, exams, lectures, and library materials—could fit on about 10 VHS tapes. A videotaped lecture could be available at the library; you could rent it, borrow it, or buy it.

A four-year program would cost about $1000 for the PC, a color monitor, and two small hard disk drives; $500 for the VCR and interface board; $1000 for the tapes, and another $500 or so for registration and administrative overhead. A B.A. for $3000 seems quite likely. That's cheap enough for the third world to do.

Doc Stanley
Calexico, CA

Good idea. The information gap is getting wider, I fear, and we need innovative ways to close it.—Jerry

Affordable CD-ROMs

Dear Jerry,

The proliferation of CD-ROM libraries greatly disturbs me. CD-ROM publishers who insist on developing proprietary retrieval software are very quickly becoming their own worst enemy. A music compact disc costs anywhere from $10 to $15 and can be played in any CD player and quite a few laser disc players. An inexpensive CD-ROM package usually starts at $100 and quickly goes up from there. I do not wish to pay several hundred dollars for a CD-ROM package that is difficult to use.

I firmly believe that the high cost of CD-ROM drives is a direct result of the price of the ROM libraries. Why should a CD-ROM drive cost more than a CD player? CD-ROM starts digital and stays digital. There is no need for the circuitry necessary to convert digital to analog, as in the CD player.

Consumers need to say no to CD-ROM publishers' high prices until the quality is reflected in the price tag. If these publishers want to carve a niche for themselves, then they need to offer affordable packages. This should not hurt their profits, but enhance them. (Seen any poor rock stars lately?)

A certain degree of standardization is also necessary. Maybe what I need is a form of compressed ASCII in combination with a widely transportable graphics format. I know the drawbacks of ASCII, but can you think of a more transportable medium? (I can pass ASCII files among my AT clone, my 512K-byte Macintosh, and my Commodore 64 without difficulty.) Publishers could develop their own presentation formats, but the basic retrieval scheme should work on any CD-ROM that I drop into my machine. This is asking for miracles, but perhaps there is a way yet.

The Library of Congress is undoubtedly the greatest repository of printed information in the world, and it has certain standards for the submission of printed text (I'm sure that you, as a writer, are aware of this). Since the Library of Congress is in the process of saving all its documents on CD-ROM, might not it enforce a standard for retrieval?

For true multimedia capabilities, we also need standardized, multipurpose drives. What we need is a CD player with a SCSI port as well as the standard stereo connections.

Wouldn't multidisk CD-ROM capabilities be nice, especially if they could all be read by the same software? It's about time the CD-ROM industry looked at what the consumers need, rather than running around with a "me first and me exclusively" attitude.

George Avent Jr.
Columbia, SC

Two things: the electronics really are more complex in a CD-ROM drive than in a CD player; and I understand that CD-ROM drives are finally going below $500 and will soon be half that. By "soon," though, I mean probably a year or so, alas.

CD-ROM technology grows slower than I like, but progress is being made. Thanks.—Jerry

Adaptive Technology

Dear Jerry,

I read with interest the letter from Arni Fredrickson concerning large-print computer displays (Chaos Manor Mail, June 1990). As a visually impaired person employed in the computer field, I know of several products that may be of interest.

PC Lens, from ARTS Computer Products in Boston, is a TSR program. It takes characters that application programs write into monochrome adapter memory and maps them into large-print characters on a color graphics display. Using this approach, you're not limited to specific application packages; you can run virtually all IBM PC–compatible programs.

Vista is a hardware device manufactured by Telesensory Systems in California. Like PC Lens, it provides a wide array of character sizes up to several inches high on a 19-inch monitor. This package has the ability to enlarge graphics images as well as text-based material.

I suggest that Fredrickson contact the Technology Center of the American Foundation for the Blind in New York City. The people there may be able to provide additional information.

Douglass M. Fitzsimmons
Sewickley, PA

Thanks. They sound like good programs.
—Jerry ■

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

PRINT QUEUE

Hugh Kenner

Math Reconstructed

A worthy volume rediscovers the golden mean for readers in the postgeometry generation

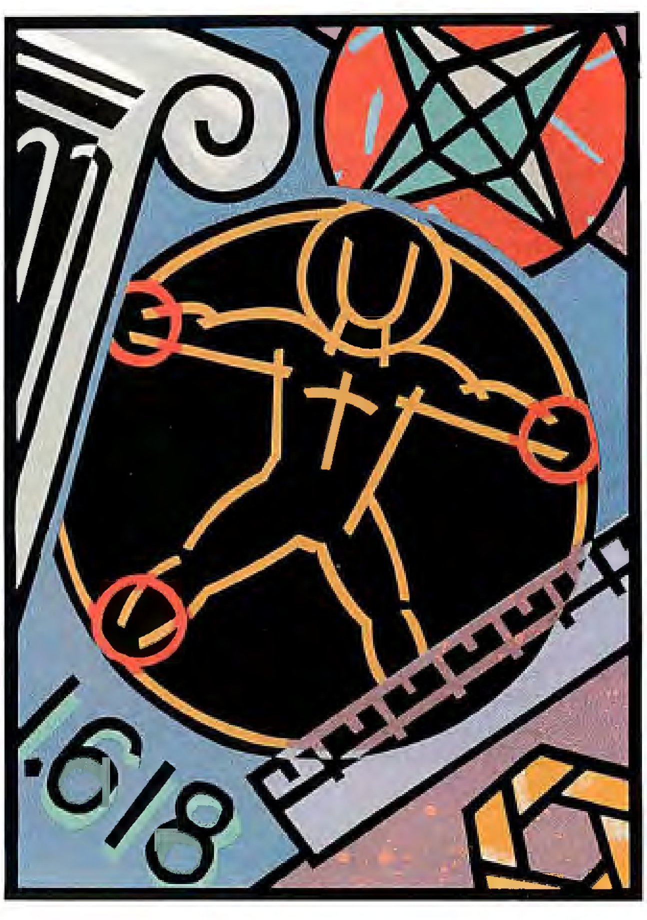
The French architect Le Corbusier imagined gods at play: "They play with numbers, of which the universe is made." He added that this play goes on behind a wall. Over that wall, for millennia, humans have been stealing glimpses.

At the New Jersey Institute of Technology, where Jay Kappraff teaches mathematics of design, his students draw on a harvest of such glimpses. They learn—and we can, too, from his *Connections: The Geometric Bridge Between Art and Science* (McGraw-Hill, 1991, $19.50)—how Renaissance architects derived room dimensions from the musical scale; what Béla Bartók's music owes to the Fibonacci series (each term the sum of its two predecessors, and the ratio of successive terms approaching the golden mean, 1.618..., as a limit); and what graph theory has to do with traffic patterns in a house, and also with reducing the count of the diagonal braces that keep houses from collapsing.

"It was only at the conclusion of my work on this book," Kappraff confesses, "that I discovered what it was about." Be assured, this is no crank book. Its theme is geometry as mediator between "the unity and harmony of the natural world and the capability of humans to perceive this order."

By page 8, the Greeks have discovered that golden mean, 1.618...; in our notation, "half of 1-plus-the-square-root-of-5." Make one side of a rectangle that long; make the other side 1. Now, down at one end, fence off a 1-by-1 square; the part that's left over will have exactly the same proportions as the rectangle you started with. That is true of no other ratio.

Being a magic number, the golden mean turns up everywhere. By page 26, Botticelli's Venus is being analyzed into golden-mean modules; therefore, the ratio, navel-to-sole/navel-to-crown, is exactly 1.618.... Now: Did the golden ratio pulsate at Botticelli's fingertips? Very likely. It was part of a quattrocento painter's education. But it's also "close to the average value for this ratio in the adult population at large." So the picture does accord with normal experience of what a fine body would look like.



Is that anticlimactic? It shouldn't be. For behold a golden principle. Some proportions seem natural because they're in nature. Having formed our sense of fitness on perceived order, we've learned to cherish formulas that describe it.

Also: Natural forms, one way or another, came into being amid forces in tension, a theme D'Arcy W. Thompson's classic *On Growth and Form* explored decades ago. That those tensions are mathematically describable is one assumption on which the whole edifice of Western science relies. The descriptions, too, are famously economical; *elegant* is a word we often hear. (Equations even get rejected by hunch: "Inelegant!") So do not be surprised when elegant numbers recur and recur to describe (1) what's just "there"; (2) how it came about; and (3) what we select as most elegant from all that we ourselves have brought about with paintbrush, chisel, welder's torch, and CAD program.

However, there's more to 1.618... than just visual experience. Once isolated by math, it acquires a life of its own. You want its reciprocal? Just subtract 1. Its square? Just add 1. A handy embodiment? Just draw a regular pentagon; the line from any corner to the corner after the next is longer than any side by, yes, 1.618.... Oh: If you have sudden need for a regular pentagon, a perfect one inheres in a mere knot; tie the simplest kind neatly in a paper tape and flatten it. Then, lo, a pentagon! Knots, pentagons, golden mean: This does all get uncanny. Is it preordained that numbers to describe our bodily experience will also be numbers interesting on paper? It does seem so.

ILLUSTRATION: JULIA TALCOTT © 1991

It nearly verges on the mystical.

Thus, if geometry describes, it also instigates, since you never know what may pop out of an unlikely abstraction. Graph theory leads to the old Tower of Hanoi puzzle (i.e., three pegs, the first with a tapering pile of rings; shift the rings one by one from peg 1 to peg 3, using peg 2 for interim storage, but *never* place a larger ring on a smaller).

Next, it turns out that an n-dimensional cube models the best strategy for transferring n rings. Kappraff presents a diagram to clarify that for $n = 3$. So, four rings? Constructing a four-dimensional cube would be a sticky problem; as a mental model, though, it does guide us as we move those rings. Finally, we learn that such merely discussable cubes are used to model "optimal networks for the flow of information in parallel processing computers." Whew. The music goes down and around and around, and parallel processors are one place it comes out.

It's fair to add that piecing glimpses together has led workers less scrupulous than Kappraff into wild places. Here's something he reports without telling us to buy it. The diameter of the earth divided by that of the moon gives us 11-to-3. To get English statute miles, multiply both numbers by 720: Lo, 7920-to-2160, earth-to-moon, just about right! But look, 720 is $(3 + 4 + 5)$ multiplied by $(3 + 4 + 5)$, and geometry buffs will recognize 3, 4, 5 as the sides of a right-angled triangle, because $3^2 + 4^2 = 5^2$, a fact Egyptian builders are known to have implemented in a 3-to-4-to-5 loop of knotted rope. (And how many knots around that rope? Why, 12, the number of months! Gee whillikers!)

Whereupon a man named J. Michell, in a 1988 book called *Dimensions of Paradise*, bade us ponder the "New Jerusalem Diagram," a plan he says was subscribed to by Plato and the builders of Stonehenge, not to mention St. John in Revelation 21. The plan is generated by a 3, 4, 5 triangle, from which (I haven't space to show you a diagram) it's easy to derive a large 11-unit square surrounded by 3-unit outriders. And lo, 11-to-3! Lo, earth-to-moon! Lo, finally, from its $(3 + 4 + 5)$ factors, that 720 multiplier! And, yes, the moon *is* just 3×720 miles thick! (Official figure: 2159.9.) Ah, what lore our ancestors must have shared with gods!

But that neatness presupposes builders of Stonehenge—Bronze Age folk chipping at chalk with deer-horn picks—who knew the relative diameters of earth and moon, a ratio, so far as we can tell, first approximated by Alexandrian Greeks some 2000 years post-Stonehenge. Yes, and they'd have had to know the absolute diameters, too.

Finally, our pleasure in a neat multiplier to convert 3 and 11 into just-right miles: Alas, that requires yet one more unlikely assumption. For it needs chalk-chippers foresighted enough to have enshrined today's English statute mile, 5280 exactly of 12-inch feet, something that got defined only as late as the sixteenth century. (That number, $8 \times 220 \times 3$, was used to obtain a match with 8 furlongs of 220 yards. English miles had previously come in several flavors, all loosely related to the Roman *milia*, "thousand." At 1000 two-step "paces," what the stocky legionaries stepped out would have been some 10 percent shorter.)

Balderdash, in short, of the kind that's given Kappraff's subject a bad name. "The reader must judge," he intones as he reports it. That comes, it's fair to add, as early as page 4, where he's feeling his way toward the sort of book he's writing. Nowhere else do his expositions assume ancients to whom gods had spoken. They assume either natural forces, or else people

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doing what seemed natural at the time, and draw our attention to congruences.

Thus, in chapter 6—and by then he's on a roll—he moves rapidly but cleanly from soap films, minimizing area, to road networks, minimizing length, to "inner tissue from the shaft of a bird-feather and the fruit of a crab-apple," in which we find nigh-identical patterns thanks to constraints that keep nudging the edge/face ratio toward 6.

Such constraints supply a social metaphor whenever "closer interaction with some neighbors makes cooperation with others less easy"—for instance, when market towns are getting located. (Fifty years ago that seemed a toy for two German theoreticians; it's since been "quite well" validated by footwork in Szechwan.)

Nor are we done. Turn the page, and we've a map of Cambridge, Massachusetts, school districts (place the school where it's closer to its children than its neighbors are); turn another, and we're back with soap-bubble patterns; later in the chapter we're examining the placement of hexagons on a pineapple, to encounter, without surprise, 1.618... yet once more. And That's Not All, Folks: It's just a skim of three-fourths of one chapter.

Kappraff's epilogue deserves a moment's pondering. "Although two- and three-dimensional Euclidean geometry has traditionally nourished the roots of mathematical thought, today it is a much neglected subject studied only by a few specialists." That is true. Math got deconstructed a generation or more before literature. The greatest geometrician of our time, Toronto's H. S. M. Coxeter, I've heard described as a crank. At Harvard, Arthur Loeb hangs in there. They are two major geometrical generalists I happen to know of. I know of them out of my (and their) interest in Buckminster Fuller, yet another "crank," to get associated with whom will do you no good in academe. (It never harmed me, but I don't claim expertise in math.)

Well, "It is out of the need to rediscover geometry as the language of the arts and sciences that design science had its origins." And design science is what Jay Kappraff professes, albeit not at a place congruent with Harvard. "To help recreate the linkages that bind us to the work of the centuries that have preceded us": Those are his book's last words. It's certainly heartening that a major publisher has issued it in both paperback and hardback. ■

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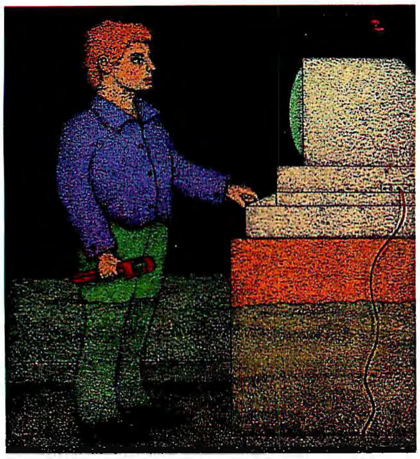

AMATEUR SYSTEMS

A new breed of software for people who don't need all the answers

A day doesn't pass at BYTE without our receiving a press release telling us about some new product or company that is at the "forefront of technology" in its particular area. It must be getting pretty crowded at the forefront. I recently heard of a guy who had bought a small piece of the forefront—with barely a hundred feet of frontage—back when it was cheap. Today, he's making millions renting it to venture capitalists by the week.

One area of the forefront to which companies periodically claim they have muscled their way is artificial intelligence, which means making computers think the way humans do. In my case, this would mean devising a system that could remember all the words to the "Flintstones" theme song but forget that the car registration ran out last week.

Of course, researchers love to spend time arguing about just what constitutes AI. These are the people who, when they were in college, spent a lot of time sitting around dorm rooms and arguing about trees falling in the forest, rather than engaging in useful activities like streaking and playing Grateful Dead records loud enough to be heard in the next state. After graduation, these people went into research and industry, where they're still arguing. (See this month's State of the Art section.)

The most common place to find AI is in expert systems—computer programs that distill the knowledge of human experts for use by nonexperts. The idea is that, when the human expert isn't available, you consult the computer. Expert systems have been around for a while now, and they're the most tangible result of the boom in AI that was predicted a few years back by consultants who make a living predicting booms in industries.

However, expert systems have never caught on as a major applications category, like word processing or spreadsheet programs. There are a few reasons for this. First, expert systems can be expensive. It costs money to extract information from experts, most of whom react to the idea that they could be replaced by a machine with as much enthusiasm as if they were going for a lobotomy.

Another reason expert systems haven't caught on is that nobody likes a know-it-all. Think about it. If you've got a problem, what do you do? First, you probably call a friend, someone who knows a little bit about the subject and won't charge you anything to offer an opinion—someone named Carl or Walter. What we need is software that can put the Carls and Walters of the world on a disk. What we need are "amateur systems."

Here's an example, something I call the Amateur Auto Mechanic. For authenticity, it would come in a jacket with greasy fingerprints and oil smudges. When you boot the disk, it would make a noise like a '67 Chevy revving its engine. A sample session might go like this:

Q: What's up?
A: My car keeps stalling.
Q. Is there smoke coming out of the exhaust pipe?
A: Yes.
Q: What color is the smoke?
A: Blue.
Q: Really? Wow, you had better have someone look at that.

How much would you pay for a program like that? Not much, huh? Well, that's the point—you wouldn't *have* to pay much. And you'd get what you paid for.

Then there's the Amateur Plumber:

Q: What's the matter?
A: There's a puddle under my kitchen sink.
Q: Where's the water coming from?
A: From the trap.
Q: Maybe you should try tightening the little silver thingamajig around the neck of the trap. Does that help?
A: Now there's water everywhere.
Q: How much water? (Choose one):
 a. a lot
 b. a whole lot
 c. get out the mop
 d. get out of the house

Here is another idea. Everybody knows that the cost of health care is skyrocketing. This is largely because people have gotten used to running off to see the doctor for every little complaint. To cut down on these types of visits, I've been collecting the knowledge base for a program called the Amateur Physician. I was a premed in college and worked in several hospitals, so I already know most of the basic terminology, phrases like, "There's a lot of that going around," or "My cousin had that, but now she's: a) much better; b) much worse; c) dead; d) in Pittsburgh."

As you can see, I've already done a lot of the preliminary work on this concept, and all I need is some backing to make it a success. Interested venture capitalists should give me a call at Amateur Systems, Inc. I plan to locate the company far from the forefront of technology, where there's lots of room for growth. ■

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