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APRIL 1993

BYTE

THE WORLDWIDE COMPUTING AUTHORITY



Best Little PCs

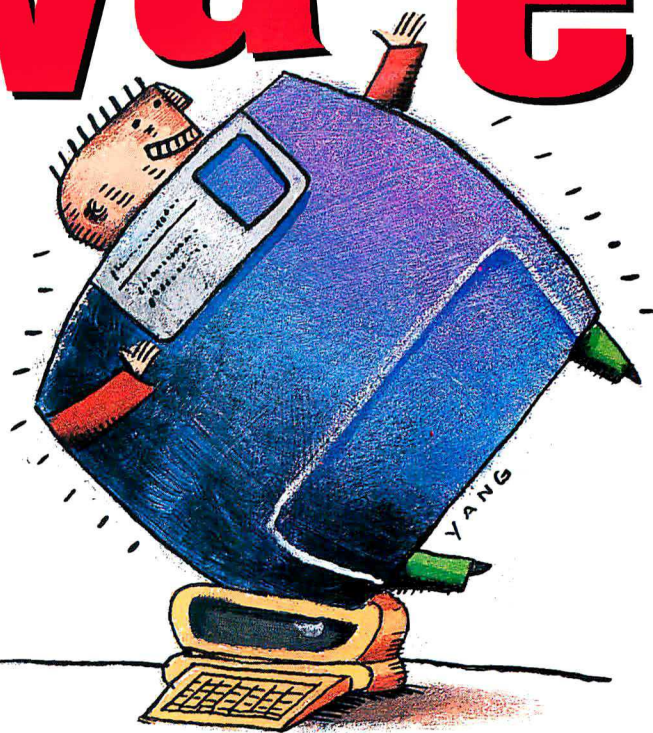
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Fighting Fatware

Software keeps getting bigger and bigger, demanding faster PCs and more disk space. Fortunately, there are solutions. Turn to page 98.

SPECIAL REPORT: Page 150

Shrink your data



8 new ways to extend your Mac PowerBook

EXCLUSIVE:

BYTE tests software makers' claims of minimum hardware requirements.



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Whether You're On The Road
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Portables And C

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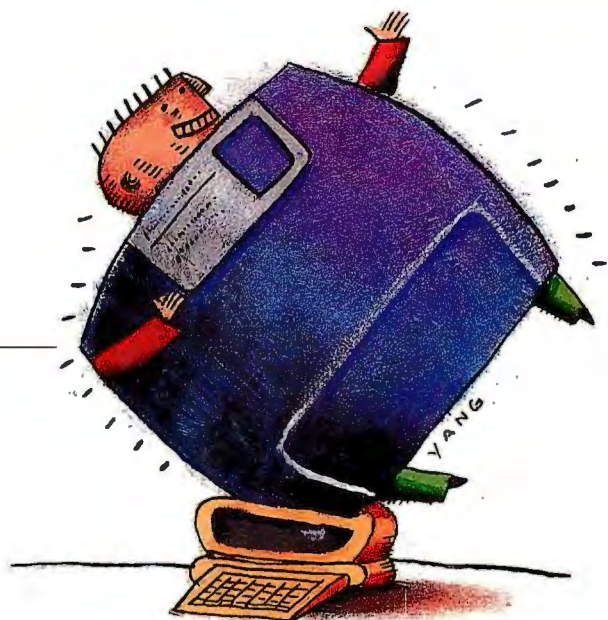
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Fighting Fatware

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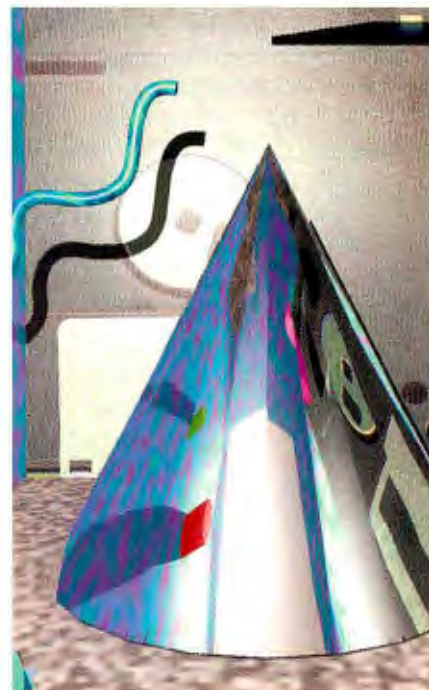
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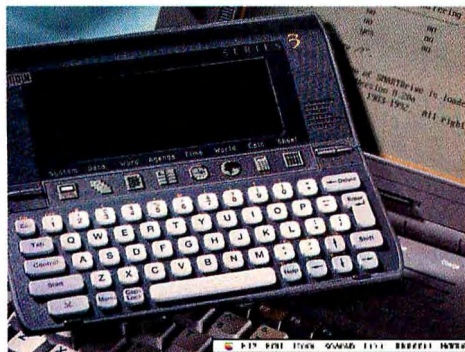
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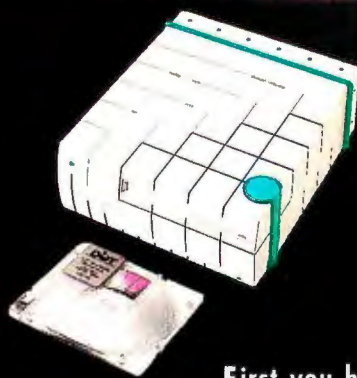
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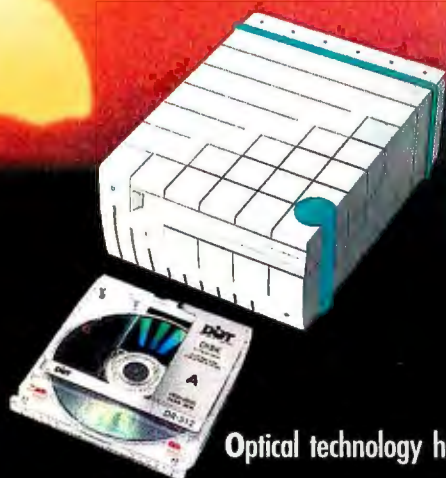
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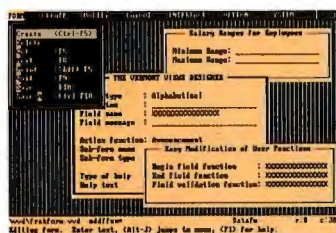


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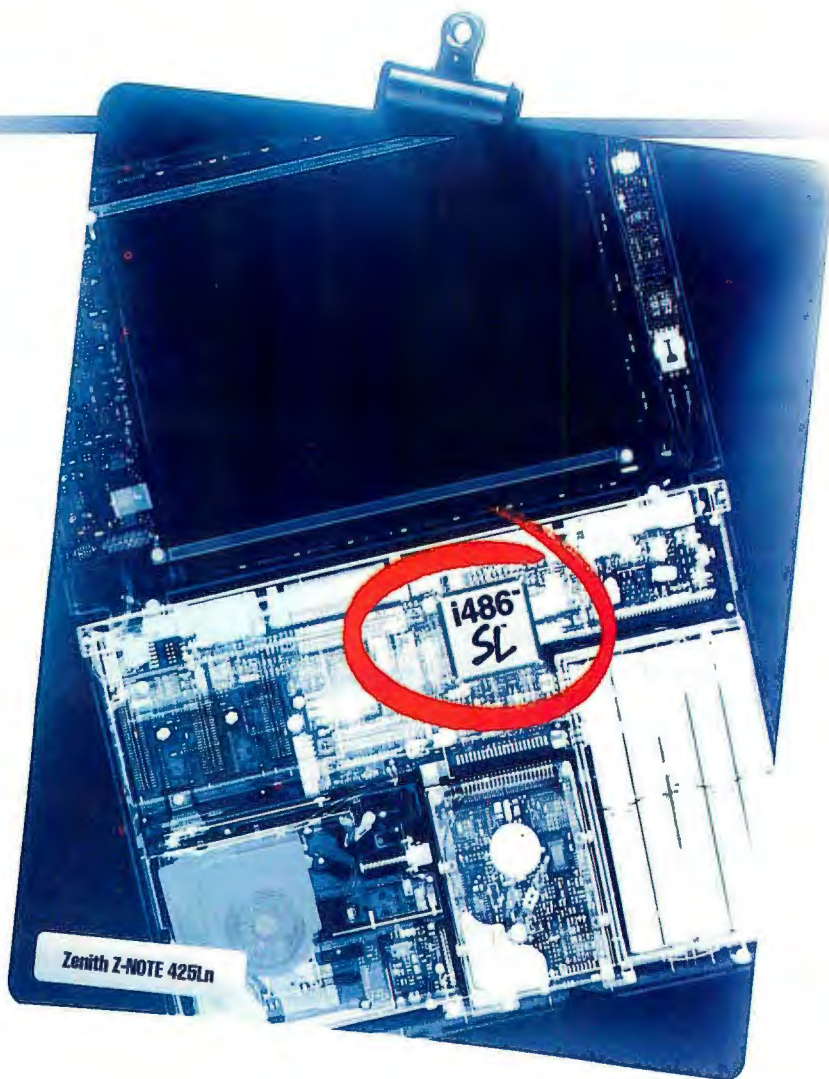


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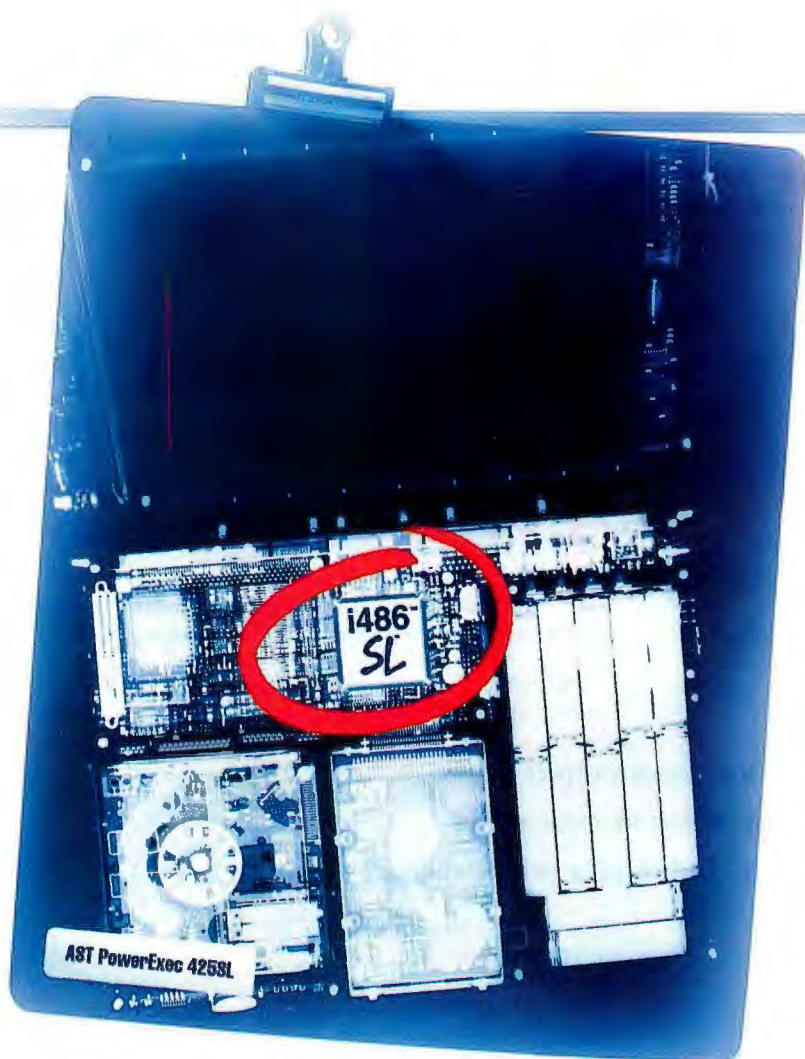
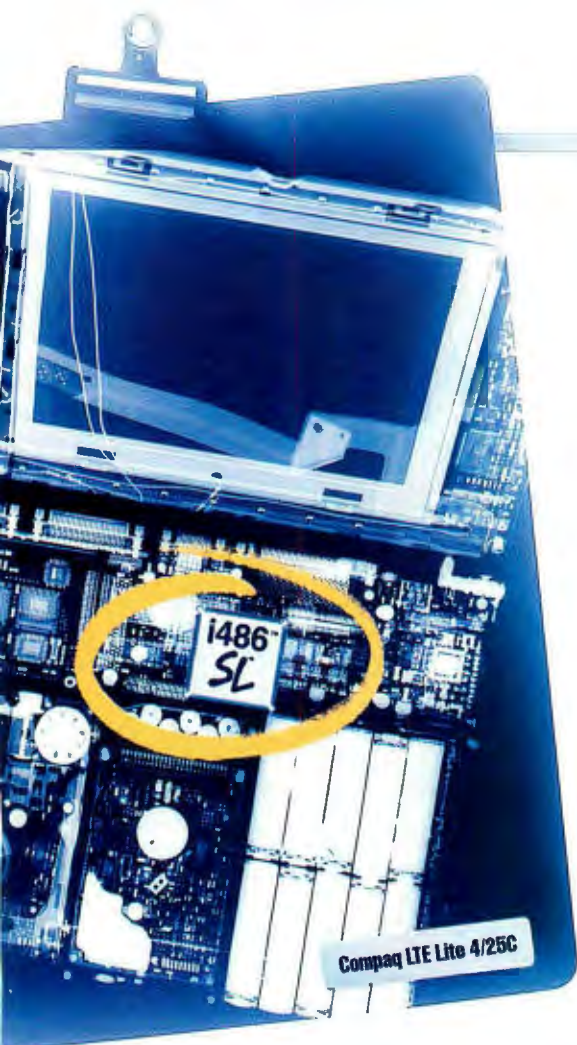


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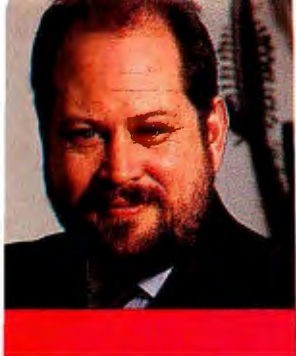
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DENNIS
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EDITORIAL

FATWARE STRATEGIES

The problem of fatware really should not be news. In fact, it should not even be a problem. For years, we have seen the coming of larger, more complex software. We wanted better graphics and more features, and it was simply a matter of waiting for the CPU horsepower that software makers could exploit.

The 486 largely delivered the horsepower (arguably, more is still needed), and the software industry was ready

The major culprit in the problem of fatware is the industry's price war

with applications that consumed every iota of that power. The problem was that the software industry assumed that along with increased CPU horsepower came more disk storage and more memory.

That wasn't a bad assumption, but it was wrong.

The culprit is the PC price war. While we have all benefited from rapidly falling hardware prices and incredibly good deals for 486-based machines, the hardware industry quietly lured many people into buying inadequate systems. It wasn't a contemptuous act on the part of hardware makers; it was simply a matter of marketing and price competition. The market seemed to cry out for 486 systems for \$2000, and seemingly no one cared about hard drive and memory size. For many systems, 4 MB of RAM and a 100-MB hard drive are standard fare.

So here we are with software fat with features and inadequate systems on which to run it. The obvious short-term solution is to upgrade your hard drive and RAM on 486 systems and to replace 386 and remaining 286 PCs. If you go by today's standards, 8 MB of RAM and a hard drive of 170 to 200 MB will do. And that's the configuration that most system vendors are leaning toward. That's still short-term thinking, though. The 8 MB of RAM may be reasonable because it is so easy to upgrade later, but going with a hard drive of less than 250 MB is not a good plan.

It doesn't take a lot of software to fill up that first 100 MB of disk space, and the second 100 MB will go fast, too. As you know, it doesn't take many applications to fill a hard drive. While software developers are trying to address the fatware problem with shared code in object-oriented environments, that solution will not be realized for this generation of systems—and perhaps not even the next.

Meanwhile, fat software will get fatter. One of the reasons, again, is the price war. While the price war has largely been limited to the hardware industry, the software

industry is now getting into the fray. After all, when you can buy a computer for as little as \$1000 or less, why should you have to pay \$795 for a software package?

Already we've seen some aggressive software pricing—mostly in the form of upgrade pricing for existing users and competitive upgrade pricing to entice users to switch spreadsheets or word processors. Also consider the \$99 introductory offer for Microsoft Access, a program that reportedly cost \$60 million to develop.

Prices will drop only so far, though. It's not reasonable to expect complex software to sell for less than \$100, although undoubtedly some will anyway. It is reasonable to expect that software makers will continue the trend of adding more features, and many of those features will come in the form of additional utilities, clip-art libraries, and bundled applications.

So for, say, \$75 you might buy a very good graphics program that comes with 15 MB of clip-art images. Or maybe the next version of your word processor will come with a library of business letters that takes up 4 MB of disk space. Or your next spreadsheet program will come with a 10-MB library of financial models. The possibilities are endless, and it's one of the best ways for software companies to compete.

What all this means is that you'll need lots of disk space just for the programs and libraries you'll want to use—not to mention your data. Add to that the increased emphasis on graphics and video, which hog many megabytes of space, and, well, you see what I mean.

How much disk space is enough? I recommend no less than 250 MB and strongly suggest 300 to 500 MB for desktop systems. Also, as I've said before, get a CD-ROM drive so that not everything has to reside on your hard drive. At least one manufacturer, Gateway 2000, says it is making CD-ROM drives a standard feature in its high-end desktop systems, and I expect other companies to follow.

The bottom line is this: Don't let the marketers' packaged system configurations dictate what size hard drive you buy.

—Dennis Allen
Editor in Chief

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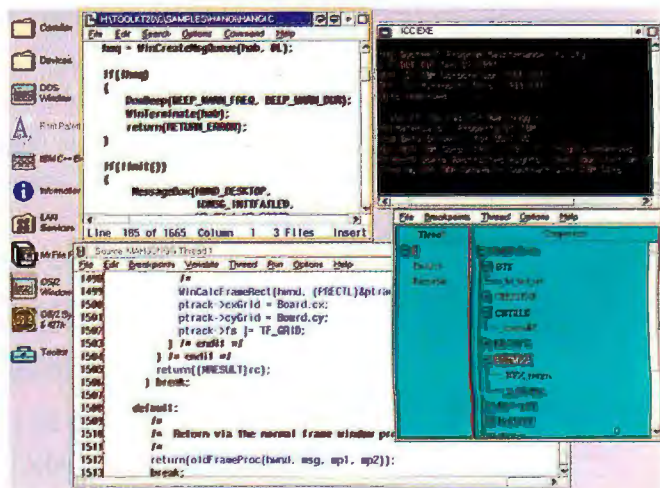
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Patrick Pearce, Software Developer, Life Care Development Corp.

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The no-comparison comparison chart.

| | Windows 3.1 | OS/2 |
|-----------------------------------|----------------------|--|
| Virtual memory limit | 4 x physical | 512MB (disk space) |
| Memory model | Segmented (64KB) | Flat memory objects |
| APIs | 16 bit | Full 32 bit |
| Multitasking—DOS apps | Time slicing | Pre-emptive time slicing |
| Multitasking—Windows/PM apps | Cooperative | Pre-emptive |
| Priority | Static (set by user) | Dynamic |
| Dispatchability | Process | Thread |
| System services | Serial | Parallel |
| Protection between apps | Unprotected | Protected |
| Kernal protection—DOS/Win/PM apps | Unprotected | Protected |
| File system | FAT | Enhanced FAT and installable file systems (HPFS, CD-ROM) |
| User interface | Windowed | Object oriented |

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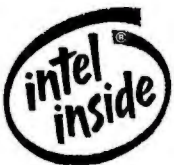


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LETTERS

Amiga Excellence

I would like to commend Tom Yager for the "Commodore Gets Tough" review (January). He pointed out some of the best features of the Amiga 3000T-040/200 and 4000-040/120. Yager was fair, but he neglected to mention the AGA (Advanced Graphics Architecture), a standard chip set in the latest Amigas. A HAM8 mode lets you display 256,000 colors in high resolution on any AGA-equipped Amiga. These new images come close to 24-bit color, and the Amiga can easily animate them for top-notch multimedia capabilities.

Despite predictions of an early death for the Amiga, it is alive and well in the 1990s.

Randy Payment
No address given

My compliments to you on the articles "Grab Your Audience with Audio" (December 1992) and the "Commodore Gets Tough" (January). It was heartening to see the inclusive and balanced coverage of Amiga audio and MIDI in December. The review of the Amiga 3000T-040/200 and 4000-040/120 was also fair and enlightened.

Thank you for expanding BYTE beyond another Mac-clone magazine. It has the unique position of being potentially platform-independent. Keep up the good work.

Jeff Johnson
Cincinnati, OH

OS/2 Gets No Respect

Your omission of OS/2 2.0 from "The 1992 BYTE Awards" (January) is puzzling. There are not yet many 32-bit programs available to take full advantage of OS/2, but the operating system is technically superior. OS/2 is a huge advance in PC operating systems. Please give OS/2 the attention it deserves.

Steven Hoagland
Asheville, NC

One of the biggest technological successes of 1992 and OS/2 2.0 is not even mentioned? I just hope that the page that OS/2 2.0 was on fell out before the January issue reached me.

Robert Mahoney
Babylon, NY

Braincel Defense

Maureen Caudill's review of Braincel ("Neural Net Adds Smarts to Spreadsheets, Slowly," January) made allegations to which I feel compelled to respond.

WE WANT TO HEAR FROM YOU. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, send BIXmail c/o "editors," or send Internet Mail to letters@bytepb.byte.com. Letters may be edited.



Caudill's most exasperating allegation was that Braincel is "inappropriate for large-scale or difficult problems." We have many Fortune 500 customers who have solved large-scale problems using Braincel.

Also, Caudill's comparative evaluation of Braincel was hardly unbiased. She selected one pet problem to test and erroneously concluded that Braincel's proprietary algorithm, back percolation, performs worse than back propagation. This conclusion was due to several avoidable errors.

First, Caudill was familiar with the optimal architecture and parameter settings of Ansim for this problem. Although these settings were in all likelihood not appropriate for Braincel, she used them on both products. Second, although suboptimal architecture and parameter settings hampered Braincel's performance on the training set, Caudill unwittingly exacerbated Braincel's testing error by letting both products train for the same number of cycles. One of the first tenets in the neural-network field is to never overtrain the network, or it will perform poorly on test data. Because back percolation is a more effective training algorithm, training it for the same number of cycles as back propagation predisposed it to overtraining.

Braincel has solved many real-world problems defined with hundreds of inputs and thousands of rows of data. Many of our customers have switched to Braincel from other stand-alone neural-network products, due to both its convenience and the efficiency with which back percolation trains. Considering the number of customers we have, I am sure I would have heard other similar complaints if Caudill's criticisms were representative.

Murray A. Ruggiero Jr.
Vice President
Promised Land Technologies, Inc.
New Haven, CT

The parameters I used in the comparison test were not optimized for Ansim. I used that product because it uses a plain vanilla version of back propagation. When Braincel's heuristics determined the parameters, it could not solve the problem at all. Since Promised Land does not give details of back percolation and since its heuristics did not work, my only option was to use reasonable parameters based on my experience with other networks.

I have seen many new networks that contain improvements that are frequently optimized for a single type of problem. When tested on other applications, they often fail. Only open scientific review of the algorithm resolves such issues—an impossibility with a proprietary algorithm. As a user, my only recourse is to buy the product first and then try it on my network to see if it actually works.—Maureen Caudill

Adapter Flap

As a manufacturer of network adapters, we read with great interest Wayne Rash Jr.'s review of laptop LAN adapters ("Making Connections," BYTE's Essential Guide

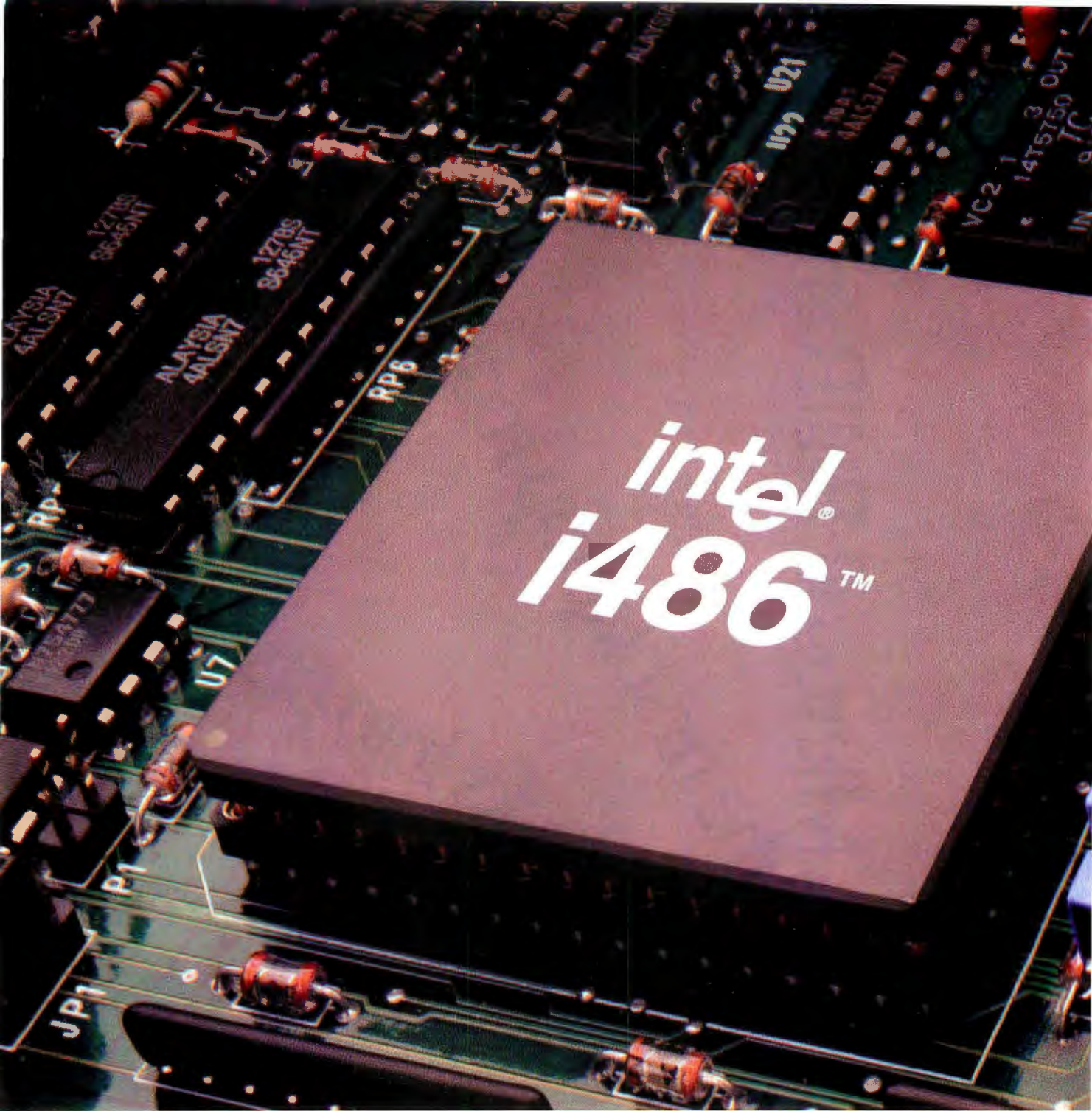
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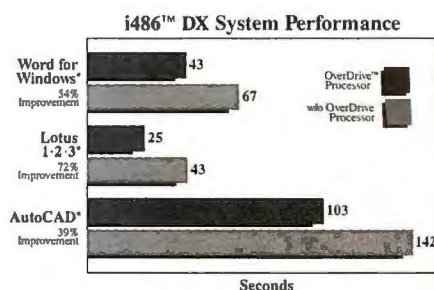
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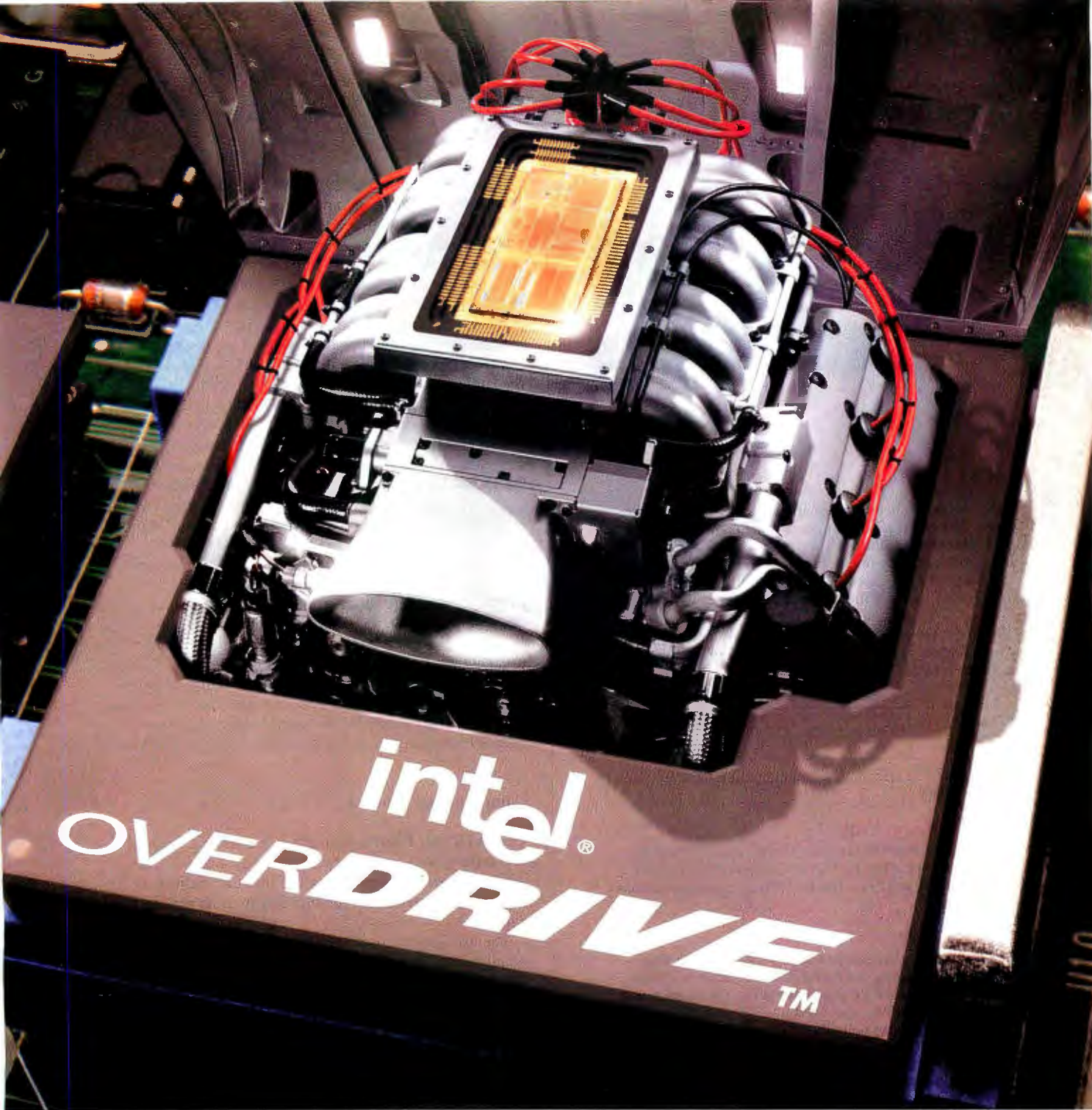
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LETTERS

to *Portable Computing*, 1992). We question the validity of Rash's test environment and criteria. He never shares the results of his test with readers; so it's impossible to make a fair assessment of them. We also question his dismissal of Novell's Perform3 as a valid test methodology. Perform3 is one of the most widely recognized and used test packages available. If speed is going to be presented as a primary test criterion, then it's important to use a widely recognized benchmark and provide all the test results.

Most important, we challenge Rash's supposition that the EPP (Enhanced Parallel Port) specification will emerge as a new standard. Although more than 60 percent of all laptops are expected to be connected to LANs through the parallel port, only Zenith and Dell have adapted the EPP approach. Most laptop vendors seem to be leaning toward the PCMCIA approach for high-speed parallel ports.

Marshall Behling
Director of Marketing
Accton Technology Corp.
Fremont, CA

Perform3 is widely recognized and produces valid results for installations with a traditional network-interface arrangement. But my tests with Perform3 on parallel-port Ethernet cards produced inconsistent results, so I did not use it. Instead, I just measured the time required to perform a 10-MB file transfer between computers. Whether PCMCIA or EPP will be the standard for high-speed parallel ports is a matter of opinion.—Wayne Rash Jr.

Computerized Cinema

I found Roger Ebert's Stop Bit "Cinema by Computer" (January) to be curiously distorted by a preoccupation with trying to fit computerization into the traditional pattern of movie-making. This blinds him to its real potentialities.

The uses he proposed are irrelevant, even from the standpoint of technique. If you want to recreate Humphrey Bogart and place him in a commercial, simply go out and hire one of the numerous skilled Bogart impersonators.

When hardware prices fall a bit more, computer animations can be good for making extremely low-budget movies with decent production values. Today, movies cost too much to make. This means that big businesses produce them rather than free artists.

Movies are a debased art form, crippled by a corruption inherent in the way they are financed. Computer animation can end that corruption and make movies into a great art.

Andrew D. Todd
Philadelphia, PA



In Hugh Kenner's review of The New Grolier Multimedia Encyclopedia CD-ROM (Book and CD-ROM Reviews, March), prices were omitted. The Windows and Mac versions both sell for \$395. ■

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Mylex now offers a range of disk array controllers, all based on the powerful Intel i960CA™ RISC processor. The controllers feature 4/16/64-Mbytes of cache, an EISA host interface and extensive software support.

RAID levels 0, 1, and 5 are supported, with hot swapping, on-the-fly reconstruction, background rebuild, hot standby, multi-threading, and scatter/gather features.

NetWare 3.11, SCO UNIX 3.2.4 and IBM OS/2 2.0 operating environments are supported. All controllers are offered with user-friendly software utilities.

► **DAC960-1/2:** Single fast and wide SCSI-II channel, which can be upgraded to two channels. Each channel has both 8-bit and 16-bit SCSI-II connectors.

► **DAC960-3:** Three fast SCSI-II channels, which can support up to 21 SCSI drives.

► **DAC960-5:** Five fast and wide SCSI-II channels, with the option to drive 8-bit or 16-bit fast SCSI drives.

NetWare, UNIX, OS/2

All Mylex disk array products support Novell NetWare 3.11, with optional support for SCO UNIX 3.2.4 and IBM OS/2 2.0.

Disk Array Subsystem

The disk array subsystem (DAS) features a DAC960 five-channel disk array controller and a flexible enclosure which houses up to five 5.25" or 3.5" SCSI drives. Each drive is powered by its own power supply for improved system reliability. Disk drives are offered as an option. Up to four of these enclosures can be powered by a single DAC960-5 controller, allowing up to 20 drives for each controller.

The DAS can be used in conjunction with any EISA-based computer to build a powerful file server. Up to four controllers can be configured into the system to offer virtually unlimited disk capacity.



y of Disk Arrays.



Integrated Disk Array Server: IDAS2000

The Mylex IDAS2000 is a high-performance integrated disk array server, utilizing state-of-the-art disk array technology.

► **CPU Subsystem:** Intel 486™ DX2-66MHz EISA system with 256-Kbytes of cache, 8-Mbytes of system memory upgradable to 256-Mbytes, six bus master EISA slots, built-in I/O, flash BIOS and future CPU upgrades with the ZIF socket.

► **Disk Subsystem:** Features a one-channel disk array controller that is upgradable to two channels for increased performance. The controller utilizes the powerful Intel i960CA RISC processor and includes a standard cache of 4-Mbytes that's upgradable to 64-Mbytes. RAID levels 0, 1, and 5 are supported with fault tolerance, hot replacement, hot sparing and background rebuild capabilities. Both 8- and 16-bit fast and wide SCSI-II drives are supported. Software support for NetWare 3.11 (Novell certified). Optional support for SCO 3.2.4 and IBM OS/2 2.0 operating environments. Extensive user-friendly software utilities included.

► **Enclosure:** Includes three redundant power supplies, five cooling fans, 10 drive bays for 3.5" SCSI drives, and four additional drive bays for tape drives, floppy, etc.

The system includes an EISA LAN adapter and super VGA graphics. Disk drives are optional.

We've Benchmed the Competition

When Mylex conducted benchmark tests to compare our disk array system's performance to our competitors', we outperformed the competition's RAID 3 and 5 systems, as well as duplexed and spanned systems, by a wide margin.

Benchmarks: Disk Array Subsystems

| | CIPRICO NetArray RAID 3 | CORE IAS RAID 3 | MICROPOLIS RAIDion RAID 5 | ULTRASTOR U124 RAID 5 | MYLEX DAC960 RAID 5 |
|--------------------------------|-------------------------------|-----------------------|---------------------------------|-----------------------------|---------------------------|
| NCOPY all drives enabled | 13:19 | 15:00 | 13:30 | 10:06 | 4:25 |
| NCOPY one drive down | 14:05 | 15:00 | 15:30 | 10:36 | 4:30 |
| NCOPY during rebuild | 26:32 | — | 20:49 | 18:30 | 10:17 |

► LAN Technology's performance tests for Ciprico, Core and Micropolis consisted of copying 2400 files—totaling about 80-Mbytes—from one directory to another using NetWare's NCOPY. The Mylex and UltraStor test configuration included a 486 DX2-50MHz CPU-based EISA system using five HP 97556-30 796-Mbyte drives. Times are shown in minutes.

Flexible Purchase Options

Controllers only, a complete system without disk drives, or a complete system with the drives are offered.

For more information on Mylex disk array systems and controllers, call 1-800-77-MYLEX or 1-510-796-6100. Or, fax us at 1-510-745-8016.

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Zoomer Could Beat Newton to the Punch

Casio Computer and Tandy's first hand-held personal information device will be a pen-based system with an LCD screen and infrared communications. It will also have the ability to run for up to 100 hours on regular alkaline batteries. Code-named Zoomer, the VCR cassette-size system is expected to ship late this summer, which is the same time frame in which Apple says it will release its Newton PDA (Personal Digital Assistant). Bruce Mendel, director of marketing at Casio's personal communications division, told BYTE that Zoomer's price, although not yet finalized, will be closer to \$600 than \$1000 (Apple officials recently hinted that the initial price of the Newton may hover near \$1000).

Casio and Tandy still aren't saying what processor they will use in the system, other than to confirm that Zoomer will be based on a low-powered, 80x86-architecture processor running the Pen/GEOS operating environment from Geo-

Works (Berkeley, CA). Zoomer will feature a top that you can flip up, much like the Star Trek communicator Captain Kirk uses. In addition, Zoomer will be PCMCIA 2.0-compatible, although company officials aren't saying how many PCMCIA slots the unit will have. Peripherals for a PCMCIA slot may include a Motorola pager and data communications devices, such as fax modems.

Most of the internal components of Zoomer will be custom developed: Zoomer's bus or video architecture is not based on standards such as ISA or VGA.

Casio officials have demonstrated a working Zoomer prototype weighing less than a pound and capable of handwriting recognition, but to date, BYTE has not been able to test it. As an alternative to handwritten pen input, Zoomer will have a pop-up keyboard that you can tap with the pen. You'll also be able to undo digital ink strokes.

Several personal productivity applications will be available when Zoomer ships, including software from Intuit (Menlo Park, CA), the market leader in personal finance software, Casio says. Other companies developing programs for Zoomer include America On-Line (Vienna, VA, interactive, on-line service) and Palm Computing (Los Altos, CA, applications software and handwriting recognition). Reference tools (e.g., an electronic dictionary) will be bundled with Zoomer.

An open API will make Zoomer accessible to software publishers who want to develop applications for the hand-held system. This could be a major distinction between Zoomer and Apple's Newton, according to Casio.

—Andy Reinhardt and Dave Andrews

Chicago Brings DOS Closer to Windows

Microsoft is developing a 32-bit version of MS-DOS to carry Windows into the future. Sources say the combined DOS/Windows operating system, code-named Chicago, will be released next year. The idea is to tightly integrate MS-DOS and Windows so that, rather than sitting on top of MS-DOS, Windows will be threaded tightly into the 32-bit DOS. Along with the new operating system will be yet

another API, called Win32c, another source said. Combining the two systems will help Microsoft progress in the direction it has already taken with MS-DOS 6 (see "Easy Does It with MS-DOS 6.0" on page 44) in integrating MS-DOS with Windows.

Microsoft's strategy is to evolve DOS into Windows by default. Another source said that Microsoft's Chicago will be an

NANOBYTES

Stac Electronics (Carlsbad, CA), developer and publisher of the Stacker data compression utility, has filed a lawsuit against Microsoft that asserts a prerelease version of MS-DOS 6 infringes



two Stac patents. In announcing the lawsuit, Stac president **Gary Clow** provided a detailed version of discussions that he said took place between his

company and top Microsoft officials before the lawsuit was filed, regarding Microsoft possibly licensing Stac's data compression for use in MS-DOS 6.

"From the very outset, Microsoft steadfastly refused to pay any royalties," Clow said. "Their position essentially was that 'we will bless Stac technology with the holy water of Microsoft and anoint you as an industry standard.'" Regarding Clow's version of what went on during these negotiations, Microsoft spokesman Collins Hemingway said, "We do not assume, and we would ask the public not to assume, that their version of the events is necessarily an accurate one." □

The FTC, apparently deadlocked in a vote on how to proceed in its investigation into possible antitrust violations by Microsoft, said in a terse statement that it "did not come to a final decision and will reconvene in the near future." The failure to take action means that, for now, the FTC is not likely to take punitive measures against Microsoft following a two-and-a-half-year investigation into the company's DOS licensing and other business practices. □

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Fox Software, David Fulton, President: "FoxPro 2.0 itself is written in WATCOM C, and takes advantage of its many superior features. Optimizing for either speed or compactness is not uncommon, but to accomplish both was quite remarkable."

GO, Robert Carr, Vice President of Software: "After looking at the 32-bit Intel 80x86 tools available in the industry, WATCOM C was the best choice. Key factors in our decision were performance, functionality, reliability and technical support."

IBM, John Soyryng, Director of OS/2 Software Developer Programs: "IBM and WATCOM are working together closely to integrate these compilers with the OS/2 2.0 Programmer's Workbench."

Lotus, David Reed, Chief Scientist and Vice President, Pen-Based Applications: "In new product development we're working with WATCOM C because of superior code optimization, responsive support, and timely delivery of technologies important to us like p-code and support for GO Corp's. PenPoint."

Novell, Nancy Woodward, VP. and G.M., Development Products: "We searched the industry for the best 386 C compiler technology to incorporate with our developer toolkits. Our choice was WATCOM."

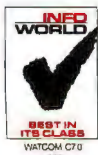
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OS/2 killer, while still another said it represented Microsoft's hedging its bets in case Windows NT is not wildly successful in its first couple of years on the market. Mike Nash, Windows NT product manager at Microsoft, said Microsoft is always working on the next versions of its applications and operating systems, and Chicago is the "gradual logical extension" to

Windows. "It is certainly not a Windows NT Lite," Nash said. However, one source at Microsoft said the Win32c API will support all the features of Windows NT's Win32 API—including multithreading—except for security and functions related to Windows NT's Hardware Abstraction Layer.

—Dom Pancucci and Dave Andrews

DEC's Alpha PCs: A Fast Chip Talking to Intel Parts

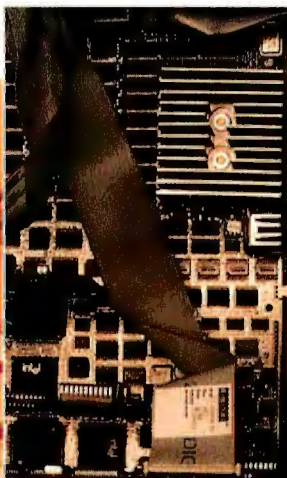
HUDSON, Mass.—DEC's first Alpha "PC" system will be a tower system with six EISA slots and five bays running on the DECchip 21064 at 150 MHz. The system will be in the \$7000 to \$10,000 price range, officials said. Expected to ship this spring, the so-called Alpha AXP PS will offer one-and-a-half to two times better performance than Intel Pentium-based systems and about four times better performance than an i486 system, says DEC. DEC also says the Alpha family of PCs will eventually support Intel's PCI (Peripheral Component Interconnect) bus and EISA.

Later this year, desktop systems supporting the EISA and PCI bus architectures will follow the AXP PS and will range in price from \$4000 to \$6000. A "future" desktop system, based on a low-cost implementation of an Alpha chip, will likely be available in 1994. DEC says the system will offer about two to three times the performance of systems based on the

i486 and could bring Alpha technology under the \$3000 mark.

Of the market that DEC will pursue with these systems, John Foesch, marketing manager for the Personal Computer group, said, "Clearly we're going to be a high-end PC." DEC expects to sell 70 percent of its Alpha PCs through indirect channels such as personal computer dealers and VARs. DEC will also sell the systems directly through its Desktop Direct unit.

David Conroy, senior consulting engineer for DEC's semiconductor engineering group, said that, other than the Alpha chip, very little Alpha-specific design was going into these Alpha PCs. In referring to the AXP PS, Conroy said, "there's buckets of parts there that believe they're only talking to Intel processors." The Alpha PCs are largely built of off-the-shelf Intel-compatible parts; glue logic interfaces the Alpha to either the



By 1996, DEC plans to manufacture Alpha chips using its 0.35-micron, 30-million-transistor, CMOS-6 process. Except for the DECchip 21064 processor (which is behind the heat sink at top right in the photo inset), most of DEC's Alpha PC's parts are Intel-compatible. (Photos by Dave Andrews)

NANOBYTES

Apple and subsidiary Claris say they will move product development of future versions of **HyperCard** into Apple's Developer Tools organization in the Apple Developer Group. Apple says it plans to coordinate HyperCard development efforts with its AppleScript project to give Apple a competitive advantage in the emerging area of next-generation software developer tools. **AppleScript**, a scripting technology for automating routine tasks, is scheduled for release in the first half of this year, Apple says. Claris will continue to sell and support the current version of HyperCard until Apple ships the next version. □

In March, Microsoft (Redmond, WA, (206) 882-8080) planned to release **Visual C++**, a full-fledged professional development language with a Visual Basic-like front end. Later this year, Microsoft is expected to ship Visual Basic 3.0 and a new version of Visual Basic for Windows NT. Get ready for the first version of Visual Basic for the Mac in early 1994. □

Computer Associates (Islandia, NY, (516) 342-5224) says it is close to releasing versions of **Realizer**, its BASIC programming tool for Windows NT, OS/2 2.0, and Windows. Jack Kramer, product manager for Realizer, said that as of February, the Windows version was in "solid beta." The OS/2 version, which was still in internal testing, will be bundled with the Windows version. The Windows NT version will ship shortly after Windows NT is released. □

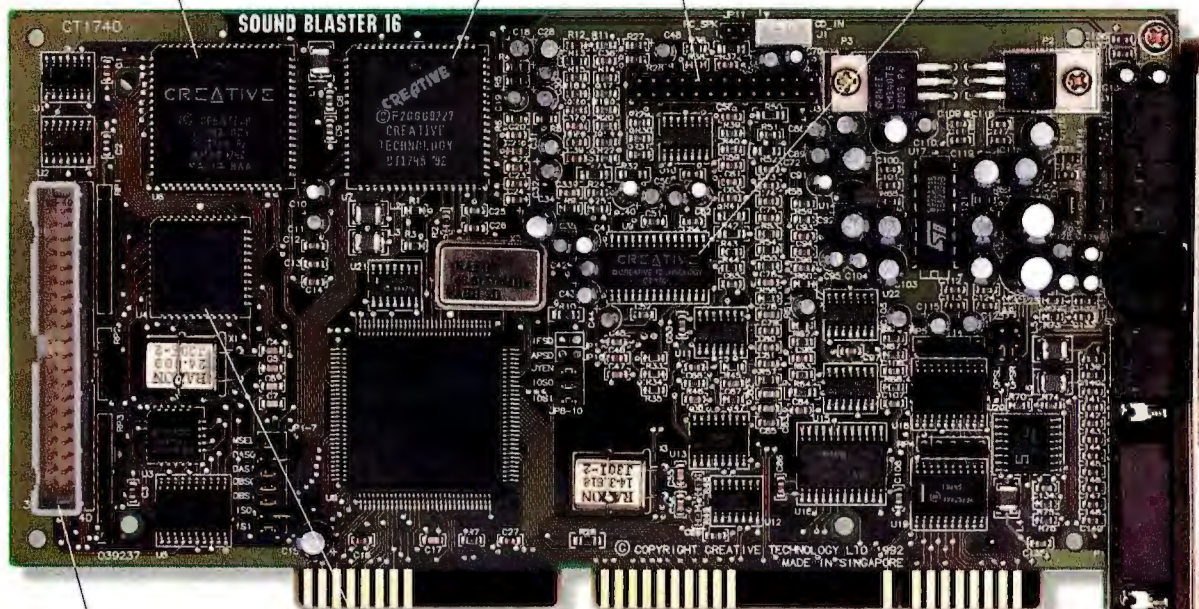
A select number of developers are now testing early versions of **Script X**, Kaleida Labs' cross-platform scripting language for multimedia, sources said. The company plans to release Script X first for the Mac and Sweet Pea, the joint Apple/Toshiba consumer device—possibly as early as this summer, although one source said that time frame was "ambitious." □

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Our T4500C features an LCD TFT active matrix color screen that can display a kaleidoscope of 256 simultaneous colors from a palette of 185,193. Our T4500 offers a large, bright, easy-to-read 9.5" VGA display with 640 x 480 resolution and 17:1 contrast ratio.

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System control hotkeys save time by allowing you to quickly change your display setting, power management, security status, etc., without having to call up menus.

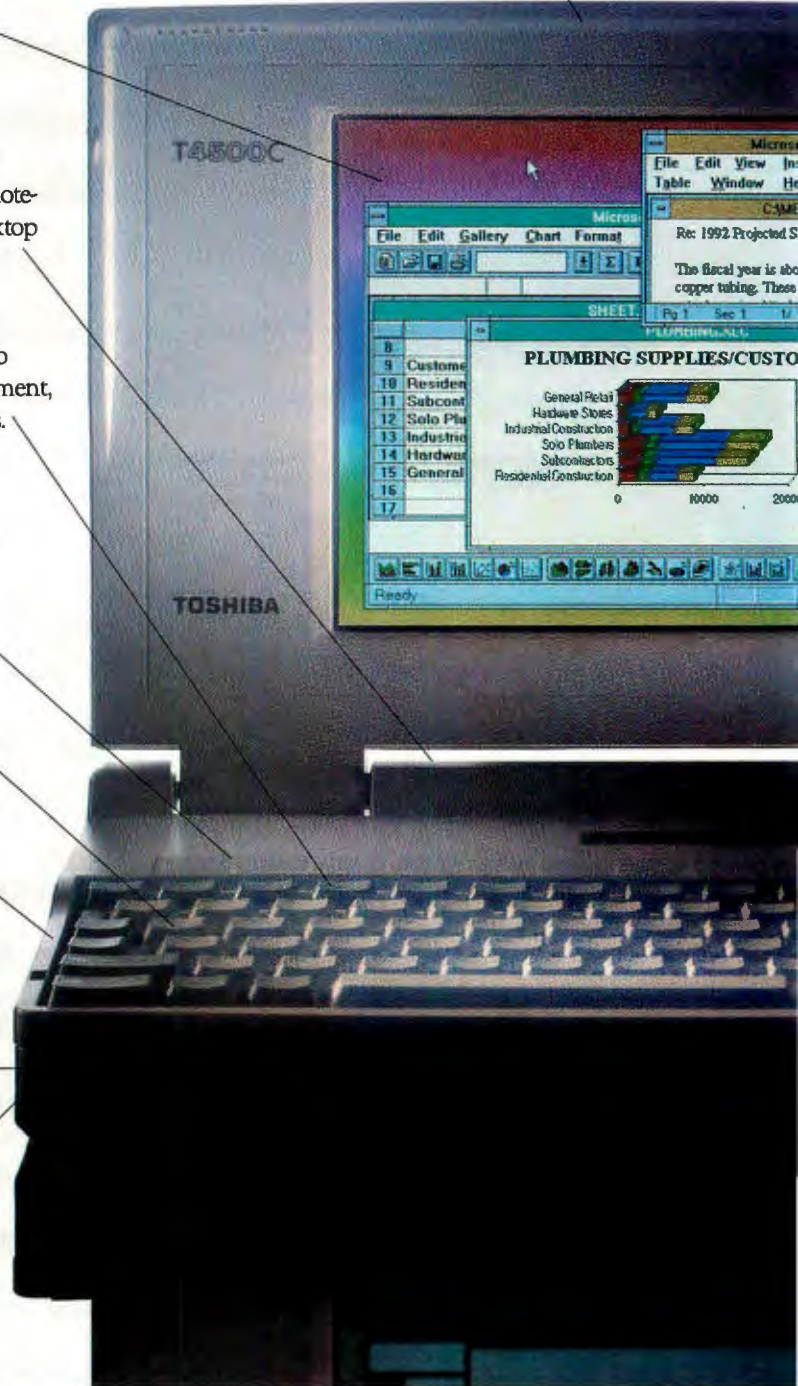
A generous 4MB RAM standard, expandable to 20MB.

Our award-winning keyboard features standard-sized keys and key spacing.

The T4500 series' advanced 20MHz i486™SX processor makes any 386 seem like a tortoise. In fact, tests reveal it's up to two and a half times faster than many 386-based notebooks.

The T4500C comes with a 120MB hard drive and our T4500 comes with a choice of an 80MB or 120MB hard drive.

3.3-volt chip technology decreases power drain by as much as 25%, while adding up to 27% more battery life.



INTRODUCING THE

OPTIONAL.

The T4500C's dimensions: 11.7"W x 8.3"D x 2.0"H.

The T4500's dimensions: 11.7"W x 8.3"D x 1.8"H.

Both fit into half of a briefcase.

Windows® 3.1 and DOS® 5.0 with Ultrafont™ come pre-installed.

AutoResume lets you start where you left off without rebooting and automatically saves your material when you turn the power off.

Our Quick Charge capabilities allow you to charge the battery while you're working.

Featuring AutoResume, AutoSave, Advanced Power Management, and CPU Sleep Mode, our MaxTime™ power management system helps you get the maximum out of every battery charge.

Quickread LCD status icons allow you to check a host of functions (including remaining battery time, keyboard status, and power-saving mode) at a glance.



An industry-standard PCMCIA 2.0 slot accepts removable hard drives, data/fax modems, network adapters, and other expansion options.

The BallPoint™ mouse connects directly to the computer through a unique "one touch" QuickPort™, so there's no cord to get in your way.

A front-loading floppy drive provides easy access.

Both the T4500 and the T4500C weigh in at about 6.5 lbs.



The T4500 features a large, easy-to-read 9.5" monochrome screen.



Tests reveal that the 3.3-volt 20MHz i486™ SX processor is up to two and a half times faster than many 386-based notebooks.



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TOSHIBA T4500 SERIES

manufacturers.

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PCI or the EISA buses.

By supporting Intel's future PCI bus, DEC will be able to take advantage of the wide variety of low-cost PCI peripherals, graphics, and I/O chips, according to Linley Gwennap, senior editor of the *Micro-*

processor Report (Sebastopol, CA, (707) 823-4004). This will provide strong competition, at least on the Windows NT platform, for Intel's Pentium processor and the Mips R4000 family of processors.

—Dave Andrews

High Cost of Chip R&D Sparks New Friendships

The high cost of R&D in creating the next wave of CPUs and memory chips has prompted a new round of collaborations among high-technology firms. Last summer, IBM, Toshiba, and Siemens Nixdorf announced they had agreed to co-develop 256-Mb chips. Currently, Texas Instruments and Hitachi say that they, too, will share research efforts in developing 256-Mb memory chips. And in another alliance, AMD has hooked up with Hewlett-Packard to share development costs and expertise in developing the technology for a new generation of 0.35-micron chips that could range from RAM chips to RISC processors.

AMD and HP are working on a process technology capable of cramming as many as 10 million transistors on a single chip. To reach that goal, they must shrink the minimum feature size to 0.35 micron. (In contrast, the first versions of the Pentium have about 3.1 million transistors and a feature size of 0.8 micron.)

While the two companies have agreed to share technology to develop the smaller submicron process, each company will

use the new chip technology individually. AMD and HP hope their collaboration will result in 0.35-micron chips by late 1994, with volume shipments beginning in 1995. That's about the same time industry observers think Intel will introduce the P6.

Although HP and AMD aren't releasing financial details of their alliance, the cost of developing the new submicron technology is estimated at \$800 million to \$1 billion, according to Charles Boucher, a senior industry analyst at Dataquest. IBM, Siemens Nixdorf, and Toshiba estimate that their development cost on the 256-Mb chip will reach about \$1 billion. "The cost is enormous," Boucher said of the HP/AMD effort. "This partnership is very strategic for AMD because it will give them the means to compete with their primary competitor, which is Intel. I think it's a positive move." HP also benefits, as it can apply the submicron technology to its line of Precision Architecture RISC processors and ASICs (application-specific ICs).

—Tom Halfhill

Digital Cellular Radio Spreads Out

PARIS—Vodafone (Newbury, U.K.), one of the U.K.'s two licensed operators of GSM (Global System for Mobile), a pan-European digital cellular-radio network, claims to have completed the world's first simultaneous text and speech transmission over the GSM. The transmission took place entirely within the U.K. between equipment from Vodafone and a digital mobile telephone that Helsinki, Finland-based Nokia manufactures. Messages of up to 160 alphanumeric characters were transmitted to and displayed on the mobile terminal. Vodafone's CEO Chris Gent said, "This first example of simultaneous speech and text transmission in mobile telephony opens the door to a whole series of value-added services, some of which will become available later this year."

Digital GSM offers the potential of bet-

ter voice transmission than analog cellular phones provide, as well as security through encryption and support for international roaming, although the implementation of cross-border GSM links is still in its early stages.

Another advanced feature promised by GSM is ISDN in cars. Despite teething troubles that delayed GSM implementation by about a year, several networks with restricted geographical coverage went live last summer.

Hong Kong and Australia have already adopted GSM. Two digital formats known as TDMA (time division multiple access) and CDMA (code division multiple access) are vying for acceptance as digital cellular standards in North America for a digital Advanced Mobile Phone Service (AMPS). (For more information on the two formats, see "Stretching the Ether,"

NANOBYTES

Microsoft has big plans for Modular Windows, the simplified version of the GUI for consumer entertainment and information devices. **Rob Glaser**, vice president



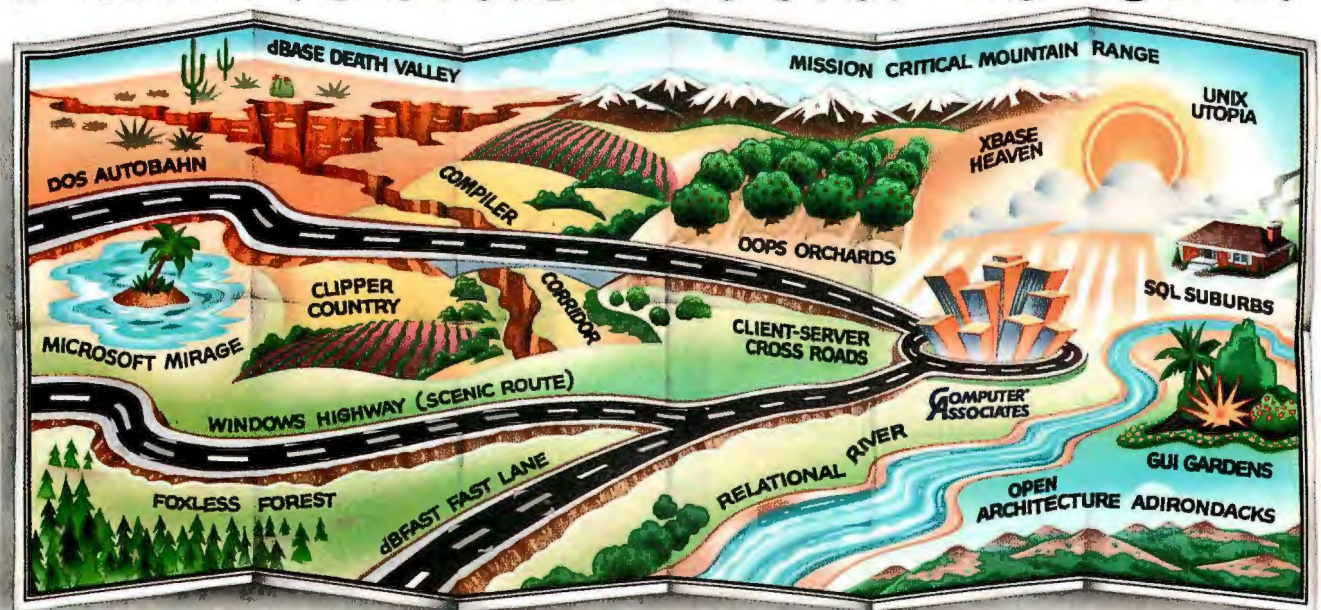
of multimedia and consumer products at Microsoft, said that one benefit of Modular Windows is that it uses many of the same API calls as Windows

3.1. However, the ease in porting a Windows program to Modular Windows will vary from program to program, he said. For one thing, Modular Windows doesn't have pull-down menus. Glaser advises programmers to "think about what kind of display hardware you want your program to run on. Your next Windows application could be running on more than just an Intel processor. It could also be running on an interactive TV or stand-alone PDA or electronic books." Glaser said Microsoft plans to eventually release a Modular Windows version of its Multimedia Viewer development tool. □

The value of all X Window System-specific products and services sold worldwide increased more than 60 percent during 1992, according to the X Business Group (Fremont, CA), a market-research company. The total value of the X industry was \$820 million for 1992, up from \$510 million in 1991. The software PC X server category grew 217 percent. □

Canon says it has reached a basic agreement to acquire the hardware development and production departments of newly refocused Next. Dr. Keizo Yamaji, president of Canon, said Next originally set out to build great hardware and software. Now it will focus on building great software for Motorola, Intel, and possibly other architectures. □

For Xbase All Roads Lead To CA.

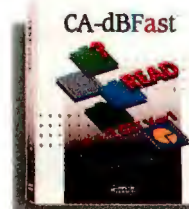


It's been a very difficult and confusing couple of years for Xbase developers. Filled with uncertainty and doubt about the future. At times, some questioned whether Xbase even had a future.

But those days are over.

With the resources, experience and support of the world's leading database company behind it, and with the combined technological wealth of CA-Clipper® CA-dBFast™ and Computer Associates, the future of Xbase has never looked brighter.

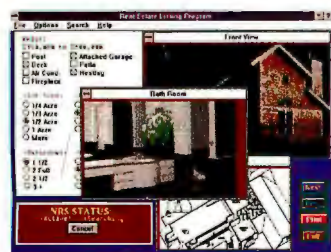
Millions Of Clipper, dBASE, Fox And CA-dBFast Developers Head For The Next Generation Xbase System.



To build the Xbase system of the future, we've added CA's visual tool and client-server technology to Nantucket's next generation Xbase project. This new system will provide a fully object-oriented Xbase language, native code compiler, an IDE (Integrated Development Environment) and both DBF-style and client-server database support.

It will support Windows, Windows NT, OS/2 and UNIX. The complete product will be demonstrated at Fall Comdex and available for beta testing in the fourth quarter of 1992.

Go GUI Today With CA-dBFast Or
Go The DOS Route With OOP Via Clipper 5.0.



There are two migration paths to this ultimate Xbase system: The OOP (Object-Oriented Programming) path of CA-Clipper and the GUI (Graphical User Interface) path of CA-dBFast with Windows support.

Both paths will provide immediate benefits and will protect and leverage the substantial investments you've made in Xbase.

CA-Clipper



Computerworld says
CA-dBFast offers top
price/performance.



Readers of Data Based
Advisor awarded first
place to CA-Clipper 5.0 for
Best Xbase Compiler, Best
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and Best Application
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Attention All dBASE IV Developers: Your CA-Clipper/Compiler Kit Has Arrived.

After four years, the compiler kit you've been waiting for has arrived.

Introducing new CA-Clipper/Compiler Kit For dBASE IV. The easiest, quickest way in the world to compile a dBASE IV application. All it takes is three easy steps. And in just minutes, you can turn most dBASE IV programs into faster running, higher performance programs.

The new CA-Clipper/Compiler Kit For dBASE IV provides compatibility and database interoperability with most dBASE IV applications. The Kit is implemented using the open architecture of CA-Clipper, including the preprocessor, the Extend System and the RDDs.



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Much more than just a PC software company, CA is the world's leading database software company. CA software is used in over 70 countries around the world by more than 10 million users including over 90% of the Fortune 500. From mainframe to midrange to microcomputers, CA database software runs on more platforms, more operating systems, and handles more mission-critical applications than any other software in the world.

For Information On CA-Clipper, CA-dBFast And
A Statement of Direction: Call 1-800 CALL CAI.



To get the complete story on The Future Of Xbase, call for this special 30-page statement of direction. It contains an Executive Summary as well as an in-depth discussion of Xbase in the 90s, CA's Open and Client-Server Architectures, Integrated Development Environment, Xbase migration plans and end-user tools.

Call for your copy today. And find out why the future of Xbase will lead you right to CA.



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COMPUTER ASSOCIATES
Software superior by design.

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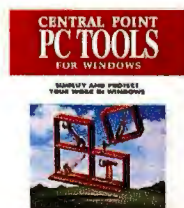
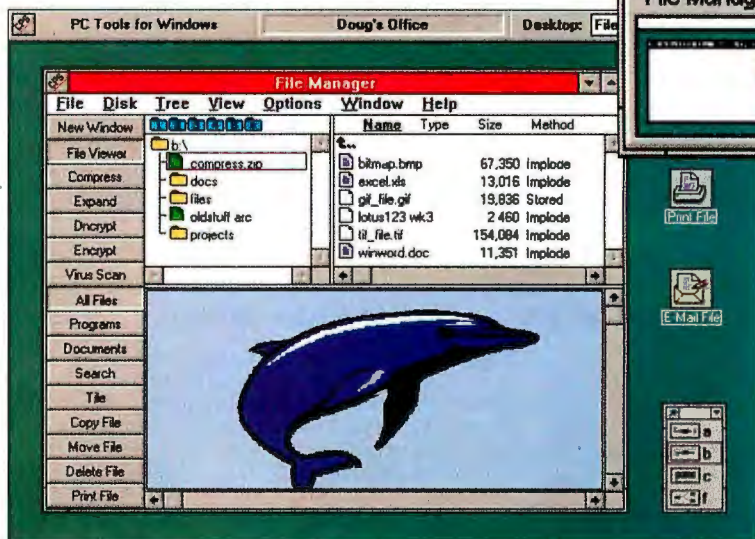
[1] Organize and simplify your work.

Our unique MultiDesk desktop manager lets you put related applications, folders and files into their own separate desktops. Set up as many desktops as you like, then switch between them instantly. It all adds up to a less cluttered, more productive Windows environment that works like you do.



[2] Improve the speed and efficiency of common tasks.

Our integrated File Manager has advanced drag-and-drop capabilities that let you quickly locate, view, copy and print files. With over 75 viewers, you can scan files (including compressed PKZIP data) without having to open their applications first. Hate to turn off your PC because you don't want to set everything up again? Our DeskSaver feature solves that problem too.



you use most often. In fact, PC Tools for Windows is so innovative that after reviewing it, the editors of

Windows® is a great product. And someday, it'll be even better. But why wait?

New PC Tools™ for Windows® is here right now. It saves you time, reduces clutter and gives you easy access to all the functions and files

PC/Computing asked, "Who needs Macs?"

For starters, there's our unique MultiDesk™ desktop. MultiDesk is an intuitive desktop manager that lets you organize your work by creating as many desktops as you need for your projects, tasks, or clients. So, if you spend the day switching between many different projects, you won't lose anything in the clutter.

Ever misplaced a file or couldn't remember its

*Our lawyers said we could run this headline if we make the following absolutely clear: Windows is a trademark of Microsoft Corporation. PC Tools for Windows is the sole product of Central Point Software, Inc. Microsoft and Central Point® PC Tools® MultiDesk® WinShield® Speed Keys® System Consultant® and DiskFix® are trademarks of Central Point Software.

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Enhance your system's performance.

System Consultant™ performs over 400 system checks and provides recommendations for improving your PC's performance. Our Disk Optimizer can automatically defragment your hard disk at prescheduled intervals, or on command.

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We've included new Windows versions of Backup, Undelete, Anti-Virus and DiskFix.® They're all integrated in WinShield; an automatic data-protection system that results in worry-free computing. Our Emergency Disk builds a bootable recovery disk to help get a crashed system up and running fast.

name? Our File Manager lets you quickly view files without having to load the program first. Tired of cryptic, abbreviated file names? Now you can attach long file names to your data to keep things clear and simple.

We also created Speed Keys™ so you can take shortcuts through Windows, and System Consultant that gives you specific tips for improving system performance.

PC Tools for Windows is at your nearest dealer.

For more information, a free demo disk, or to upgrade from PC Tools for DOS, call us at 1-800-967-9251. Your purchase is backed by our 60-day guarantee.

Find out for yourself why the editors are already heralding PC Tools for Windows as "The ultimate desktop." It may just be the best thing since, well...Windows.

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Circle 73 on Inquiry Card.

February BYTE.) Minoru Kuramoto, executive manager of R&D for the Mobile Communications Sector at NTT (Japan), said that in Japan, standardized digital systems are also being developed.

Although the Japanese TDMA-based standard is not compatible with Europe's GSM, its use may soon extend into other Asian countries.

—Raymond Boulton

Next Abandons the Hardware Business

Next is out of the hardware business. Next chairman and CEO Steve Jobs says the imminent (late May) shipment of NextStep for Intel Processors, the "commoditization" of the hardware industry, and the need to capitalize on its lead in the object-oriented operating-system market forced the company to sell its hardware operations.

The announcement marks the closing of a major chapter in computer history.

Despite the Next cube's brilliant design, the company's decision to focus early on the education market, the halfhearted attempt by reseller BusinessLand to sell Next systems, and the machine's design flaws (e.g., the lack of a floppy drive in the original Next cube) doomed the machine. The Next cube may go down in history as a great machine that never found a market.

—Nicholas Baran

General Magic: Come Together with Telescript

General Magic, a company founded in 1990 by former Apple employees, wants to reinvent the telephone, but it may take a decade. Now that the company has announced its formidable partners, it intends to release further details this summer on its Magic Cap operating system and Telescript protocol.

Apple, AT&T, Matsushita, Motorola, Philips, Sony, and others expect the Telescript communications language to form

the basis of a new wave of hand-held devices with ubiquitous communications capabilities. EO (Mountain View, CA), an affiliate of AT&T, will use General Magic software in its Hobbit processor-based communicator. But General Magic's president and CEO Marc Porat warned that it will be many years before users can electronically access a train schedule, pay bills, or call up a favorite restaurant's menu.

—Ed Perratore

First Simultaneous-Translation Telephone Call Demonstration

Do you need to negotiate a business deal with the CEO of a German company, but all you can remember from German 101 is how to count to five? Then check out Janus, an experimental continuous-speech translation system with a 400-word speaker-independent vocabulary that translates spoken communication back and forth between languages in close to real time.

The Consortium for Speech Translation Research, a group of scientists from Carnegie Mellon University (Pittsburgh, PA), the University of Karlsruhe and Siemens Nixdorf (Munich, Germany), and the Advanced Telecommunications Research Institute International (Kyoto, Japan) demonstrated Janus in a first-of-a-kind video conference held in January. People in Japan, the U.S., and Germany spoke to one another live in their respective languages while the system simultaneously translated each person's phone conversation.

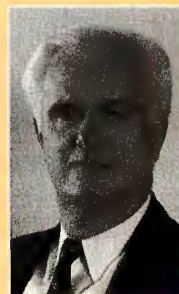
In Janus, as each person speaks into the system, the speech signal is digitized and preprocessed. Using front-end signal analysis, a recognizer detects the sounds in the input stream by applying neural-network-based classification strategies. The system reviews the top 50 sentence hypotheses so the translation module can select the most plausible sentence to output. Further processing occurs downstream from this point.

Alexander Waibel, senior computer scientist at Carnegie Mellon's School of Computer Science, said that within five years, new learning algorithms should allow for voice-activated dictionaries and phrase books that translate business phrases, travel information, and directions. Waibel said that in five to 10 years, we should see spontaneous domain-specific speech-translation devices for planning trips, reserving hotel rooms, and ordering food. ■

—Janet J. Barron

NANOBYTES

Ross Systems (Redwood City, CA), a company with experience in developing commercial accounting software programs in the minicom-



puter market, is releasing a suite of financial accounting products for client/server computing on a variety of platforms, including Windows NT, HP-UX, and

OSF-1. Larry Smart, president of Ross Systems, on the process of rewriting its time-sharing application for the client/server model, said, "The biggest hurdle was rethinking the applications into event driven from time sharing. The interface is different, the old way was sequential, but in an event-driven world, we never know what the user will do next." □

Santa Monica, California-based Quarterdeck has reduced its workforce by about 45 people, or about 15 percent. One of the challenges facing the company is to educate the public on its Desqview/X product (see "Was Desqview/X Worth the Wait?" August 1992 BYTE). Stephen Auditore, president of the X Business Group, called Desqview/X a good product from a technical point of view. "They [Quarterdeck] are to be applauded for their efforts, but their [technical accomplishment] doesn't necessarily translate into market success." Quarterdeck plans on releasing version 7.0 of its QEMM memory manager shortly after the release of MS-DOS 6. □

A report from the City University Business School (London) says that 80 percent of companies using groupware apply the technology for tactical work, such as increasing efficiency. The other 20 percent are changing core business practices through computer-based teamwork. ■

We're Playing Your Song!

Gateway 2000's Greatest Hits

1. Gimme the Good Stuff
by Hammer and the Boys
2. Baby, Let Me Baby You
by The Support Group
3. We Got the Goods
by The Systematics
4. Megahertz So Good
by Pup and the Cells

5. So You Wanna Fly?
by The Screamin' Vs
6. Big Bandwidth Boogie
by The Gates
7. Software Improv
by Good Vibes
8. More Jazz Extras
by The Cool Cats





Cold



If Gateway 2000 was a record, what would we sound like? Music to your ears!

Those Old-Time Country Values *by The Low Overheads*

Our album would kick off with some great Country tunes because, after all, we're the original country PC company with the low-overhead prices. We're located

Country

in the heartland of America where our factory is bordered by corn and bean fields. KSUX country radio, the Super Pig, is the number one station in these parts (no fooling). Gateway folks are mostly midwest born and raised, and it shows in our quality workmanship and in the friendly, down-home way we treat our customers. We'll bend over backwards to please you. When you buy from Gateway, you get the best price, quality and service. That's a value nobody can beat.



Gimme the Good Stuff – *by Hammer and the Boys*

This song is dedicated to everybody who's tired of new technology becoming affordable only after it's upstaged by something better. At Gateway, we offer the latest, newfangled technology at homespun prices.

Baby, Let Me Baby You *by The Support Group*

Every Gateway 2000 system comes with excellent after-the-sale support. You get a **30-day money-back guarantee**. If you don't like your system, send it back within 30 days for a refund. All systems come with a **one-year limited warranty** and telephone **technical support** for the life of the system from our award-winning tech department. We received *PC World's* World Class Award in 1992 for best service and support in the hardware category. And in a February 1993 survey, *PC Magazine* readers once again gave Gateway an excellent rating for service and reliability. You also get a **lifetime BBS membership** for additional technical support and online forums.

We offer **on-site service** to most locations in the country (factory service only for notebooks). **Replacement parts** leave our factory as quickly as possible; we pay overnight shipping. Plus we now have **interactive documentation** on desktop systems with pictures and text right on your hard drive (in addition to comprehensive hardware and software manuals).

We make it easy for you to buy a Gateway PC, too, with convenient payment options including major credit cards and C.O.D. terms. Net 30-day terms and leasing options are also available to qualified commercial customers. All this *and* your great-looking Gateway PC comes in our distinctive, country cow-spotted box!

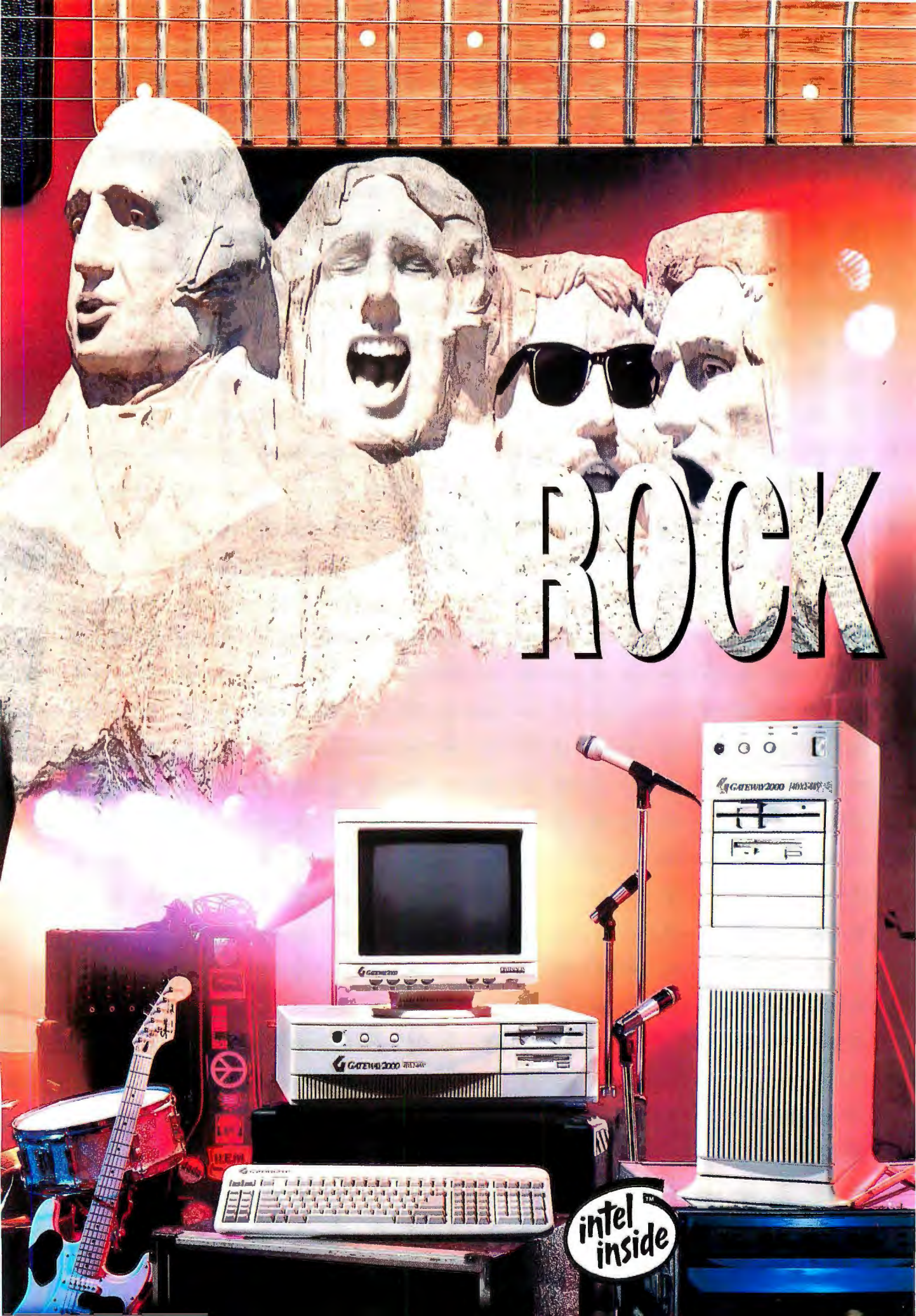


To serve you better, we've hired and trained over 500 new people for customer service, technical support, sales and manufacturing in the past five months, bringing our total number of employees to over 1,900.



 **GATEWAY2000**

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ROCK

intelTM
inside

We Got the Goods – by The Systematics

Gateway's album would continue with some heart-pounding rock 'n roll cuts because our systems are definitely pure rock. They're cool-looking, hot-performing, high-energy machines – at some sweet prices. There's a model that's perfect for you.



Megahertz So Good – by Pup and the Cells

Gateway's mini-desktop systems – 3SX-33, 4SX-33 and 4DX-33 – are petite but plenty powerful, based on an integrated design that incorporates many subsystems on the motherboard for the best price-performance ratio. All mini desktop systems include: 4 to 8MB RAM; a large and fast hard drive, operating on the local bus in 486 models for even faster drive performance; a fast video chipset with 1MB; a brilliant, crisp display from the standard 14-inch CrystalScan non-interlaced color monitor; and more available expansion slots than you find in most small-footprint PCs. The combination of these features makes a cool Windows machine for an unbeatable price.



So You Wanna Fly? – by The Screamin' Vs

Power users, pick up the phone and order a Gateway 2000 VESA local bus 486 machine right now. You'll never regret it. With our 4DX2-50V or 4DX2-66V models, you get screaming PC performance. We put ATI's Graphics Ultra Pro video card with 1MB VRAM on our VESA local bus for results that are simply awesome! Plus these systems have a hefty 8MB RAM with cache, and hard-rockin' hard drives running on the local bus. Extra VESA local bus expansion slots, too. You get a 15-inch flat, square CrystalScan color monitor – our top-of-the-line – and more choices of cool application software than you'll find anywhere else.

Big Bandwidth Boogie – by The Gates

If you're looking for the 32-bit power of an EISA system, we offer three models – 4DX-33E, 4DX2-50E and 4DX2-66E. All models include: 8MB RAM with 256K cache; a very large, very fast SCSI hard drive; 32-bit EISA SCSI controller; and a standard tower case. Please call for details and prices on models not listed on our price page.



We custom-build each Gateway 2000 computer to your order. We'll gladly provide you with a quote on a special configuration. Call our sales department!

Workin' Up Some New Riffs –

by The Harmonics

This one's our theme song. At Gateway, we're always looking for ways to make your PC easier and more fun to use. For example, we now install a Mach 32 video driver icon in your Windows control panel so you can change your video resolution quickly and easily.

All Gateway systems go through extensive compatibility testing to ensure flawless performance with all products from major software developers and peripherals manufacturers.



8 0 0 - 8 4 6 - 2 0 5 8

◀ According to PC World, "(Gateway 2000's 4DX2-66V is) by far the fastest machine we've ever tested!"





Windows to the Other Side – by Tommy Gee

Gateway's album would also include jazz favorites because we offer a complete line of software and peripherals to make your system extra cool.



Software Improv – by Good Vibes

All Gateway systems come with some very hip software, all pre-installed and ready to run the moment your PC arrives. With mini desktop, desktop and tower systems that include "choice of application software," you get to pick one of the following applications, all latest versions:

- Microsoft® Excel for Windows™
- Microsoft Word for Windows™
- Microsoft Word and Bookshelf 92® CD
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- The MS Entrepreneur Pack (Works,™ Publisher,™ Money,™ and games)
- Borland Paradox® for Windows™
- The Windows Programmer Pack (MS Quick C,™ Visual Basic and more)
- Upgrade to Microsoft Office™ for \$175

All Gateway desktop systems also come with Cool Tools for DOS, a diagnostic and utilities package including QA Plus™ from Diagsoft, Central Point® Anti-Virus and more.

Connectivity – by The Local Area Group

TelePath™ Fax/Modem. A 14,400bps modem, V.32bis, with 9,600bps fax capability. Includes WinFax Pro, Crosstalk for Windows, Qmodem. \$195

Network Cards. Call for a selection of Ethernet cards and Token Ring adapters, installed and configured.

Microsoft Windows™ for Workgroups. Networking made easy! Price includes an Ethernet adapter and software. Hardware and software factory-installed. \$159

WOW – by Talking Pictures in Motion

CD-ROM Kit. Includes CD-ROM, interface card and everything you need to add MPC-compliant CD-ROM to your PC. \$225

Microsoft Windows Sound System.™ Package includes sound board, microphone, headset and software. \$149

Multimedia Accessories. Call for details on other multimedia hardware and software.

The software and peripherals listed here are sold only with the purchase of a system. For details on our complete line of extras for Gateway customers, call direct to our special add-on components division: 800-846-2080.

Accessorize – by The Wizbangs

We offer many other system options and upgrades, including:

- 17" and 20" Monitors
 - Tape Backup Units
 - Texas Instruments Laser Printers
 - Panasonic Dot-Matrix Printers
 - Bigger Hard Drives
 - Other Software
- Call today!



◀ Gateway's 4DX-33V is shown here with Windows Sound System components, the CD-ROM kit and optional speakers. Call for details on this system.



8 0 0 - 8 4 6 - 2 0 5 8

Gateway 2000's Hit Parade

Desktop Systems

3SX-33

- 33MHz 386SX Intel® Processor
- 4MB RAM
- 5.25" & 3.5" Diskette Drives
- 80MB 17ms IDE Hard Drive
- Windows Accelerated Video w/ 1MB DRAM
- 14" Color CrystalScan™ 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 124-Key AnyKey™ Keyboard
- MS-DOS, Windows™ & Mouse
- Cool Tools for DOS
- MS Works for Windows™ 2.0

\$1295

4SX-33

- 33MHz 486SX Intel Processor
- 4MB RAM
- 5.25" & 3.5" Diskette Drives
- 170MB 13ms IDE Hard Drive
- Local Bus IDE Interface
- Intel OverDrive Socket
- Windows Accelerated Video w/ 1MB DRAM
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 124-Key AnyKey Keyboard
- MS-DOS, Windows & Mouse
- Cool Tools for DOS
- MS Works for Windows 2.0

\$1495

4DX-33

- 33MHz 486DX Intel Processor
- 8MB RAM, 64K Cache
- 5.25" & 3.5" Diskette Drives
- 250MB 13ms IDE Hard Drive
- Local Bus IDE Interface
- Intel OverDrive Socket
- Windows Accelerated Video w/ 1MB DRAM
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 124-Key AnyKey Keyboard
- MS-DOS, Windows & Mouse
- Cool Tools for DOS
- MS Works for Windows 2.0

\$1995

4SX-33V

- 33MHz 486SX Intel Processor
- 8MB RAM, 64K Cache
- 5.25" & 3.5" Diskette Drives
- 250MB 13ms IDE Hard Drive
- Local Bus IDE Interface
- Intel OverDrive Socket
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RECOVERY THROUGH TECHNOLOGY

ZAGREB—Only months ago, we were spending most of our time in bomb shelters. That terrible experience is behind us, but we still have to repair the damage that was done to our newly formed nation. One can feel the winds of change, however. Exhausted as we are, Croatians are awakening—lethargy is behind us.

Now it is imperative that Croatians act as quickly and as effectively as we can. And one of the ways to achieve maximum efficiency is through the use of sophisticated computers and communications, from personal computers to large systems. That is probably why the personal computer market is one of the fastest recovering markets in the country. Proof of that recovery was seen quite clearly last October at the Fair Interbiro-Informatika (Interoffice-Information Fair) here in Zagreb. The fair—which is the largest computer and communications exposition in this part of the world—had to be canceled in 1991 because of the war. But the show bounced back in 1992 with about 30,000 attendees—more than it ever had before.

Despite the recent hard times, the shape of Croatian personal computing is not drastically different from that in most Western European countries. The personal computer has invaded both our professional lives and our private lives. It is part of everyday life, just like a car or TV set. Our children are flying spacecraft or driving race cars, destroying joysticks almost on a daily basis. Parents, on the other hand, are more conservative and mostly Tetris fans.

Compared to Western countries, it is true that we have slightly fewer of the more powerful systems, such as those based on 386, 486, 68030, and 68040 processors, or Unix, VMS, or VM operating systems. Also, our distribution network is not completely in place. Many of us—including some local dealers—buy our systems directly from dealers in other countries, especially Germany, the U.K., and Italy. When you look at the number of personal computers imported in this way, you could argue that Croatia is already a member of the European Community.

Unfortunately, so far we are mostly computer buyers. But we do have the potential to produce and export. This would probably not be supercomputers or microchips, but surely it is possible to manufacture some type of peripheral or accessory. The truth is, with a population of only 5 million, Croatia is too small a nation to change the world computer market. However, we can certainly try to make some contribution.

We do have some interesting specialized software products to offer to the world. Croatian programmers are working on all platforms and have already sold many of their products, such as Clipper applications and terminal-emulation programs, to U.S. and Western European software firms.

At the moment, a great deal of attention is being given to changing the educational and legal regulations affecting the computer software market. For example, two years ago, Croatia had poor regulations on software ownership. New regulations, however, are expected to give a boost to software production. With copyright laws in place to help in combating piracy, domestic and foreign software vendors will have a greater incentive to market products in Croatia. Also, new regulations concerning foreign investment should help reassure potential investors from other countries. These changes are now in progress, so more specific information is not yet available.

One important change for Croatia's future is a greater openness to the rest of the world. Last October, my company, Art Plus Publishing, signed an agreement with McGraw-Hill to publish a Croatian version of BYTE. It's the first agreement by a Croatian firm to publish a magazine in cooperation with a foreign publisher.

As tension continues in the former Yugoslavia, Croatians face many challenges that technology can't solve. However, as this young country looks to a more peaceful future, it hopes for a greater role in the world computer market. ■

Neven Prasnikar is the president of Art Plus Publishing and the publisher of a Croatian version of BYTE. You can contact him at Art Plus d.d., 41040 Zagreb, Kapelska 5, Croatia, or you can fax him at +38 41 259 201.

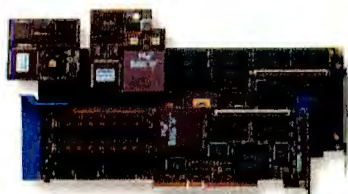
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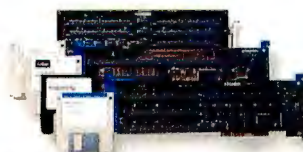
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All systems tested with 1GB installed except ATMaster, tested with 8MB, and MCMaster, tested with 8MB on-board and 8MB on mother board. All system prices are MSRP at standard configuration as of 2/1/93. Processor upgrade prices are MSRP as of 3/1/93. Recount conducted on 3MB Excel for Windows spreadsheet generated by Kingston Technology.

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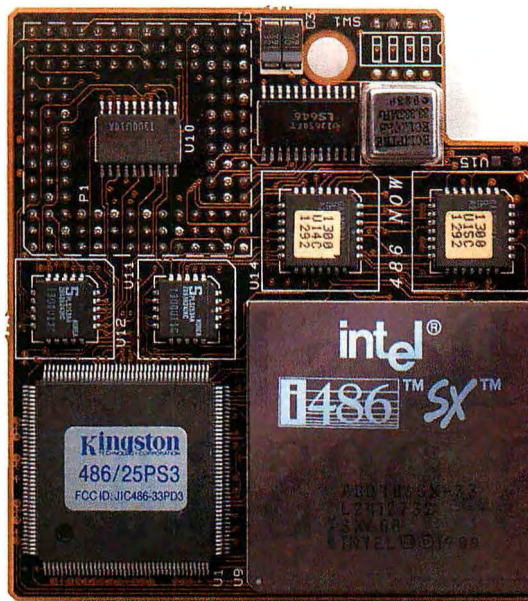
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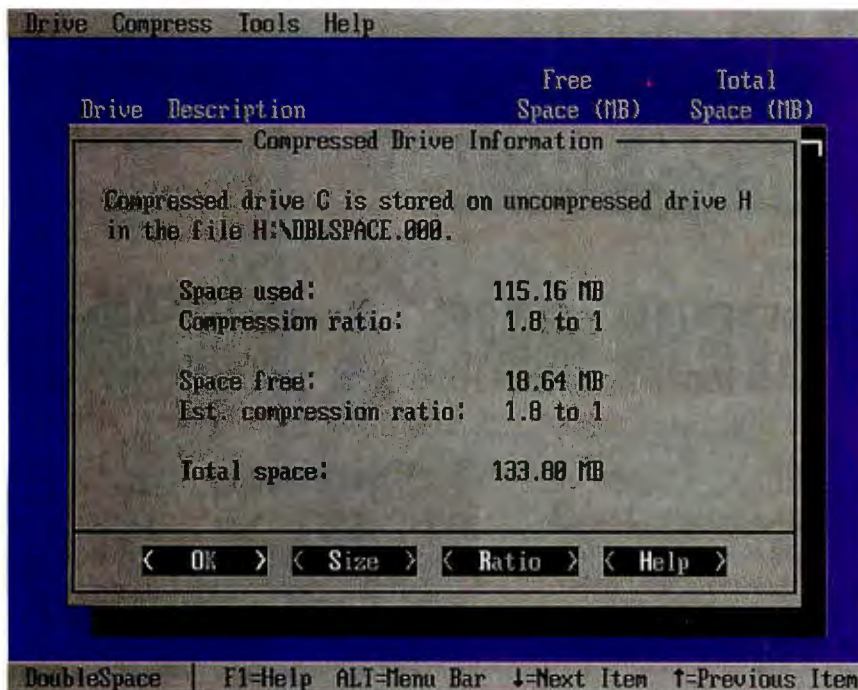
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Easy Does It with MS-DOS 6.0

JON UDELL



Screen 1: MS-DOS 6.0's file compression utility, DoubleSpace, typically expands your hard disk space by a factor of 1.8.

Compression and memory management take center stage in version 6.0 of Microsoft's venerable operating system

MS-DOS 6.0 aims to make file compression and upper-memory-block management safe for the masses. "I wanted to be sure that my own mother wouldn't have any trouble using it," says Microsoft's Eric Straub, program manager for MS-DOS 6.0, of the new automatic memory management utility, MEMMAKER.

That's the MS-DOS 6.0 upgrade story in a nutshell. The two headline features—compression and memory management—are robust, automatic, and fault-tolerant. I'd hesitate to ask

my mother to install Stacker and QEMM, but I'm pretty sure she could install an MS-DOS 6.0 upgrade and achieve essentially the same benefits.

Like other compression utilities, the MS-DOS 6.0 DoubleSpace utility will typ-

ically boost your disk space by a factor of 1.8 (see screen 1). My laptop's hard disk, for example, "grew" from 84 MB to 151 MB thanks to DoubleSpace. Multiplied by the 50 PCs in the BYTE editorial department, that effect would translate into more than a gigabyte of space created essentially out of thin air. Multiplied by the 50 million PCs in use worldwide, it would translate into a million-gigabyte ocean of new storage. That much storage will not materialize, of course, but a good chunk of it likely will. Bundled and tightly integrated with MS-DOS 6.0, DoubleSpace tears down barriers of inertia and intimidation that have prevented more widespread use of other compression tools.

Version 6.0 comes with a number of additional tools that you've previously had to buy separately. The package includes a disk defragger, a serial/parallel file transfer tool, an antivirus tool, and client-only NetBIOS LAN software, as well as greatly enhanced backup and undelete tools. Three of these—the antivirus, backup, and undelete tools—offer to install for MS-DOS, Windows, or both.

Truthfully, with the exception of the disk defragger, which is intimately connected to the compression system, I don't expect to use any of these tools much. I've long since settled happily on the likes of LapLink, NetWare, and Network Architect, and the new MS-DOS 6.0 tools don't begin to compete with these. Still, I'm pleased to see that MS-DOS finally provides a reasonably complete basic toolkit.

Wide Open Spaces

When you finish installing MS-DOS 6.0, you're invited to type ...DBLSPACE to begin the compression process. A great deal of activity ensues, all of it automatic. Like Stacker, DoubleSpace creates a CVF (compressed volume file) in place, so there is no need to reformat your disk. The CVF is a huge MS-DOS file (78 MB of the 84 MB on my laptop's hard disk) that contains an alternative file system used to store compressed files.

To convert an uncompressed disk, DoubleSpace compresses each file (using the Lempel-Ziv-Welch technique) and stores it in the CVF. Space reclaimed from the uncompressed disk enables the CVF to grow. DoubleSpace checkpoints its progress continuously. It is extremely fault-tolerant and will recover without a hiccup even if someone kicks the plug in the middle of a conversion. Files that should not be

compressed, like the Windows permanent swap file, won't be.

The next trick is to get the CVF to show up as drive C. It's here that DoubleSpace differs most noticeably from Stacker and other add-on utilities. MS-DOS 6.0 adds a third kernel file, DBLSPACE.BIN, to the venerable pair of IO.SYS and MSDOS.SYS. Because DBLSPACE.BIN loads early in the boot-up process and maps the CVF as drive C before CONFIG.SYS processing begins, there is no need to manage one version of CONFIG.SYS on the uncompressed disk and another in the CVF.

If you've never used compression, it may take a while to get used to the fact that the free space reported by DIR and CHKDSK is, necessarily, an estimate based on the current average compression ratio. In other words, with 1 MB of actual space left on your disk, the system might report 1.8 MB free. If you try to copy a 1.5-MB text file onto the disk, it will probably fit, because most text files will shrink by at least half when compressed. But if you try to copy a 1.5-MB .ZIP file onto the disk, it won't fit, because the .ZIP file is already compressed and can't get any smaller.

The compression system performs quite well in most cases, thanks partly to the enhanced MS-DOS 6.0 disk cache. SmartDrive now stores compressed data, so it uses the memory allocated to it more effectively. There are times, though, when compression will just get in the way. If you're recording compressed sound samples, for example, you'll probably want to use an uncompressed disk. DoubleSpace doesn't "know" that data won't squash any further, and it will waste time trying to compress it anyway. Fortunately, DoubleSpace makes it easy to slide the boundary between the CVF and the uncompressed disk up or down, so you can put whatever free space you have available where you need it most.

The MS-DOS 6.0 Toolkit

MS-DOS 6.0 provides two disk defraggers. One, based on Norton's Speed Disk, performs a traditional disk reorganization. The other, internal to DoubleSpace, compacts the CVF. They're linked, so when you type DEFRAG, the first defragger invokes the second. (Similarly, CHKDSK spawns a CVF-aware helper when run on

a compressed disk.) In the beta version of MS-DOS 6.0 that I tested, defragmentation was an overnight, not a lunchtime, affair. Even so, CVF defragmentation only compacts sectors. It doesn't ensure that all sectors of a compressed file are contiguous. That job will be left to the third-party tool vendors.

MEMMAKER provides much-needed automation for those who use EMM386.EXE and the LOADHIGH and DEVICEHIGH commands. When you run MEMMAKER, it prepends the SIZER command to every device driver and program named in CONFIG.SYS and AUTOEXEC.BAT and reboots your machine. SIZER enables MEMMAKER to figure out how much space these programs really use when loaded. Then MEMMAKER computes and writes out the optimal LOADHIGH and DEVICEHIGH commands, exploiting their new ability to specify particular regions of upper memory, and reboots the machine.

Like DoubleSpace, MEMMAKER is designed to be restartable in case of failure. Some uses of high memory that it attempts are bound to result in a hung machine. Anticipating the possibility of an unscheduled reboot, MEMMAKER always records

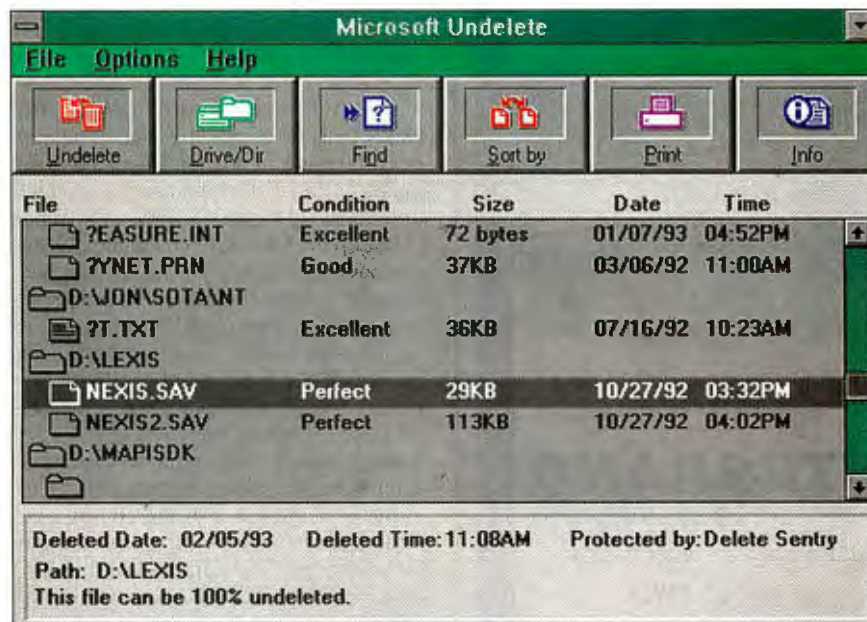
enough data to pick up where it left off.

The antivirus tools, licensed from Central Point Software, include a monitor that watches for suspicious disk or memory access and MS-DOS and Windows versions of a scanner that checks for (and can expunge) known viruses. The scanners also record file checksums used to detect changes to executable files that may signal viral infiltration. Of course, you've got to take all this with a grain of salt. Many legitimate programs do sneaky things—Windows itself, for example, patches COMMAND.COM when installing. So be prepared for some false alarms.

The undelete tool adds a new level of protection, Delete Sentry, which uses a shadow directory to retain deleted files (see screen 2). With MS-DOS 6.0, you can now undelete directories. However, you can't recover a whole subtree with a single undelete; you've got to reconstruct one level at a time.

With the new backup tools, you can define archive sets and store them on floppy disks or network drives using the same compression technology that's in DoubleSpace. Unfortunately, though, there's no support for tape drives, so if you're not connected to a network, you'll have to trundle a whole bunch of floppy disks to back up your newly enlarged hard drive.

MS-DOS 6.0 will support networking



Screen 2: DOS 6.0's undelete tool, Delete Sentry, puts deleted files in a shadow directory. You can now undelete directories.

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NEWS

FIRST IMPRESSIONS

and E-mail through a separate Workgroup Connection module (\$79.99), which Microsoft had considered incorporating into MS-DOS 6.0. The network support, comprising MS-NET and Microsoft Mail clients, originally debuted as a Windows for Workgroups option, and it's in that context that it would be most useful. Lacking server capability and the protected-mode protocol support of Windows for Workgroups, MS-DOS 6.0 networking in no way competes with the many excellent DOS peer-to-peer LAN products.

The file transfer system has client and server components. INTERSVR runs full-screen on a host, waiting for clients to connect to its local drives (or printers). INTERLNK runs on the client and establishes connections. Unfortunately, you have to load INTERLNK by way of CONFIG.SYS, so you must either pay its 9-KB price all the time or reboot to use it.

Assorted Goodies

If you press F5 while booting up, MS-DOS 6.0 boots clean; that is, it skips your CONFIG.SYS and AUTOEXEC.BAT files. Because I'm constantly reconfiguring my machines and then trying to sort out what went wrong, this little feature is a major convenience for me. There's an even better way to zero in on specific CONFIG.SYS troubles. If you press F8 while booting up, the system prompts for permission to execute each line of CONFIG.SYS. Have you ever been frustrated trying to read the message printed by a problematic device driver as it flashed by on the screen? Now you can freeze the action and take a good look at those messages.

MS-DOS 6.0 also provides a set of handy tools for organizing the boot-up process. Using a new CONFIG.SYS command, MENUITEM, you can create multiple paths through CONFIG.SYS. When I boot up my laptop, I get a menu of three choices: Standalone, NetLocal, and NetRemote. All configurations share a common block of commands. Standalone loads no network support, NetLocal connects me to NetWare and Windows for Workgroups through a Xircom adapter, and NetRemote connects me to Windows for Workgroups by way of an asynchronous connection to a Shiva NetModem.

Because the name of the chosen configuration shows up in the environment variable config, I can branch appropriately in AUTOEXEC.BAT as well (using goto %config%). I use at least two of these configurations almost every day, so I really appreciate the multiconfiguration support. There's one glitch, though. MEM-

MAKER isn't aware of multiple configurations, so for optimal results, you still have to maintain multiple CONFIG.SYS files and run MEMMAKER on each of them.

Another nice touch is the ability to slosh memory back and forth between EMS and XMS (Extended Memory Specification) memory as needed. In earlier versions of MS-DOS, the boundary between the two was fixed. As a FoxPro user, that caused me considerable grief. FoxPro 2.0 really wants a chunk of EMS, but it comes out of the same pool of extended memory that Windows as well as other MS-DOS applications (including the DOS-extended FoxPro 2.0) would prefer to treat as XMS. MS-DOS 6.0 solves the problem, enabling the EMS and XMS pools to adjust dynamically.

I'm also glad to note the belated arrival of three long-needed commands. DELTREE and MOVE are the MS-DOS equivalents of the Unix commands `rmdir` and `mv`. DELTREE lops off entire trees of directories and subdirectories, and it can also delete individual files marked hidden, system, or read-only. MOVE transplants files from one directory to another, and it can also rename a directory. The third command is CHOICE, which prompts for a single character of input and returns an ERRORLEVEL. It's crude, but it means you can finally write interactive batch files without resorting to an external utility.

MS-DOS 5.0 wasn't the long-rumored "high-tech" DOS with protected-mode capability, threads, and long filenames, and neither is MS-DOS 6.0. But I'm not complaining about version 6.0. It delivers enormous practical benefits and is by far the most compelling MS-DOS upgrade yet. ■

Jon Udell is a BYTE senior technical editor at large. You can contact him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.

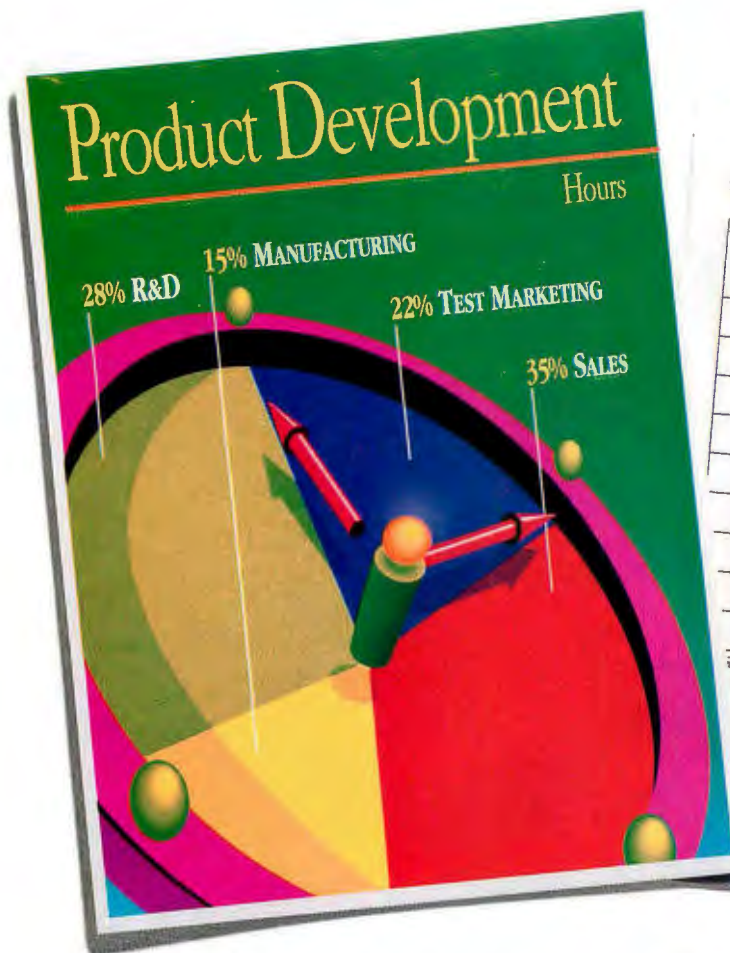
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Windows and revs up
its image on the Mac**

Photoshop is so reserved. In the time it spent running exclusively on the Mac, Photoshop established itself as the standard for desktop color-image processing. (More than a few Macs were bought expressly to run Photoshop.)

Photoshop's attraction is its scope: This one tool handles practically everything you'd want to do with a color image. Scanning, converting format, painting and retouching, correcting color, composing, cropping and resizing, separating color, printing, and creating special effects are but a few of the capabilities of this do-everything image-processing application.

Adobe, whose graphics products have helped define the Macintosh, is extending its reach with the release of Photoshop for Windows. At the same time, the company is upgrading the Mac Photoshop to version 2.5, a release that matches its PC counterpart.

If you have never seen Photoshop, you've missed one of those glorious rare moments when software approaches perfection. Adobe is humble about Photoshop, calling it a "photo design and production tool," but no one who's used

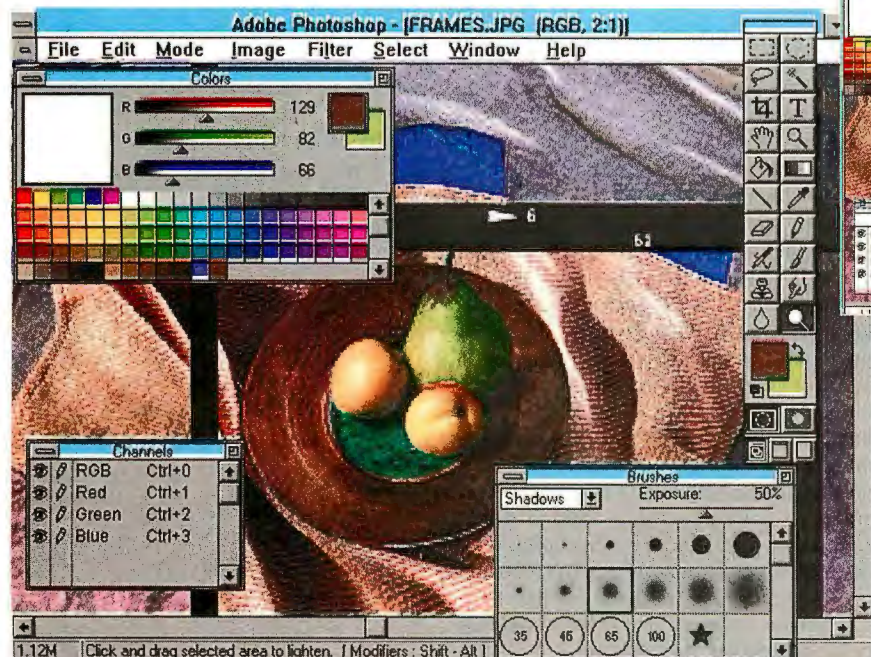
I worked with prerelease copies of both the Windows and Mac editions of Photoshop 2.5. The systems I used were a Mac IIci with 8 MB of memory and an 8•24 GC graphics card and a Uniq 486/50 EISA system with 8 MB of memory and a Matrox Illuminator Pro graphics card (part of my Matrox Studio setup). Both systems were set to run in 24-bit graphics mode.

Feature Heaven

Both versions of Photoshop 2.5 include some impressive features and usability enhancements. The most visible new stuff falls roughly into eight categories: quick mask mode, dodge and burn, brushes and channels palettes, a pen tool, duotones, a variations interface, and new special effects filters.

Quick mask mode causes Photoshop's tools to switch from image to mask modification. You see a mask as a semitransparent film (red by default) over your image. You can use selection and painting tools to build your mask and then switch out of quick mask mode to turn that mask into a selection. You can use a selected area to protect portions of your image from modification or as a target for filters and other selection-oriented tools.

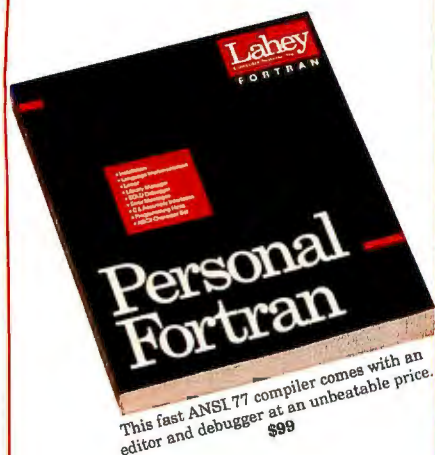
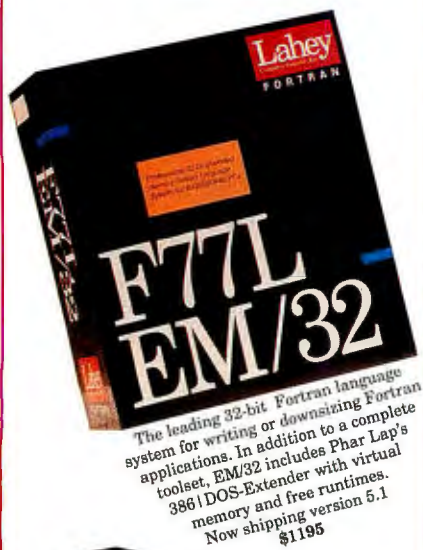
The dodge and burn tool's purpose is



Screen 1: Photoshop 2.5 for Windows (left), showing tools, brushes, channels, and colors palettes. Adobe designed the interface to offer rapid access to common functions and information.

Screen 2: Photoshop 2.5 for the Mac is almost identical to its Windows counterpart except for the Mac look and feel. System 7 Publish/Subscribe and QuickTime image manipulation are two features unique to the Mac version.

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NEWS

FIRST IMPRESSIONS

similar to that of darkroom tools of the same name, which either block light from the enlarger to lighten parts of an image (i.e., dodge) or cause regions of the print to darken through additional exposure (i.e., burn). You can use this tool to enhance or soften shadows, make a background less distracting, or otherwise darken or lighten portions of an image.

The dodge and burn, paint, stamp, and other tools alter your image using shapes stored in Photoshop's brushes palette (see screens 1 and 2). A selection of circular brushes is standard, with both hard and feathered edges. In the new Photoshop, you can add any selected shape to the brushes palette. As you select tools, the top of the brushes palette window offers quick access to useful tool options. When the dodge and burn tool is in use, for example, the brushes palette lets you select the range of brightness values (i.e., shadows, midtones, or highlights) to affect your image and the percentage of exposure each sweep with the tool will apply.

One way to use the channels palette is to view and modify the components of your color image separately. A 24-bit RGB image, for example, starts with three channels: red, green, and blue. The channels palette lets you switch your view from the composite color image (i.e., the default) to one or more of the component channels. You can also add channels (up to a total of 16) for alpha-channel effects in other programs (e.g., Matrox Studio's Personal Producer), saving masks and selections, image overlays, and calculated operations such as subtracting one channel from another.

The new pen tool gives you more precise control over the shapes you create to define selection areas and masks. The tool builds Adobe Illustrator-style paths with straight lines and Bézier curves. A path the pen tool creates can, in addition to acting as a means of creating a selection, be filled or stroked. That is, the interior of the shape created with the path can be painted with a color or pattern.

Duotones refers to a process in which a gray-scale image is printed with two colored inks. Each of the inks is assigned to a range of gray tones, expanding the number of distinct gray levels a screened, printed image can represent. Photoshop supports monotoes through quadtones, meaning you can manage up to four ink colors. You create a curve to set the range of grays covered by each ink. You can apply inks other than grays to the image to create attractive toning and colorization effects.

The new variations dialog box simplifies color correction by presenting multiple

miniature views of your image (or a selected portion) and letting you see the effect changes would have before you apply them. You can modify hue, saturation, brightness, and contrast here through a commonsense interface. If you need to color-correct an image, for example, you can simply click on the icon that says "more magenta," and you see a preview of the effect the added magenta would have. You can continue to click on the preview icons until the "current pick" image reflects the effect you want. A comparison between the original and would-be modifications is always visible.

Finally, Photoshop 2.5 adds a host of special effects filters. Users of Adobe Premiere on the Mac will recognize many of them. Tile breaks an image into squares and slightly (and randomly) skews each segment to give the image the appearance of being printed on a matrix of cardboard shapes that weren't fitted together very well. Extrude, similar to Tile, turns the image into a matrix of square-capped tower shapes that convincingly simulate depth in a weird but appealing way.

A distortion filter warps the image, other filters build line-art-like drawings, and a host of others apply either purely artistic or functional changes. One functional filter prepares an image for display on a TV monitor by filtering out NTSC-illegal (oversaturated) colors and diminishing interlace jitter through scan-line duplication or interpolation.

Photoshop 2.5 is one of those grand tools that adapts itself to the shape of the work to be done. In bringing it to the PC, Adobe legitimizes the use of Windows systems for serious graphics work. ■

Tom Yager is a multimedia consultant and author of The Multimedia Production Handbook for the PC, Macintosh and Amiga (Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.

THE FACTS

Adobe Photoshop 2.5 for Windows and the Macintosh
\$895 each

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(415) 961-4400
fax: (415) 961-3769

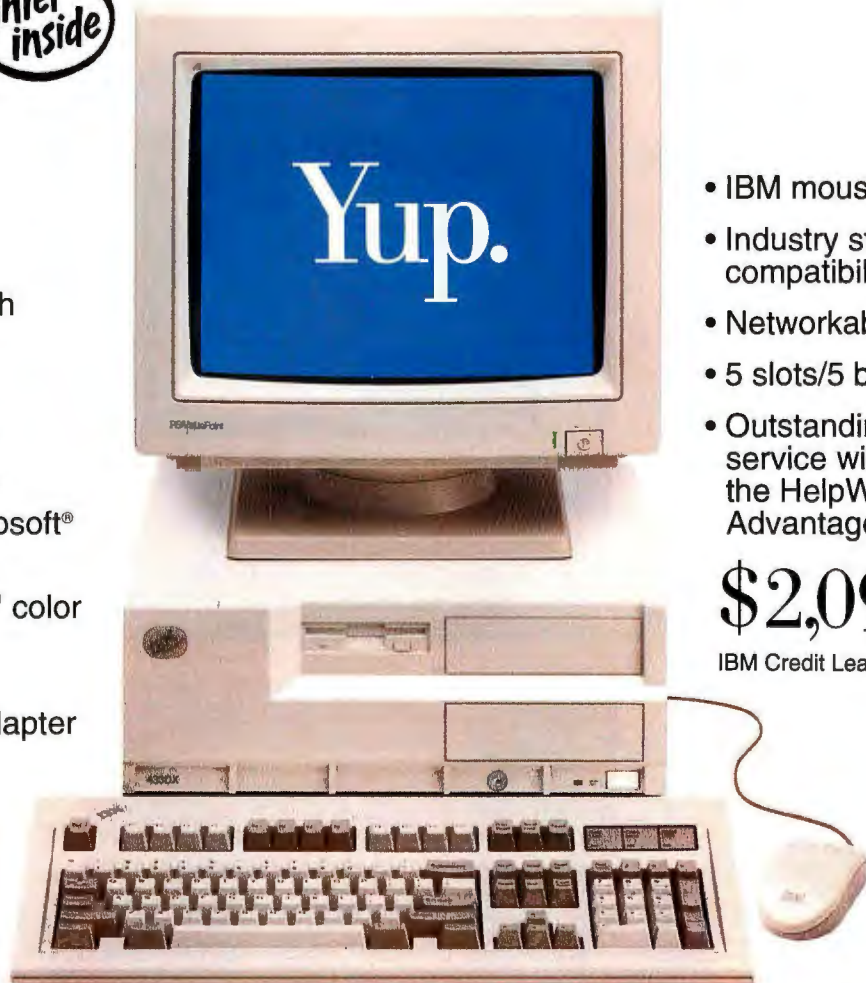
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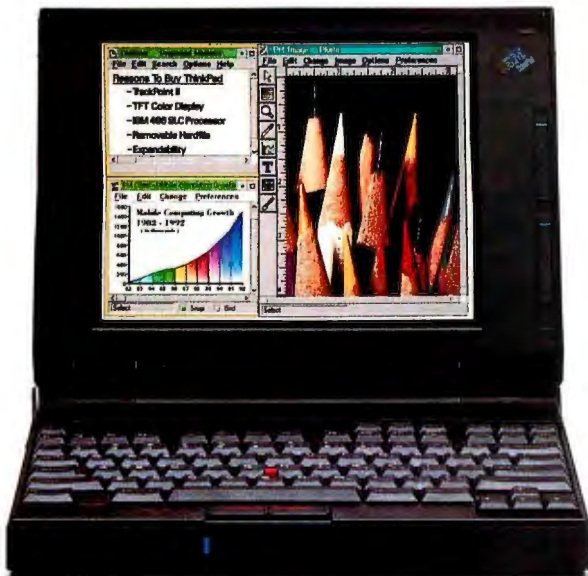
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***Screen at right depicts OS/2, also available pre-installed on this model.

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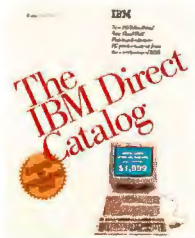
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Attractive Pricing and Attractive Printing



Epson America's 1985 foray into the ink-jet printer market was a brief one. By 1987, the company had quietly stopped selling its \$2295 SQ-2000. Now Epson is returning to an ink-jet market dominated by Hewlett-Packard and Canon.

Epson hopes to challenge the leaders with the **Stylus 800**, a plain-paper ink-jet printer based on the MACH (Multilayer Actuator Head) technology that the company announced last November. The 360-dot-per-inch, 48-nozzle black-and-white model, list-priced at \$499, is expected to sell in the \$350 to \$400 range to small-business and home users who want near-laser quality at dot-matrix prices.

Epson says its printer uses fewer disposable parts and has a lower cost per page than the competition. But when comparing competing models, be aware of statistical sleight of hand on the part of all vendors and their printer specifications. Using a 1000-character text page for reference, the

Stylus, at 2.8 cents per page, does seem to win out against products such as the Canon BJ-200 (5 cents per page). It also appears that, on average, the Stylus's cost per page is lower than the HP DeskJet 550C's claimed cost of 3 cents per page in black-and-white mode and matches the per-page cost of Lexmark's IBM 4072 ExecJet (another product with a permanent print head). Epson's cartridges list at \$19.99 apiece; Lexmark's list at \$28.

The 10.6-pound, compact Stylus 800 is well suited for general-purpose jobs, with an ease of use that begins with plug-and-play installation and continues through all-control-panel configuration. Four of the seven resident fonts are scalable (through hardware or software) from 8 to 32 points. An economy mode uses half as many dots, to extend the life of the 700,000-character cartridge. Other adjustable settings include a character table, a toggle switch for mixed text and graphics (toggled off if your software integrates scalable fonts and graphics), and head cleaning.

Paper options are plentiful up to legal size. The feeder holds 100 sheets of letter-size or, for the European version, A4 paper. A manual feeder takes single sheets and number 6 or number 10 envelopes.

The beta model that I saw excelled in print quality, with a smooth, nearly satellite-free (i.e., no stray ink dots around the letters) letter-quality text. It falls short of,

say, the HP LaserJet II under close scrutiny, but not noticeably enough to make a difference for routine use. Graphical images that I printed from Windows were attractive, although they betrayed a hairline banding that is sure to vary depending on the quality of plain paper you use.

It's ironic that the company that virtually defined the printer market now has much to prove. In spite of its name recognition, Epson is slipping behind Panasonic in the dot-matrix printer market, according to the market-research firm InfoCorp. In laser printers, Epson never made it out of the "Other" category. However, with its Stylus 800, Epson could have a big impact on the nonimpact printer market.

—Ed Perratore

THE FACTS

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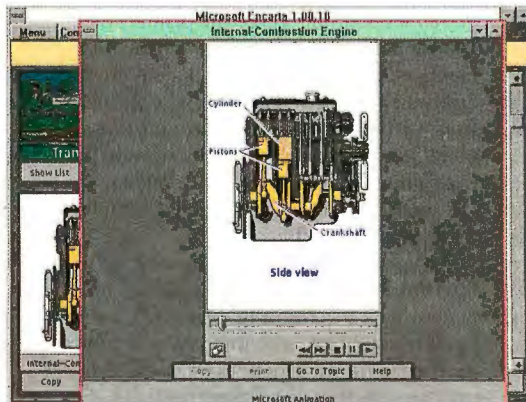
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Encarta: Explore New Worlds from the Desktop

Whether you're seeking answers to one of life's eternal questions, researching the intricacies of quantum theory, or just looking for a quick mental escape, browsing through **Encarta**, Microsoft's new Windows-based multimedia CD-ROM encyclopedia, makes for an excellent adventure. Encarta, under development at Microsoft for nearly two years, never ceased to intrigue during my examination of an alpha version. I was drawn both back in time and to faraway places by the encyclopedia's rich mixture of text, sound, photographs, and animation sequences.

Encarta encompasses some 21,000 articles in 94 categories, and it includes more than 7 hours of sound in its animations, music clips, and literature. Although Mi-



crosoft licensed the contents of Funk & Wagnall's *New Encyclopedia*, Encarta is largely a rewrite to meet the needs of a multimedia title, according to Craig Bartholomew, product group general manag-

er for Microsoft's multimedia publishing business unit.

Part of Encarta's strength comes from the volume of original animations and photos added to the encyclopedia. The collection, which can display graphics in 256 colors at 1024 by 768 pixels, contains more than 7000 photographs, charts, and graphs. For example, I found an interesting short animated sound clip, detailing the inner workings of the internal combustion engine, accompanying an article on automobiles.

Among Encarta's more enjoyable features is the 20-foot historical time line of important events in history, dating from 15,000,000 B.C. to the present. Clicking on an event in the time line pops up a short synopsis or an even longer article on the subject. Encarta also makes it easy for

users of all ages to search for articles by using the program's category browser, which offers a graphical method of sorting through the entire encyclopedia by subject. In this way, you could, for example, quickly look up your favorite hockey, baseball, or basketball player by selecting the sports category.

You can access articles in Encarta directly by name by clicking on graphical images of a 26-volume encyclopedia set on a bookshelf. Encarta is also organized into nine major categories: physical science and technology; life science; geography; history; social science; religion and philosophy; art, language, and literature; performing arts; and sports, games, hobbies, and pets. Each category is further divided into subcategories that you can easily search via a category browser. Or you can research topics in a much more sophisticated manner through Encarta's Find feature, which allows powerful Boolean searches that can be narrowed to specific data types, such as photographs

or animations. You also have access to an atlas with about 800 color maps, a word processor, and a Webster's dictionary and college thesaurus.

Microsoft also threw in a game called MindMaze as a fun way for younger users to build their knowledge. The MindMaze game asks youngsters questions as they try to navigate a maze by going through doors in a medieval castle. Although I was told that successful MindMaze players would get a Master of Knowledge certificate from Bill Gates, I never got that far (even though most of the questions were relatively easy).

Originally announced in October 1992, Encarta was expected to be available in late March or early April, according to Encarta product manager Sonja Gustavson. Microsoft, which has set Encarta's list price at \$395, plans to sell the multimedia encyclopedia to students, educators, and school administrators for \$249. If you order the initial edition by March 31, you will receive a free 1993 update. Microsoft

plans to price future updates at less than \$100.

—Patrick Waurzyniak

THE FACTS

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System requirements:

A 386 or higher with Windows 3.1, 2 MB of RAM (4 MB is preferred), a CD-ROM drive, a VGA or Super VGA color monitor, a sound card, and speakers.

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TI's microWriter Pricing Breaks New Ground



Plain-paper, laser-quality output for the lowest price on the planet: That's what Texas Instruments promises with the **microWriter**, a svelte little desktop printer that carries a starting list price of just \$729. At that price, TI hopes to entice a lot of first-time printer buyers away from ink-jet and dot-matrix printers.

The basic microWriter has an LED print engine rated at 5 pages per minute, Hewlett-Packard LaserJet compatibility (PCL 4), a parallel interface, and 512 KB of RAM (expandable to 4.5 MB in PCL mode). For \$999, you can buy the PS 17, with an Adobe PostScript Level 1 inter-

preter with 17 fonts, 2 MB of RAM (expandable to 4 MB in PostScript mode), an Apple LocalTalk port, and automatic emulation switching between PostScript and PCL. For \$1299, you can get the microWriter PS 35, with the full complement of 35 PostScript fonts.

Paper handling is one of the microWriter's strong points. The 250-sheet paper tray is contained entirely within the printer's footprint. Printed pages normally come out at the top of the printer, face-down, and go into a fold-out paper catcher. A manual feed slot accepts envelopes and other odd-size paper. The combination of the manual feed slot and a rear-panel-access door gives you a straight paper path for heavier paper or card stock. An optional universal paper feeder attaches underneath the printer.

I spent a week with a beta unit of the 35-font PostScript configuration, connected to a PC running Windows and a network of Macs. The microWriter holds its own quite nicely against most other printers in the 4- to 6-ppm class. On BYTE's PostScript tests (a slimmed-down version of Genoa Technology's PostScript suite), the microWriter ran faster than Apple's Personal LaserWriter NT, an HP IIIP with HP's PostScript cartridge, and TI's own microLaser. The print quality is typ-

ical of other LED printers.

For a beta-test unit, this printer was unusually reliable and well built. The PCL interpreter and automatic emulation sensing worked flawlessly. There was one hiccup when printing bit maps from a Mac running System 7 printer drivers; TI says this will be remedied by the time the unit ships. The microWriter-specific printer drivers weren't ready for testing, so I used the standard Apple LaserWriter drivers.

TI should make lots of friends by shipping a real Adobe PostScript printer that breaks the \$1000 price barrier. The microWriter will present a serious challenge to many printers twice its price and make a welcome addition to almost anyone's desk.

—Howard Eglowstein

THE FACTS

microWriter
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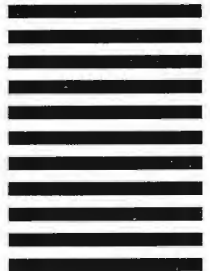
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Manufacturer Costoso Ltd.

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Qty. 53

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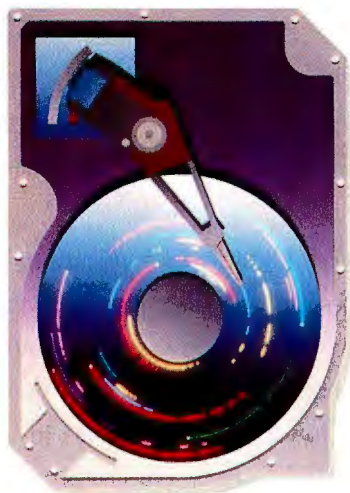


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NEWS

FIRST IMPRESSIONS

Windows Sound in a Small Package

Adding sound to Windows applications is becoming de rigueur in some circles, but the cost of the equipment and the potential difficulty of adding it to the computer are stumbling blocks to many prospective sound users. And if you use a Windows notebook, sound hasn't been an option. A refreshing solution to this situation is Logitech's **AudioMan**.

A small, attractive, and inexpensive external device with a built-in microphone, speaker, and sound board, AudioMan eliminates the fuss of having to open your computer and install a sound board or attach external speakers that take up space on your desk. The device attaches to the parallel port of your computer and has a pass-through connector for uninterrupted printer availability. AudioMan's light weight and small footprint make it ideally suited to mobile computer users, who can choose to use the unit as a hand-held or desktop device.

AudioMan uses OLE to embed sound in any Windows document that supports OLE. The device is compatible with any Windows sound utility. AudioMan is not SoundBlaster compatible, so it won't play back sounds that were created by products that adhere to that standard. This means that you're limited to the 60-second recording limit imposed by Windows Sound Recorder, although you can link several 60-second lengths together to create a longer message. The 60-second limit may be a blessing, though: Since each second of sound takes 11 KB of disk space, a full minute would eat up 660 KB on your hard drive.

AudioMan is particularly geared toward the annotation of spreadsheets and text files. I used a beta version of the package to add a verbal annotation to a text file, to play when I go back into the document to make updates.

You can also connect AudioMan to an external sound source such as a CD player via the alternative recording audio jack and then insert that recorded sound into your document. You should note that AudioMan's sound quality (8-bit mono at 11 kHz for input and 22 kHz for output) is well below CD quality (16-bit at 44 kHz). However, its sound quality is perfectly suitable for its most likely application—



adding personal comments to Windows documents. Two small buttons on the front of the unit let you control the volume for the current session; for a permanent change, you reset the default volume in AudioMan's dialog box.

You install the AudioMan software by using the Run command in the Windows Program Manager or via the Drivers icon in the Program Manager Control Panel. I chose to use the Run command, which was simple and straightforward.

To add sound to a Windows document, I positioned the insertion bar at the place in the document where I wanted the sound to go. After choosing Insert Object from my word processor's Edit menu and Sound from the subsequent Object Type list, I selected a .WAV file from the Sound Recorder file listing. I then clicked on Update in the Sound Recorder's File menu and closed the Sound Recorder. A Sound Recorder icon then appeared in my document at the place I had designated. To play the embedded sound, I simply double-clicked on the icon; AudioMan did the rest.

Despite the program's recording and compatibility limits and the less-than-specific instructions in the user's guide, AudioMan is a likable, low-cost way to add sound to Windows documents. And it's the easiest way I know to add sound to my files as I travel. ■

—Carol J. Swartz

THE FACTS

AudioMan
\$179

System requirements:

A 286 or higher with 2 MB of RAM, DOS 3.1, Windows 3.1, and one parallel port.

Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA 94555
(510) 795-8500
fax: (510) 792-8901

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Programmer's Paradise®

WATCOM SQL Developer's Edition by WATCOM



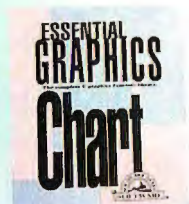
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| dBFast Windows | \$359 | PGL | CALL |
| dGT-Unlimited Runtime | \$499 | .RTLink/Plus | \$445 |
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| GX Products | CALL | Turbo C++ for Windows | \$112 |
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Essential Graphics Chart™ for Windows by South Mountain Software



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CA-dBFast Windows 2.0 by Computer Associates



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Dan Bricklin's Demo II by Lifeboat Software



Experience for yourself why 30,000 people have made Demo II 3.0 the leading tool for producing program prototypes, demonstrations, and tutorials. Demonstrate commercial software to potential customers without shipping live software. Produce effective tutorials that interactively teach products. Create Computer Based Training for a fraction of the cost of dedicated CBT authoring software.

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FAX *cetera* # 0233-0003

Q+E Database Library (QELIB) 1.1 by Pioneer Software



A set of Dynamic Link Libraries providing a common call level interface for developer tools such as Visual Basic, ToolBook, Actor, Smalltalk, C, C++, etc. and most macro language products to access data from Oracle, SQL Server, Sybase, EE Database Manager, DB2, Netware SQL, dBASE, Paradox, Excel, and text files.

List: \$399 Ours: \$359
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MediaDeveloper by Lenel Systems



Create multimedia-enabled applications with MediaDeveloper and ObjectVision. It is THE Multimedia Development Toolkit to integrate sound, images, animation and full-motion video into Windows applications. Includes media and device control for multimedia peripherals including CD-ROMs, VCRs and laserdisc players; support for major animation, video, audio and graphics formats; a multimedia database; OLE server; and many DLLs.

w/MS VB Win. 2.0 **List: \$595 Ours: \$449**
w/MS VB Win. Pro 2.0 **List: \$794 Ours: \$569**
FAX *cetera* # 1005-0302 **List: \$1090 Ours: \$739**

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Lahey F77L - Fortran Compiler by Lahey

Version 5.01 includes Fortran 90 features: ALLOCATABLE Arrays, CASE Constructs, Cycle and Exit, Construct Names, and many other new features. Package includes Editor, Make Utility, Profiler, Debugger, SLR Linker, Opus Make, Video Graphics, and Excellent Diagnostics. 386/486 users have the option of generating 32-bit instructions.

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WindowsMAKER Professional 4.0 by Blue Sky Software

Next generation of industry standard C/C++ development tool for Windows. The easiest fastest way to create Windows apps, just point and click. New architecture uses Switch-It™ Code Generation Modules for generating ANSI C, MFC++, or OWL C++ code among others. Award-winning Visual Prototyper lets you test the look & feel and make changes on the

fly. TrueCode technology ensures the user code is preserved during code regeneration. Generates Windows .EXE w/fully commented C or C++ source.

List: \$995 Ours: \$695
FAXcetera # 2602-0003

PRODUCT OF THE MONTH

Microsoft Visual C++ by Microsoft Corporation



Microsoft Visual C++ combines the power of reusable, prebuilt code with a seamless, visual environment to shorten the development process. Design user interfaces, build, debug, and browse using a set of tightly integrated tools, while "wizards" assist you with fundamental tasks for maximum productivity. It's the fast, powerful way to program in C++!

Standard Edition (Comp. Upgrade)
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FAXcetera # 1269-0040

List: \$99 Ours: \$95
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ED-The Programmer's Editor for Windows by Lifeboat Software

A full-featured Windows-based programmer's editor is here! ED is setting the standard with features like background compilation, automatic code indenting and completion, hypertext function/procedure lookups, "smart" language-specific editing, a fast "C" extension language, Windows Toolbar, unlimited undo and redo, keyboard macros and remapping, and emulation of popular DOS editors.

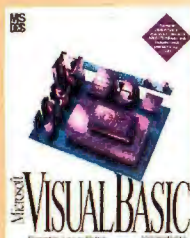
List: \$269 Ours: \$199
FAXcetera # 0233-0011



CA-Clipper 5.2 Competitive Upgrade by Computer Associates

Yes, the newly released CA-Clipper version 5.2 is being offered to Xbase language product owners at the low retail price of \$199. This competitive upgrade is available for a short term only! What a great opportunity to get the power of CA-Clipper, at a super price! And now when you buy, get your choice of dBFast, Clipper Tools or dBase Compiler Kit FREE!

List: \$199 Ours: \$149
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MS Visual Basic for DOS

Draw forms and controls, write event-procedures, use and create custom controls-in DOS! Create all-new apps or combine with existing C/C++ or Pascal code. Highly compatible with VB/Win for multi-platform development. Even run existing MS Quick Basic/Basic PDS code! Includes a native 80 x 86 compiler that creates 100% standalone .EXE files, 386 code generation, MOVE overlays, an integrated ISAM and much more!

Standard Edition List: \$199 Ours: \$139
Professional Edition List: \$495 Ours: \$325
FAXcetera # 1269-0039



OS/2 2.0 by IBM

OS/2 2.0 increases your operating system choices by providing you with DOS, Windows and OS/2 support. Because OS/2 was created for use with 386SX and above processors, it offers full 32-bit addressability and true concurrent multitasking. OS/2 2.0 also features an object-based user interface, enhanced file system, advanced memory technology and the ability to complete many processes within a task simultaneously.

List: \$195 Ours: \$126
FAXcetera # 3142-0009

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Programmer's Paradise®

MetaWare High C/C++ by MetaWare, Inc.

MetaWare, Inc. announces its newest product! The 32-bit High C/C++ compiler version 3.0 is a true compiler, not a C to C++ translator. "Incremental Strengths" let you specify the level of C++ compilation, allowing you to migrate from C to C++, one C/C++ block at a time. Included is a C++ tailored source-level debugger and a 32-bit Application Development Kit for Windows. MetaWare offers a full line of multi-language, multi-platform compilers for professional software developers.

List: \$795 Ours: \$669
FAXcetera # 1590-0008



VM Data by PocketSoft, Inc.

VMData for Windows is a DLL that manages up to 128 MB of dynamic data. Eliminates annoying slowdowns commonly seen in 386 Enhanced Mode when programs use large amounts of dynamic data, and eliminates out-of-memory problems in Standard Mode. Provides superior run-time performance and ensures that your program is a good citizen under the Windows environment.

List: \$495 Ours: \$359
FAXcetera # 1987-0005

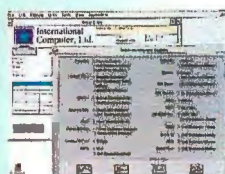


WinGEN by Buzzwords International

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Make the title bar disappear and run your application at compiled speed. WinGEN produces code for Windows versions of dBASE, C/C++, and Turbo Pascal. Supported engines include: Paradox Engine, Sequiter Codebase, POET, Raima, Faircom c-tree, Sybase, Novell Btrieve, Novell Btrieve with SQL/XQL Manager, OLE & DDE/DDEML, and Q & E.

List: \$149 Ours: \$79
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DataBoss by Kedwell Software

Relational database application generator. Use to develop complete applications with menus, forms, browse tables, memo fields, reports and more. Includes sophisticated screen painter; field definition template for defining field characteristics, indexes, data files and their relations; WYSIWYG report designer; generator engine and skeletal files. Generates structured C/C++ or

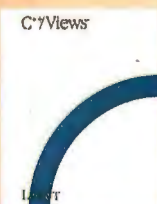
Pascal source code. No license or runtime fees.

List: \$695 Ours: \$499
FAXcetera # 3758-0001

WATCOM C/386 9.0 by WATCOM

Develop and Debug 32-bit applications for extended DOS, Windows, and OS/2 2.0 with the most complete 32-bit C development package available. Includes the royalty-free DOS/4GW DOS extender by Rational Systems, components from MS Windows SDK, compiler, linker, debugger, profiler, plus numerous development tools. Supports other industry standard 32-bit DOS extenders. Create ADS Applications for AutoCAD or embedded systems development.

List: \$895 Ours: \$599
FAXcetera # 1683-0003

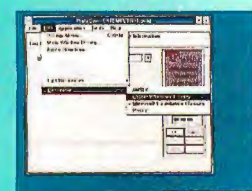


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Includes C++/Browse object class browser and source code at no additional charge.

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FAXcetera # 1812-0001



PROTOGEN 3.0 by ProtoView Development

NEW VERSION! The industry standard for code generation and prototyping Windows applications. Develop the user interface of your application using Visual prototyping methods. ProtoGen generates expert

level, commented code for ANSI C, Microsoft NT Win32. All generators included! User Code is preserved from one generation to the next. It's easy and fast.

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A Pentop to Flip Over

A flip-up, flip-down passive-matrix VGA color display is just one reason for considering the Dauphin 5500 Color Pentop. Other reasons are its 25-MHz 386SL processor with 64 KB of cache SRAM (static RAM), 4 MB of RAM (expandable to 20 MB), and an 80-, 130-, or 200-MB hard drive. A PCMCIA slot in place of the standard 3 1/2-inch floppy drive is an option.

The backlit color display has a resolution of 640 by 480 pixels in 256 colors; you can simultaneously use an external Super VGA monitor with an 800- by 600-pixel resolution display in 256 colors. The unit includes a Centronics parallel port, an RS-232 serial port, and a port for an external floppy drive. Operating systems supported include Windows for Pen Computing, PenPoint, DR DOS, DOS, and OS/2.

Price: About \$3495.
Contact: Dauphin Technology, Inc., Lombard, IL, (708) 627-4004; fax (708) 627-7618.
Circle 1131 on Inquiry Card.

Passive Color Can Turn Active

Based on a 25-MHz 386SL processor with a 64-KB cache, the DECpc



The DECpc 325SL.

Computing power on the Dauphin 5500 Color Pentop comes partly from the 87SLC math coprocessor.

325SL notebook can be upgraded to a 486SL. The 4 MB of main memory is expandable to 20 MB, and the monochrome or passive-matrix color display can be upgraded to an active-matrix color display.

The DECpc 325SL's 80- or 120-MB hard drive is removable, and the unit has two sockets for attaching PCMCIA Type 2 peripheral cards. The power management system in the notebook provides up to 6 1/2 hours of battery life. Other features include a cableless trackball that connects to a built-in hot shoe on the front of the unit.

Price: \$2399 and up.
Contact: DEC, Maynard, MA, (800) 722-9332.
Circle 1133 on Inquiry Card.

Designed for Windows

A notebook computer designed for Windows users, the WinBook features a built-in trackball and 4 MB of RAM (expandable to 8 MB). The basic unit has a 120-MB hard drive, a PCMCIA 2.0 slot, and a 2400-bps data/9600-bps fax modem. With 1 MB of ROM for the BIOS, 512 KB of VRAM (video RAM), a 25-MHz 486 SLC/E processor, and a 1-KB internal cache, the 5.4-pound WinBook packs a lot into its 11- by 9- by 2-inch frame.

The Winbook's 10-inch display is a 64-gray-scale supertwist transreflective screen with a resolution of 640 by 480 pixels. You can simultaneously display on it and on an external CRT. Powered by a detachable nickel-metal-hydrate battery pack, the unit runs for up to 4 hours.

Price: \$1699.
Contact: Micro Electronics, Inc., Columbus, OH, (800) 468-2162 or (614) 481-8041.
Circle 1132 on Inquiry Card.

VL-Bus-Based Desktops

Insight's new 486-based computers have a VESA (Video Electronics Standards Association)-standard video controller as well as a VESA-standard IDE hard drive controller. The upgradable systems feature two VL-bus slots and a 238-pin ZIF (zero insertion force) OverDrive socket.

The computers have 4 MB of RAM, 128 KB of cache memory, and a 210-MB IDE hard drive with cache. Dual floppy drives, two serial ports, a parallel port, a mouse, and a 14-inch noninterlaced Super VGA color monitor are also standard equipment.

Price: \$1699 and up.
Contact: Insight Distribution Network, Inc., Tempe, AZ, (800) 755-9628 or (602) 350-1128.
Circle 1134 on Inquiry Card.

Cache Tucked in a Subnotebook

Smaller than a notebook, the Bicom SL60 runs DR DOS 6.0 as its standard operating system. Based on a 25-MHz 386SL chip with a cache controller, the unit has 2 MB of RAM (expandable to 20 MB), 64 KB of cache memory, and a 25-MHz 387SX coprocessor socket. The 60-MB hard drive comes with power management.

The viewing area of the high-contrast, nonglare, reflective LCD is 6 1/4 by 4 1/2 inches. The unit weighs about 2 pounds with the battery.

Price: About \$1150 (HK\$149).
Contact: ABC Computer Co., Ltd., Kwai Chung, New Territories, Hong Kong, +852 481 6118; fax +852 481 5836.
Circle 1135 on Inquiry Card.

Dedicated SCSI Caching

A dedicated SCSI-2 caching device that has a cache access time of less than 0.03 ms, Atto's Silicon-Cache connects to your computer through the SCSI bus. The device, designed for disk-intensive and time-critical applications, resides between the host computer's SCSI port and its disk storage devices.

The SiliconCache's basic capacity of 32 MB is expandable in 32-MB steps to 512 MB; its transfer rate is 6 MBps. The device has a write-through design to eliminate data loss and provide an extra level of system fault tolerance. Transparent to the host, the unit supports up to 49 SCSI devices.

Price: \$7995.

Contact: Atto Technology, Inc., Amherst, NY, (716) 688-4259; fax (716) 636-3630.

Circle 1136 on Inquiry Card.

More Power for the PowerBook

Portable storage for your PowerBook is now available in the form of the Powerbox and the MicroMD 200.

With the same footprint as the PowerBook, the 4-pound, 1.4-inch Powerbox fits under the notebook and connects through the SCSI port. The Model 200-T (with a 200-MB hard drive) and the Model 500-T (with a 500-MB hard drive) Powerboxes each have a 155-MB tape drive for microstreaming tape backup. Average seek time of the hard drive is 12 to 15 ms; the data buffer size is 64 KB.

A standard PowerBook battery in the Powerbox typically provides 2 hours of hard



SiliconCache uses special caching hardware and adaptive software for access times under 0.03 ms. The device can manage up to 512 MB of cache memory.

drive operation. The System 7.0-formatted Powerbox ships with Adambyte utilities and integrated backup software.

Price: \$1990 and up.

Contact: Adambyte, Mountain View, CA, (415) 988-1415; fax (415) 988-1418.

Circle 1138 on Inquiry Card.

Procom Technology's MicroMD 200 incorporates the company's Atom 200 2 1/2-inch hard drive, with an average access time of 12 ms. A miniature external AC power supply powers the unit.

Features include 132 KB of RAM cache, a 3.2-MBps sustained transfer rate, a 4000-rpm spindle rate, and a 100-g shock rating. The drive supports System 6.x, System 7.x, AppleShare, and A/UX.

Price: \$1695.

Contact: Procom Technology, Irvine, CA, (714) 852-1000; fax (714) 852-1221.

Circle 1139 on Inquiry Card.

Stack Up Your Storage

SmartStack is Envisio's modular answer to SCSI expansion. Comprising three main components, SmartStack uses just one SCSI cable and one power cable to

automatically connect multiple hard drives.

SmartSource, the base unit of the storage system, features a 120-W power supply, a quiet fan, a power switch that accesses all connecting drive modules, and a power cable. The unit's two 50-pin SCSI connectors let you add other peripherals.

Attached to the base unit via the snap-on/snap-off SmartStack cover unit, the SmartStack drive modules each include PTB (pass-through bus) connectors on the top and the bottom; a SCSI loop-back connector on the cover unit sends the SCSI signal throughout the system. The drive modules include a standard hard drive, an optical drive, and a DAT (digital audiotape) drive.

Price: SmartSource, \$249; drive modules, \$699 and up.
Contact: Envisio, Inc., St. Paul, MN, (612) 628-6288; fax (612) 633-1083.

Circle 1137 on Inquiry Card.

Color in Full Bleed

Seiko Instruments' Professional ColorPoint PSH dye-sublimation printer lets you create extra-large full-bleed prints that fill an 8 1/2-by 11-inch area. Standard memory in the 300-dpi printer is 16 MB, expandable to 64 MB. The primary processor is a Weitek RISC XL8220 that runs at 25 MHz.

The PostScript-compatible PSH accepts incoming files at speeds as fast as 200 KBps via its Centronics parallel port. Additionally, the PSH has LocalTalk/AppleTalk and RS-232C interfaces, letting you connect Mac, PC, and Unix systems. Features include simultaneously active ports, multitasking capability, automatic input polling, and off-line printing.

Price: \$9999.

Contact: Seiko Instruments USA, Inc., San Jose, CA, (800) 888-0817 or (408) 922-5800; fax (408) 922-5840.

Circle 1140 on Inquiry Card.



Sized to take up minimal desk space, the SmartStack modular storage system can run up to seven SCSI peripherals.

Render Graphics in AutoCAD

The 32-bit display list in the Diamond accelerator board from the Norwegian company Rasterex lets you take full advantage of the no-regen rendering feature in release 12 of AutoCAD. When you're drafting in AutoCAD at 8-bit color and you use Rasterex's rendering tool Rx-AutoIcon release 12 (built-in on the board), the Diamond will switch to 24-bit color (i.e., true color) without your having to reconfigure anything. In multimedia applications such as Animator Pro and 3D Studio, you can use RxAutoIcon for real-time capture at high resolution.

If you work in Windows, the Diamond, which is based on the TI-34020 processor and comes with 4 MB of video RAM, lets you run true-color applications. The board's 1280- by 1024-pixel resolution is reconfigurable to lower resolutions.

Price: \$2495 and up.

Contact: Expert Graphics, Inc., Atlanta, GA, (800) 648-7249 or (404) 320-0800; fax (404) 315-7645.

Circle 1141 on Inquiry Card.

PCMCIA for Palmtops

Available with capacities of 256 and 512 KB and 1 and 2 MB, the SRAM Memory Card Family from Memorex is geared toward users of palmtop computers. The PCMCIA-standard, solid-state memory cards use an 8- or 16-bit data bus with an average access time of 200 ns. Each card ships in an anti-static envelope and with a lithium battery.

Price: From \$199.95 to \$749.95.



The Diamond 32-bit graphics accelerator board lets you do rendering in true color.

Contact: Memorex Computer Supplies, Santa Clara, CA, (408) 957-1000; fax (408) 957-1145.

Circle 1142 on Inquiry Card.

Orange You Closer to DOS, Mac?

Two boards use different methods to let you join your Macs and PCs. One puts DOS on the Mac; the other puts Mac applications on the PC.

The OrangePC is Orange Micro's latest solution to DOS/Mac incompatibility. With either a 25-MHz 386SX or a 25-MHz Cx486SLC processor, on-board VGA hardware, DOS 5.0, and 1 MB or more of RAM (up to 16 MB), the board lets you display VGA graphics on any Mac monitor or Mac-compatible monitor. You can also launch Windows 3.1 inside a Mac window and run your Windows applications simultaneously with Mac applications in another window.

The entry-level board is only RAM expandable. Expandability on the intermediate 25-MHz 386SX model consists of an AT bus slot for add-on PC cards and PC serial and parallel ports, so you can attach a modem, printer, pocket network adapter, or software key. The 2 MB of RAM is expandable

to 16 MB via SIMMs. The top-of-the-line Cx486SLC board includes the same expandability features.

Price: From \$1099 to \$1799. **Contact:** Orange Micro, Inc., Anaheim, CA, (714) 779-2772; fax (714) 779-9332.

Circle 1143 on Inquiry Card.

An expansion board that lets you run Macintosh applications on your PC in addition to all DOS and Windows applications, the 50/50 Dual Desktop displays DOS and Mac screens side by side. You can also use hot keys to toggle out of a DOS screen into a Mac screen running Mac software for a full-screen display.

The 16-MHz 68000-based board works with the ISA or EISA bus and System 6.0, 7.0, and 7.1. It treats IDE, MFM, SCSI, and ESDI PC hard drives as standard Mac hard drives and lets PC 3½-inch floppy drives read and write to 800-KB and 1.44-MB Mac formatted floppy disks.

TSR software for switching between the Mac and PC platforms is standard, as is the x-Fer file transfer program. The board has 50- and 25-pin SCSI ports and an AppleTalk-compatible serial port; it can connect directly to an AppleTalk or PhoneNet networking system and

is compatible with PC networks such as NetWare and Ethernet.

Price: \$995.

Contact: 50/50 Micro Electronics, Inc., Sunnyvale, CA, (408) 730-5050; fax (408) 732-5050.

Circle 1144 on Inquiry Card.

On-the-Fly Image Capture

The WinVision capture board lets you capture images on the fly in 256 gray scales. The source of the image can be a camcorder, VCR, or videodisc player. With a fax board installed in your computer, you can immediately send the images to someone via fax. WinVision ships with PhotoFinish 1.01; if you don't use Windows, you can get PC Paintbrush IV Plus instead.

Price: \$155.

Contact: Quanta Corp., Mountain View, CA, (415) 967-5791; fax (415) 967-8762.

Circle 1145 on Inquiry Card.

Upgrade to Multimedia

Sigma Designs' WinSound 16 CD-ROM Kit lets you upgrade your PC with multimedia capabilities. The Sony Light Internal CD-ROM drive in the kit has a data transfer rate of 150 KBps and an average access time of 550 ms. The 3-inch, 3.5-W speakers are magnetically shielded and have an external DC jack, volume control, and power-on indicator. The kit comes with six applications and is Kodak Photo CD ready.

Price: \$799.

Contact: Sigma Designs, Inc., Fremont, CA, (510) 770-0100; fax (510) 770-2640.

Circle 1297 on Inquiry Card.

Why some software sells more than others.



Success. All software developers strive for it. Now, Don Gall was on top of the world. Software protection made all the difference. Especially in Europe and Asia. Sales were four times better than before. He is the founding father of Sentinel — the guru of software success.

Struggling Software Sales

One day, trekking through the coffee fields of Java, Don ran into his old college buddy Simon Seagull. "Don, my sales are well below expectations." Simon explained his plight, "My software should sell like yours, Don!" Yet despite critical acclaim Simon's company, SimonSays Software, teetered on a financial tightrope. "What's your secret, Don?"

They spent hours analyzing potential problems. They looked at everything.

The Key to the Problem

Finally, Don leaned back and asked the assumptive question, "What about protection — are you using Sentinel?"

Nervously, Simon sipped his coffee. His hands shaking as his eyes darted the room. "No. I didn't think I needed to."

Don's chair slid out from under him and he crashed to the floor. Amazed in disbelief, Don cried, "You What?!" Grabbing his tattered scrapbook, Don pulled out photos of his travels. "Ever been to Seoul? Prague? Anywhere? Ten bucks will buy you anything, even bootlegged copies of software."

Don's Road to Success

Thumbing through the scrapbook, Don shared his experiences. "Back in the '80s, I was in your shoes — beaten, battered and bruised." Simon listened. "Then, after a heart breaking trip around the world, I called the Software Publishers Association (SPA)."

"I could hardly believe it. They told me developers lose billions of dollars each year. Why? Illegally copied software. In some countries there are nine pirated copies for each legal copy sold."

Simon was disgusted, "It's just not fair."

"That's why I committed myself to solving the piracy problem," explained Don.

Simon's eyes lit up. "The dongle!" he shouted. Don corrected him, "Not just any dongle — the dongle that paved the road to success for over 10,000 developers worldwide — Sentinel."

Successful Developers Use Sentinel

Don pulled a stack of letters out of his gunny sack. "All of these people tell the same story." Don read about a successful developer from California who swears she wouldn't be in business without Sentinel. Another company says protection costs less than litigation, plus they don't have to spend time and money supporting illegal users.

Others confessed they wouldn't market products internationally without protection.

The hours flew by, story after story, Simon learned Don Gall's secret. To succeed is to protect. To protect is to secure with Sentinel.



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Backed by the world leader in software protection, Rainbow Technologies, the Sentinel Family of hardware keys is the most diverse and comprehensive selection available. For DOS, Windows, OS/2, Macintosh, LAN, UNIX and others. They're simple to install, and are the most reliable and compatible available.

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Power Supply Check

Data Depot's PC PowerCheck diagnostic and test card detects the major causes of problems in power supplies for IBM PCs and Amigas. With a normal PC edge connector as well as a 12-pin power supply connector identical to those on the motherboard, the card can be plugged into your PC or directly into the power supply for testing.

The card tests all four output voltages on the power supply for overvoltage, undervoltage, noise, and spikes. Except for the spike detectors, which trap the error condition, the detectors monitor continuously.

Price: \$229.

Contact: Data Depot, Inc., Clearwater, FL, (800) 275-1913 or (813) 446-3402; fax (813) 443-4377.

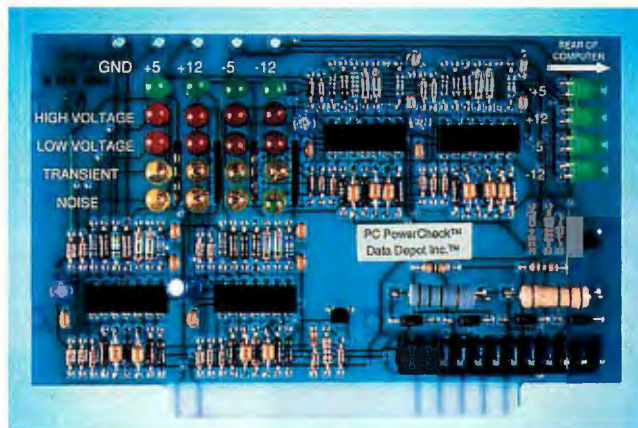
Circle 1271 on Inquiry Card.

A Power Pack for Traveling

A removable stand-alone AC module that you can use to provide 120-VAC power from any car cigarette lighter socket distinguishes the AC PowerPack from



The AC PowerPack.



The PC PowerCheck detects poor regulation, misadjusted outputs, leaky or noisy components, and blatant component failure in your power supply.

other power supplies. The PowerPack, designed for 120-V products up to 50 W, combines 12-VDC and 120-VAC capability. The removable module can also be used as an inverter to run AC devices from a DC outlet.

A built-in regulator prevents overcharging, and you can recharge the PowerPack as many as 1000 times on its replaceable, sealed lead-acid battery. Recharging from your car's cigarette lighter takes 1 to 3 hours; using the Innova AC Charger takes 4 to 6 hours. The company's solar charger takes less than 6 hours on a sunny day.

Price: \$175.

Contact: Innova Electronics Corp., Fountain Valley, CA, (714) 432-1184; fax (714) 432-7910.

Circle 1273 on Inquiry Card.

Tone Up Your Cartridge

With a newly designed photosensitive drum and toner bin, the DoubleFill retrofitted EP-S printer cartridge holds twice as much toner as the original cartridge. The DoubleFill can also be refilled six times rather than the once or twice of the original cartridge. The reusable cartridge is compatible with laser printers such as the Hewlett-Packard LaserJet Series II, IID, III, and IIID; the Apple LaserWriter; the Brother HL-8; the NEC SilentWriter; and the QMS Turbo.

Price: \$109.95; your conventional cartridge retrofitted, \$99.95; subsequent refills, \$79.95.

Contact: M&S Computer Products, Inc., Boonton, NJ, (201) 263-9041; fax (201) 316-0653.

Circle 1272 on Inquiry Card.

Two Ways to Power Protection

T rue sine-wave UPSes (uninterruptible power supplies), the 600- to 1250-V Minuteman PM600 and PM1250 include automatic

frequency selection of 50 or 60 MHz. When input voltage is between 92 and 103 VAC, the units switch to boost mode and boost output voltage 12 percent while continuing to charge the batteries. When the input voltage is 92 VAC or over 103 VAC, the units automatically switch to inverter mode and run on the batteries; when normal power returns, the units automatically switch back to AC mode.

Other features of the UPSes include an overload measurement in AC mode that uses lights and audible alarms to let you know that the unit is overloaded. Nonlinear current capability and automatic unit test at power-on are also present.

Price: PM600, \$579;

PM1250, \$1049.

Contact: Para Systems, Inc., Dallas, TX, (214) 446-7363; fax (214) 446-9011.

Circle 1274 on Inquiry Card.

For those who don't need the sophisticated prowess of a UPS, a simple solution to being one step ahead of a power brownout is the Line Alarm. The device sounds an alarm whenever the 120-VAC power varies by more than 10 percent. Response time of the 3- by 1½- by 1-inch device is about 300 ms. LEDs light to indicate brownouts at 108 VAC or overvoltage at 132 VAC. Neon lamps show if you are using proper electrical wiring and grounding. When the device signals a problem, you take responsibility for protecting your computer.

Price: \$29.95.

Contact: Power Alarm, Inc., Santa Rosa, CA, (800) 786-6610 or (707) 579-2364; fax (707) 579-8084.

Circle 1275 on Inquiry Card.

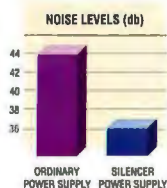
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STANDARD UNITS

These UL/CSA approved, fully-tested power supplies are the best basic units available.

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| STANDARD 220 BABY | \$89 |
| STANDARD 220 AT/TOWER | \$89 |

ULTRA-QUIET UNITS



Unrattle your nerves with a **Silencer** power supply, recognized since 1986 as the industry's quietest. Cooled with efficient, variable-speed fans that are virtually inaudible!

A must for home office or *multimedia* applications.

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| SILENCER 205 SLIM | \$119 |
| SILENCER 220 AT/TOWER | \$129 |
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HIGH-PERFORMANCE UNITS



Upgrade your computer with one of our premium **Turbo-Cool** power supplies—the choice of PC professionals. You'll get 50% - 100% more power, built-in line conditioning, a dual-stage EMI filter, super-tight regulation, ultra-clean DC output, our high-capacity **ThermaSense** variable-speed fan (300W models), UL/CSA/TUV approvals, and a no-hassle 2-year warranty! Ideal for high-end workstations and network file servers.

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| TURBO-COOL 200 XT | \$159 |
| TURBO-COOL 300 SLIM | \$169 |
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| TURBO-COOL 300 AT/TOWER | \$189 |
| TURBO-COOL 450 AT/TOWER | \$349 |

REDUNDANT POWER SYSTEM

Eliminate the risk of network downtime or data loss due to power supply failure with the **TwinPower 900** redundant power system. It delivers high-capacity, fault-tolerant power to your entire network server. Consists of two **Turbo-Cool 450** power supplies in parallel, utilizing a special power-management interface module. A must for mission critical LANs.



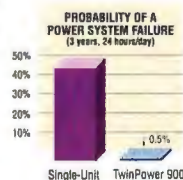
- **Super Server Power.** With 900 watts of peak power, the **TwinPower 900** effortlessly runs any array of drives—without the need for sequencing.
- **100 Times More Reliable.**

Why gamble with a single-unit system? **TwinPower's** load-sharing, redundant design lets you take the power system for granted. It's the peace-of-mind a network manager needs!

- **Hot-Swap Capability.** In the unlikely event that one of its 450s should fail, an alarm sounds, and the other 450 sustains the server while the user simply swaps in a new unit. No downtime!

- **Optional Enclosures.** We offer "monster" cases that hold **TwinPower's** two power supplies and interface. The Commercial Tower (76 lbs.) holds 13 drives, while the all-steel Industrial Tower (102 lbs.) allows dual systemboards and holds up to 16 drives. Now, that's expandability!

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| TWIN-POWER 900 | \$995 |
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486 CPU COOLER



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1. Even before it fails, an inferior power supply can be trouble. Nasty hard-to-track problems such as interference, rebooting, overheating, and hard drive errors are often power supply related.
2. You can't have too much power. A power supply delivers only what the PC needs and actually performs best at 25% - 75% of its rated capacity.
3. For greater hard drive reliability, use a power supply with independent regulation and extra cooling such as the **Turbo-Cool 300/450**.
4. Buy from a reputable power supply specialist. You'll get real service, not some runaround like: "Here's a number in Taiwan, give them a call".
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Pocket Faxing

A wallet-size message-entry and telecommunications center, the Pocket Faxxer fits comfortably in your shirt pocket, a purse, or a briefcase. The paperless fax-transmission device can send messages to fax machines and beepers (i.e., radio pagers). The multipurpose communications center features 100 built-in functions that enable you to create, modify, store, and transmit information.

The Pocket Faxxer can operate as a data terminal, providing interactive communications with remote computer systems. It provides Touch-Tone dialing, reminder messages, audible alert signals, and a directory that can store names, telephone numbers, and general information.

You can program Pocket Faxxer to answer incoming calls and receive E-mail messages. The device can back up and restore all internal information to a PC.

With optional software, you can prepare messages on a PC for faxing or paging. The Pocket Faxxer can also communicate with text telephones (TDDs) used by people with hearing impairments.

Price: \$399.

Contact: Telecraft Industries, Brooklyn, NY, (718) 972-0900; fax (718) 972-4695.

Circle 1276 on Inquiry Card.

Overcome Analog/Digital Barriers

The Volante modem from Sonix Communications features a high-speed digital interface that breaks traditional divisions between modems and ISDN. The modem combines high analog-transmission performance with a digital interface running at up to 115,200 bps.



To use the Pocket Faxxer, you plug it into a telephone line, type a message on the machine's mini-keyboard, and send the message via the phone line.

This allows it to exploit the full benefits of data compression, particularly in applications requiring regular file transfers. In addition, the Volante is totally reprogrammable through the use of flash EPROM chips.

The Volante features V.42 error correction, including MNP, as well as V.42bis and MNP 5 data compression for maximum throughput. The package includes installation software, cabling, send and receive fax software, and data communications software.

Price: About \$1148 (£795).

Contact: Sonix Communications, Ltd., Cirencester, Gloucestershire, U.K., +44 285 641651; fax +44 285 642098.

Circle 1277 on Inquiry Card.

Fax on Demand

Bogen Communications offers a full-featured fax-on-demand system, called Fax Vault, that stores documents for retrieval via fax. Using a Touch-Tone telephone, callers are requested to follow a menu of voice prompts that allow them to select and receive up to 999 pages of information 24 hours a day, seven days a week, from anywhere in the world.

You load documents into the Fax Vault from standard fax machines or PC fax modems. Fax Vault lets you change the factory-recorded voice prompts, security codes, and other components of the system from any Touch-Tone telephone. You can also individually configure lines to accept only calls, to transmit only information, or both.

A three-level security system controls access to the entire system, to specific documents, or to messages. In addition, Fax Vault features multiple-language voice prompts, international calling access, automatic cover-page generation, digital-voice messaging, and one to nine retries to send faxes. It provides you with reports on what information was requested, how many requests were filled, and the fax and phone numbers of those requesting information.

Price: Two-line model, \$2995; four-line model, \$3995.

Contact: Bogen Communications, Inc., Ramsey, NJ, (201) 934-8500; fax (201) 934-9832.

Circle 1278 on Inquiry Card.

Monitor Network Traffic

You can use PacketView 1.0, a PC-based network-traffic capture, decode, and display utility, with standard network controllers to capture and analyze network traffic. Compatible with Ethernet, Token Ring, and ARCnet, PacketView uses a packet driver to capture packets from any of the three media types. It then decodes the packets to display meaningful information.

Some of the protocols that PacketView recognizes include TCP/IP, Banyan Vines, Novell IPX/SPX/NCP, XNS, and AppleTalk. PacketView also lets you create your own protocol decoders using C or assembly language.

Price: \$249.

Contact: Klos Technologies, Inc., Merrimack, NH, (603) 881-7777.

Circle 1279 on Inquiry Card.




Cross platforms easily.

New Timbuktu is the easiest way to network Macintosh and Windows computers, so you can share printers, files and screens.



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Moving information between Macintosh® and Windows™ computers used to be quite a feat of skill. Let alone nerves.

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Timbuktu is the easiest way to create a peer-to-peer network. So, whether you're on a PC or Mac, you can share expensive peripherals like printers. And exchange files quickly and easily.

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Of course, Timbuktu is easy to use and install. You don't need a dedicated gateway or server. And it works with what you've got. Even other networks on NetWare or TCP/IP.

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*Call 1-800-678-5075 for upgrades from Timbuktu and PhoneNET PC (previously AppleShare PC and PhoneNET Talk). Upgrades also available for SitkaTOPS and Carbon Copy.

A copy of Timbuktu is required on each machine on the network. Single- and multi-packs are available. All trademarks are property of their owners. ©1992 All rights reserved. For customer service, call (510) 814-5000. Or contact us on America Online® or AppleLink® ID: Farallon, CompuServe® ID: 75410, 2702. Internet ID: Farallon@farallon.com.

Circle 82 on Inquiry Card.

Unix Software Development

The ParaSet family of Unix software development products can improve the way you develop and maintain software. The products first establish and then dynamically maintain relationships among all the key activities of the software development process, including specification, analysis/design, coding, testing, and maintenance.

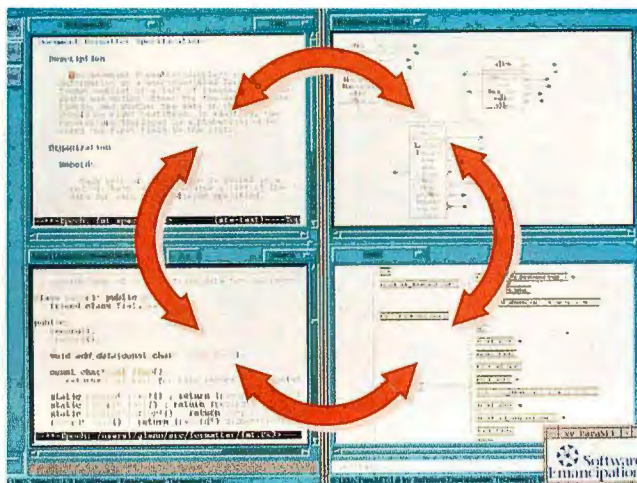
The ParaSet products support C and C++ and consist of three core modules and two options. The core system includes Para/Designer, which helps you design software using structured or object-oriented design techniques; Para/Programmer, which supports forward and reverse engineering of software; and Para/Online, which provides a hypertext-based EMACS editor for creating documentation.

The ParaSet options include Para/Analyzer, which helps you analyze and restructure existing software, and Para/Debugger, an interpreter-based debugging environment that supports incremental recompilation and relinking and mixed interpreted/compiled execution of software.

Price: \$7500 and up.
Contact: Software Emancipation Technology, Inc., Waltham, MA, (617) 466-8600; fax (617) 466-9845.
Circle 1281 on Inquiry Card.

C++ Design Tools

C++ Designer combines a graphical PC-based design tool with C++ code-frame generation. The product helps you manage and manipulate objects at the design stage, as well as produce outline code. In addition,



The ParaSet family of software development products uses the same model for forward engineering to develop new software, and for reverse engineering to modify, maintain, and improve existing software.

C++ Designer provides integral rule and consistency checking to help you adhere to the principles of good object-oriented design.

Price: About \$282 (£195).
Contact: Select Software Tools, Ltd., Cheltenham, Gloucestershire, U.K., +44 242 226553; fax +44 242 251491.
Circle 1284 on Inquiry Card.

Workbench for Windows

Curran's Bench 2.01 integrates and manages multivendor compilers, editors, linkers, make systems, and debuggers, so you can create an organized and intuitive Windows software engineering environment. You can configure DOS and Windows tools into the user-defined toolboxes and start a tool as a DOS or Windows process with the associated environment.

Bench lets you customize any tools to access files and directories and assign these tools execution context, command-line arguments, and initialization files. You can group tools into functional

areas that correspond to the way a development team works, such as programming, documentation, and testing, or you can group them on a user or project basis.

Bench stores document revision information, comments, and changes associated with each revision under the reverse delta technique. It supports branching, multiple parallel versions, and version locking. Check-in and check-out facilities transparently accommodate team development.

Price: Bench, \$395; five-user LAN license, \$995; 10-user LAN license, \$1695.
Contact: Curran Software, Seattle, WA, (206) 521-3790; fax (206) 822-3872.
Circle 1285 on Inquiry Card.

Automatic Documentation for OOP

Now development teams that use Digitalk Smalltalk/V can eliminate the lag between the production of code and the availability of

documentation. Synopsis for Smalltalk/V automatically generates class documentation for any class in the system. In addition, you can print your class documentation with popular word processors or as text files.

Synopsis stores class summaries in class encyclopedias, which you can access via browser windows. It packages class encyclopedias in separate files, so you can distribute detailed descriptions of classes to other developers without having to ship source code. Two versions are available: Synopsis for Smalltalk/V Windows and Synopsis for Smalltalk/V PM.

Price: Windows version, \$295; PM version, \$395.
Contact: Synopsis Software, Raleigh, NC, phone and fax (919) 847-0650.
Circle 1282 on Inquiry Card.

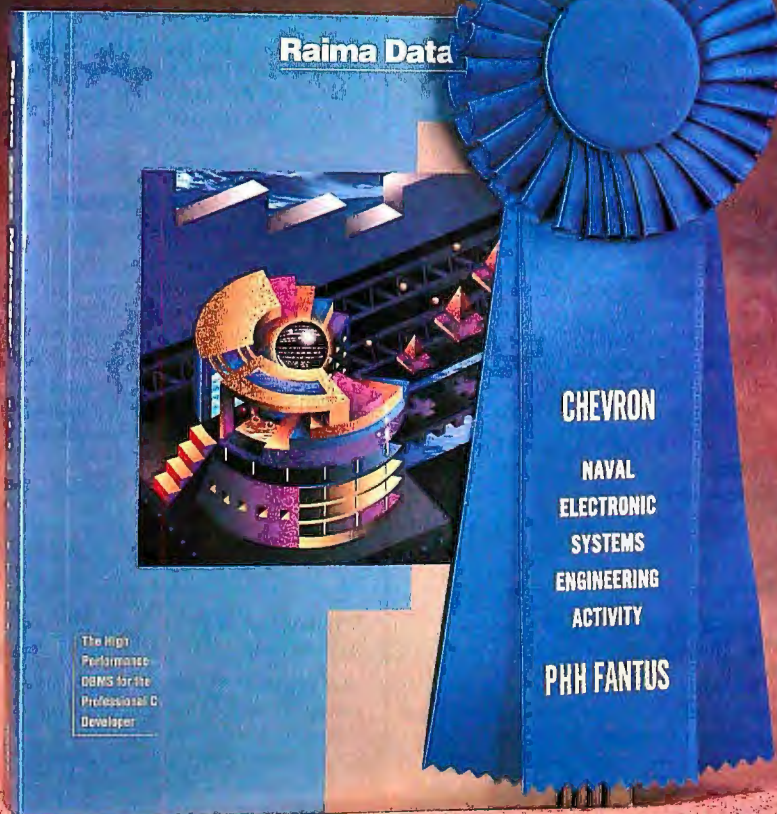
Simplify Error Tracking

An add-in utility, Feedback for 4th Dimension simplifies debugging and refining four-dimensional databases on the Mac. The software takes a snapshot of the screen, records your previous actions, and logs the exact date and time you made the request.

The utility can also trap 4-D errors, record the screen, generate a feedback slip, and store a log of events. And if other users are logged on to a network, Feedback for 4th Dimension can record a history of their actions. The software includes a copy of Backtracker, a companion program that provides more reporting and follow-up features.

Price: \$295.
Contact: Macintosh Business Systems, Inc., Mamaroneck, NY, (914) 698-7215; fax (914) 698-0224.
Circle 1283 on Inquiry Card.

Since when is Raima first in Corporate Database Development?



Since April 7, 1992

Raima Database Manager was the database of choice in the First Annual Windows World Open. The competition featured innovative custom applications built with Windows development tools. Three of the seven winners, and two of the finalists, used *Raima Database Manager* to solve their critical application needs.

For professional developers like yourself, Raima products offer:

- High performance: unmatched application speed.
- Portability: runs on DOS, Windows, OS/2, UNIX, VMS, QNX.
- Royalty-free distribution: increase your profits.
- Source-code availability: total programming flexibility.
- Affordable pricing: starting at just \$395.
- Language support: ANSI C, C++, and Visual Basic.

Listen to what some of our customers say about our products:

"No other products matched Raima for the price."

James Lisiak, developer, Chevron

"Raima provided us with speed, flexibility, and royalty-free distribution which allowed us to meet and exceed our customers' needs."

Dave Cooper, developer, Atlantic Research Corp.
(subcontractor, Naval Electronic Systems Engineering Activity)

"Database Manager gave us the edge we needed to handle large amounts of data quickly and efficiently within Microsoft Windows."

Kelly Patrick, developer, PHH Fantus

If you're looking for an award-winning application development tool, give us a call. And discover the Raima advantage.

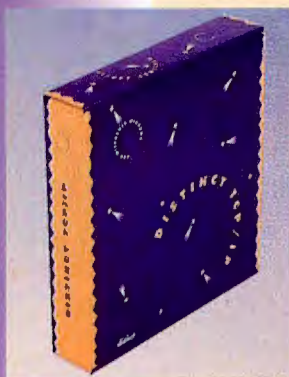
Raima Database Manager The high-performance DBMS
Raima Object Manager The object storage class library

Raima Corporation, 1605 NW Sammamish Rd., Suite 200, Issaquah, WA 98027 (206) 557-0200 Fax (206) 557-5200

1-800-DB-RAIMA Also available for DOS, OS/2, and UNIX

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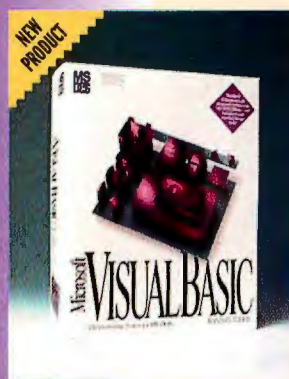
Save lots of time, save money, too...



Distinct TCP/IP for Windows by Distinct Corporation

Distinct TCP/IP for Windows SDK extends the TCP/IP and RPC/XDR networking capabilities to Microsoft Windows. Includes the smallest and fastest DLLs today available for Berkeley Sockets, RPC, Telnet, and FTP. Coexists on the same board with Lan Manager, Novell and Banyan. Supports Packets, NDIS and ODI drivers. Only 5KB of DOS memory required.

(SDK) LIST: \$495 **PS Price: \$439**
(Applications) LIST: \$395 **PS Price: \$379**
FastFacts 1951-003: (SDK), 1951-007: (App.)



Visual Basic for DOS by Microsoft Corporation

Draw forms, controls; write event-procedures; create custom controls—in DOS! Create new apps or combine with existing C/C++ or Pascal code. Highly compatible with Visual Basic for Windows. Run existing Quick Basic/Basic PDS code! 80x86 compiler creates 100% standalone .EXE files; 386 code generation; MOVE overlays; an integrated ISAM and much more!

| | LIST | PS Price |
|-----------------|-------|--------------|
| PRO | \$495 | \$339 |
| Standard | \$199 | \$139 |

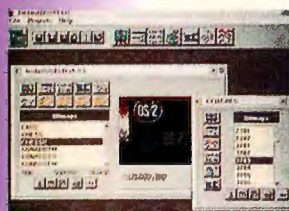
FastFacts 502-408: (PRO), 502-407: (Stand.)



High C/C++ v3.0 by MetaWare Incorporated

MetaWare Incorporated introduces its newest product: the 32-bit High C/C++ compiler, version 3.0. High C++ is a true compiler, not a C to C++ translator. "Incremental Strengths" lets you specify the level of C++ compilation, allowing you to migrate from C to C++ one C++ block at a time. Included in the package is a C++-tailored source-level debugger, and a 32-bit Application Development Kit for Windows. MetaWare offers a full line of multi-language, multi-platform compilers for professional software developers.

LIST: \$795 **PS Price: \$749**
FastFacts 89-063



ResourceSHIELD by The Stirling Group

ResourceSHIELD integrates the process of creating, editing, translating, compiling and managing resources for graphical applications. A visual resource development tool with seven resources editors will edit resources in binary or text resource files. Pre-designed resource templates for dialogs, menus and icons are included.

| | LIST | PS Price |
|-------------------|-------|--------------|
| Windows | \$149 | Call |
| OS/2 2.0 | \$295 | \$289 |
| Windows NT | \$295 | \$279 |

FastFacts 2929-019: (Win. & OS/2)

R&R Report Writer by Concentric Data

Create custom analytical reports from any dBASE compatible with R&R Report Writer Xbase Edition for DOS or Windows! Turn your raw data into useful publication-quality reports. Then, using the R&R Report Writer Code Generator (DOS), turn those reports into Xbase code. You've never had custom reports faster or easier!

(Report Writer) LIST: \$249 **PS Price: \$159**
(Code Generator) LIST: \$199 **PS Price: \$159**
FastFacts 308-030: (Report Writer)
FastFacts 308-033: (Code Generator)

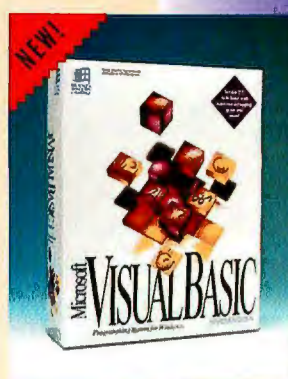


Visual Basic for Windows 2.0 by Microsoft Corporation

When you need to create a Windows application quickly, nothing offers the sheer productivity of Microsoft Visual Basic 2.0, Standard Edition. A visual development environment, flexible programming language, and fast runtime execution make this the shortest route to full-featured Windows applications. The Professional Edition includes messaging and data access capabilities, a wide variety of add-on tools, and more.

| | LIST | PS Price |
|-----------------|-------|--------------|
| PRO | \$495 | \$339 |
| Standard | \$199 | \$139 |

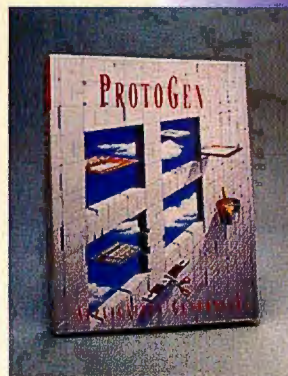
FastFacts 502-443: (PRO), 502-431: (Stand.)



ProtoGen 3.0 by Protoview

NEW VERSION! The industry standard for code generation and prototyping Windows applications. Develop the user interface of your application using Visual prototyping methods. ProtoGen generates expert level, commented code for ANSI C, Microsoft MFC C++, Borland OWL C++, Turbo Pascal, and Microsoft NT Win32. All generators included! User Code is preserved from one generation to the next. It's easy and fast.

LIST: \$199 **PS Price: \$185**
FastFacts 2115-009



Plastic Software by Atlas Software Pty. Ltd.

Plastic is a complete Clipper 5.01 environment that accelerates systems development from database design to fully tested and documented single- and multi-user applications. Plastic comes with fully relational data dictionary, WYSIWYG screen painter, relational report generator, menu builder, powerful data-driven engines, pop-up windows, and AutoDoc documentation system. PowerCode, which builds custom UDPs, is included free.

Single Dev. ver. LIST: \$495 **PS Price: \$449**
8 Dev. ver. LIST: \$895 **PS Price: \$819**
FastFacts 9229-001



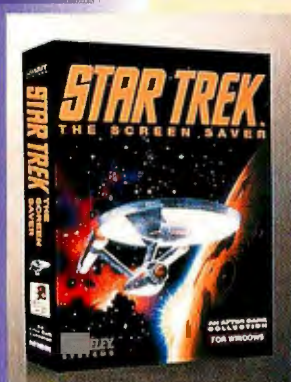
...The Programmer's Shop makes it easy to do. Shop the Shop.



New Low Price! F77L Fortran Compiler by Lahey

Version 5.01 includes Fortran 90 features: ALLOCATABLE Arrays, CASE Constructs, Cycle and Exit, Construct Names, and many other new features. Package includes Editor, Make Utility, Profiler, Debugger, SLR Linker, Opus Make, Video Graphics, and Excellent Diagnostics. 386/486 users have the option of generating 32-bit instructions.

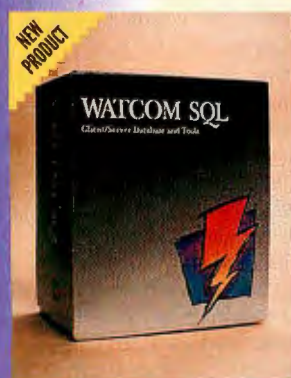
LIST: \$295 **PS Price: \$275**
FastFacts 334-004



Star Trek™ : The Screen Saver. by Berkeley Systems

Beam aboard the Enterprise™ with Captain Kirk and Mr. Spock on a mission to prevent screen burn-in. Encounter trilling Tribbles, Klingon battlecruisers, and burrowing horta. This all new screen saver provides over 15 animated displays, password protection, SystemIQ and full compatibility with After Dark.

LIST: \$60 **PS Price: \$39**
FastFacts 2900-007



WATCOM SQL Developer's Edition by WATCOM

NEW PRODUCT—SPECIAL INTRODUCTORY OFFER. Complete client/server development tool allows you to develop and deploy single-user standalone applications, and to develop applications for use with the Network Server Edition (sold separately). Includes: Single-user database server (both 16- and 32-bit versions); ACME application development system; Embedded SQL/C preprocessor; SQL libraries for WATCOM C, C/386, MS C/C++ and BC/C++.

LIST: \$795 **PS Price: \$379**
FastFacts 1044-035

WindowsMAKER™ Professional by Blue Sky Software™

Considered the easiest and fastest way to create MS-Windows applications in C/C++. Generate the Windows .EXE w/complete source & production files (no royalties). Just Point & Click to define the Windows user interface. Lets you animate your design to instantly test look & feel and make changes on the fly without needing to compile. Custom code is preserved during code regeneration. The leading development tool for Microsoft Windows. Highly Recommended.

LIST: \$995 **PS Price: \$895**
FastFacts 2001-006



Auto Function Tester v2.0 by Talis Computer

AFT is a Testing Tool/Database that automates the design, documentation, validation, and execution of "C" functions. ANSI/IEEE test documentation is automatically generated and updated. All testing results including Multi-Condition coverage are verified and saved in database for custom reporting. Easy to learn and use, AFT hooks to your Editor/Compiler and requires no changes to source code.

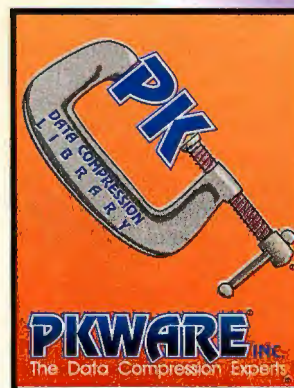
Single user ver. LIST: \$695 **PS Price: \$679**
Network 5 user ver.
LIST: \$1,495 **PS Price: \$1,425**
FastFacts 2044-007



The PKWARE Data Compression Library by PKWARE

The PKWARE Data Compression Library allows software developers to add data compression technology to applications. The application program controls all data I/O, allowing data to be compressed or extracted to any device or area of memory. Only 35K of memory is needed to compress data, and only 12K is needed to extract data. Compatible with MSC, BC++, TC, TP 6.0, Clipper, Basic 4.5, 7.1, ASM.

LIST: \$295 **PS Price: \$275**
FastFacts 3043-011



But wait, there's more: Bargains galore!

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|-------------------------------|------|-----|------------------------------|------|-----|----------------------------|------|-----|
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| • Blinker | 299 | 269 | • LapLink Pro | 170 | 109 | • ProComm Plus | 129 | 89 |
| • Borland C++ 3.1 | 495 | 319 | • Lotus 1-2-3 for Windows | 495 | 359 | • Qemm 386 | 100 | 64 |
| • BTRieve for DOS | 595 | 399 | • MS Excel | 495 | 329 | • QuattroPro | 495 | 349 |
| • Carbon Copy 6.1 | 199 | 139 | • MS Windows 3.1 | 150 | 99 | • WATCOM C 9.0/386 | 895 | 599 |
| • Clarion Prof. Developer 2.1 | 845 | 469 | • MS Word (Windows) | 495 | 339 | • WordPerfect | 495 | 279 |
| • Clipper | 795 | 499 | • Norton Desktop for Windows | 179 | 139 | • 286/DOS Extender SDK 2.5 | 495 | 435 |
| • DESQview 386 | 220 | 149 | • Norton Utilities | 179 | 115 | • 386/DOS Extender SDK | 495 | 435 |

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Program CNC Machines

Pathtrace Systems offers a Unix version of PAMS (Pathtrace Advanced Manufacturing System), its package for parts programming of CNC (Computer Numerical Control) machines, including milling machines, machining centers, lathes, milling/turning centers, and coordinate measuring machines. The Unix version offers a new GUI and a range of links to popular CAD systems.

Graphical icons show you machining cutting cycles and tool selection. The multitasking package lets you run operations such as CNC code generation and tool-path solid modeling as background tasks. Complete parts-file compatibility between the DOS and Unix versions of PAMS supports mixed networks and facilitates moving from the DOS version to the Unix version.

PAMS/X runs under the X Window System and is available in a Sun OpenLook version for SPARC workstations or in an OSF/Motif version for Hewlett-Packard 9000 Series 700 systems.

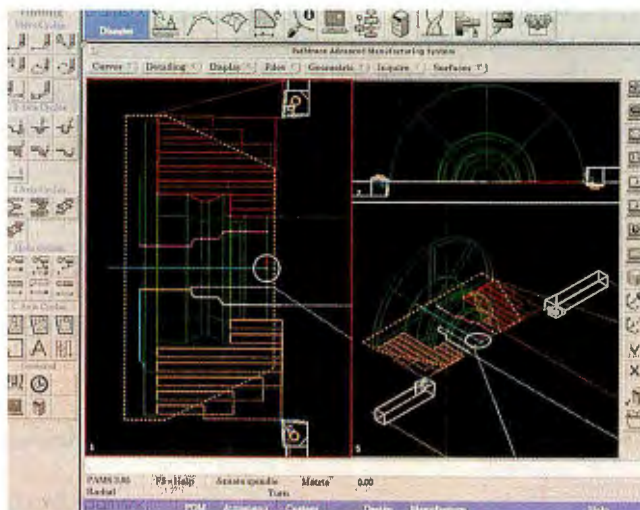
Price: About \$7225 (£5000 and up).

Contact: Pathtrace Systems, Ltd., Reading, Berkshire, U.K., +44 734 756084; fax +44 734 756143.

Circle 1287 on Inquiry Card.

Create Schedules

Guide Line and Guide Line Maker, two additions to Symantec's family of project management software, bring the benefits of project management to those who can answer fill-in-the-blank questions. Guide Line automatically builds project schedules, based on simple user input, that work with Time Line for Windows, Time Line 5.0 for DOS, On



With PAMS/X, you can program CNC lathes and show 4 Axis Lathe simulation with twin turrets.

Target, and Microsoft Project for Windows. Guide Line Maker also lets you import files from these project management packages.

Guide Line contains 16 guides, including construction, office relocation, LAN installation, software development, consulting, small-business start-up, market research, a marketing plan, a trade show plan, and a general project plan. Three versions are available: Guide Line for Windows, Guide Line for DOS, and the Guide Line License Pack, which supports Microsoft Project for Windows.

Guide Line Maker lets you build your own project management guides from scratch or by importing previously created project schedules. It features a scripting language that facilitates development of guides and provides simple editing facilities, reusable templates, visual tools for detailed inspection of task and local variables, and report generators.

Price: Guide Line, \$149.95; Guide Line Maker, \$499.

Contact: Symantec Corp., Cupertino, CA, (800) 441-

7234 or (408) 253-9600; fax (408) 253-4092.

Circle 1289 on Inquiry Card.

Personal Finance Software

Aatrix Software's Hi Finance is a personal finance package for the Mac that includes everything from basic bookkeeping to handling stocks and bonds to inventory tracking for individuals and small businesses. The package supports Apple's QuickTime technology, as well as unattended dial-up and downloading of stock information.

Hi Finance includes a loan calculator; retirement, savings, college, and insurance planning; an automobile pricing calculator; and even a lottery number picker. You can write checks, transfer between accounts, create budgets, and produce custom reports. The inventory manager lets you store information—such as records of family heirlooms and equipment for insurance purposes—as pictures, sound files, QuickTime movies, and text.

You can download and track stocks, bonds, mutual

and money-market funds, and other investment data via modem. The software updates your portfolios and net worth and warns you of unusual market activity.

Price: \$129.

Contact: Aatrix Software, Inc., Grand Forks, ND, (701) 746-6801; fax (701) 746-4249.

Circle 1288 on Inquiry Card.

Accounting for Windows

The latest version of Sybiz Accounting for Windows features flexible user-designed invoicing, integrated bank reconciliation, improved end-of-period processing, standing journals and payments, and more-focused planning and forecasting capabilities. Sybiz Accounting for Windows 3.0 lets you design and print custom invoice statements and forms in virtually any stationery layout.

Version 3.0 records payments and details of receipts and prints out full bank reconciliation reports, showing outstanding checks, deposits not listed on the bank statement, and differences between your reconciliation and that of the bank. Other features include DDE, which lets you set hot links between the accounting package and other Windows packages; mail merge; and an instant view facility, which lets you view anything in the program to service customer calls without interrupting the transaction in progress.

Price: Sales, Purchase, and Nominal Ledger modules, about \$432 (£299); with Inventory module, about \$576 (£399); with Job Costing module, about \$1010 (£699).

Contact: Sybiz Solutions, Ltd., Newbury, Berkshire, U.K., +44 635 877777; fax +44 635 871887.

Circle 1290 on Inquiry Card.

Important News For The Power Hungry: Your Dinner's Ready.



Come and get it.

The new Amiga® 3000T multimedia workstation tower—the most expandable, flexible Amiga ever built.

Now powered by a 25 MHZ Motorola 68040 CPU, the A3000T is faster than ever



before. (Current A3000T users can upgrade to a 040-based accelerator card.)

The A3000T features a 200MB hard disk drive. A 3.5" floppy disk drive. 5MB of RAM, expandable to 18MB. And 32-bit bus architecture to transfer mammoth amounts of information at breakneck

speed. The truly power famished will be happy to know that the A3000T is stuffed with an abundant selection of expansion slots. There's a co-processor slot. A video slot for internal devices. Up to four PC slots. And up to five Zorro III slots. Every Amiga 3000 series computer comes with

Commodore Express™ Gold Service options.* And convenient leasing terms are available.

Now, you'd expect a power feast like this to carry a fat price tag. But now with our new low price, you can sit down to an Amiga 3000T for just \$2,875.** Which in itself is a powerful reason for seeing your Commodore dealer today. For a dealer

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Circle 76 on Inquiry Card.

Statgraphics 6 for the PC

Manugistics has added increased flexibility to Statgraphics 6 and Statgraphics Plus 6 in the manipulation, presentation, and subsequent analysis of critical data. The latest versions feature a new graphical interface, improved text and data screens, and faster data queries and graph title selection.

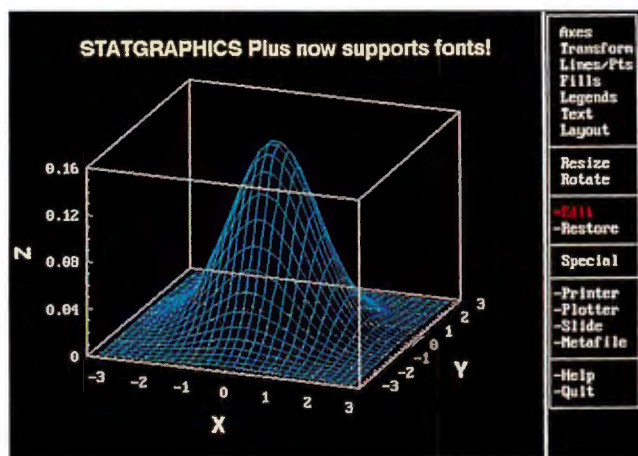
Statgraphics and Statgraphics Plus give you the choice of using simple pull-down menus or the traditional Statgraphics menu structure. In addition, version 6 lets you choose between APL conventions and standard mathematical rules for evaluating expressions. They also feature a File Utilities procedure that makes navigating through data more convenient.

Price: Statgraphics 6, \$995; Statgraphics Plus 6, \$1595.
Contact: Manugistics, Inc., Rockville, MD, (301) 984-5000; fax (301) 984-5290.
Circle 1292 on Inquiry Card.

Double Unix Throughput

Programmed Logic says that adding its HPFS (High Performance File System) to your Unix system is like getting twice the computing power out of your existing hardware configuration. The package helps your system run twice as fast or supports the workload of twice the number of users.

HPFS incorporates a new approach to meta-data management and fundamental enhancements to System V release 4's file system algorithms that collectively eliminate I/O bottlenecks. In addition, because the SVR4-compatible file system maintains plug compatibility and



Statgraphics 6 and Statgraphics Plus 6 both feature a new graphical sidebar menu that lays out all your options.

media compatibility with the Unix file system, you don't need to back up and restore your files—simply plug in the HPFS software module.

Price: Single-user, \$249; multiuser, \$499; multiprocessor, \$999.

Contact: Programmed Logic Corp., Somerset, NJ, (908) 302-0090; fax (908) 302-1903.
Circle 1295 on Inquiry Card.

Organize Online Sessions

If you regularly access on-line information services, now there's a software program that can help you organize your on-line sessions. Online Log for the IBM PC records your on-line sessions, along with the vendor, database, subject or client designation, connect time, filename, and session cost.

Online Log works with communications software to post an entry for each on-line session. If you search multiple databases consecutively,

you can update it midsession. Online Log stores a completed entry in a log that you can later search, edit, display, archive, or print. The program lets you search by date, client, vendor, filename, and database.

When it's time to reconcile a vendor invoice for the month, you simply enter the dates and the vendor name. Online Log then displays a list of that vendor's sessions for the month, along with a dollar total.

Price: \$59.

Contact: Et Cetera, Inc., Dover, DE, (302) 738-7335.
Circle 1293 on Inquiry Card.

System 7.0 Utilities

Designed as a control panel accessible through the Apple menu, the nine Wiz Tools modules include Launcher, SubMenu, Keystroke Recorder, FinderTools, Twins, PowerBook Utilities, ColorSwitcher,

WorldClock, and WatchFolder. Wiz Tools help you quickly access applications, documents, DAs (desk accessories), folders, and control panels; create up to five levels of submenus for all folders and volumes listed in the Apple menu; switch between two preset screen displays without going to the Monitors control panel; and view the time for different geographical areas worldwide.

Price: \$129.

Contact: ASD Software, Inc., Montclair, CA, (909) 624-2594; fax (909) 624-9574.
Circle 1294 on Inquiry Card.

Curve Fitting and Statistics

SlideWrite Plus for DOS 5.0 combines linear, nonlinear, and weighted curve-fitting functions, statistical analysis, and sophisticated drawing and text capabilities. The program includes 100 built-in linear-approximating functions arranged in linear, exponential, power, and polynomial groups; and 15 resident parametric nonlinear equations.

In addition to curve-fitting capabilities and statistical analysis, SlideWrite Plus for DOS 5.0 has a WYSIWYG interface, on-screen drawing, sizing, and text formatting, scalable Nimbus-Q fonts, and vector-format clip art. You can import both Lotus and ASCII files.

SlideWrite Plus for DOS 5.0 comes with over 400 logically grouped vector-format illustrations. Clip-art packages are also available with illustrations relevant to specialized technical areas.

Price: \$445.

Contact: Advanced Graphics Software, Inc., Carlsbad, CA, (619) 931-1919; fax (619) 931-9313.

Circle 1296 on Inquiry Card.

SPREAD THE WORD

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Get the new skills you need for a high-paying career in computer programming!

Only NRI at-home training gives you real-world programming skills in three in-demand languages: QBasic, C, and Visual Basic, today's hot new language designed for writing popular Windows applications. Best of all, you get hands-on training with a powerful new 486sx-based computer system, complete with 80 meg hard drive, Windows, and professional programming software you keep!

► NRI, the recognized leader in at-home computer training, shows you how to take advantage of today's newest programming opportunities

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And the fastest-growing segment of programming jobs will be PC programming, fueled by the phenomenal popularity of Windows, the efficient power of C, and the ascent of exciting new languages like QBasic and Visual Basic.

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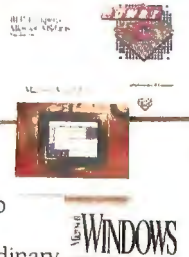
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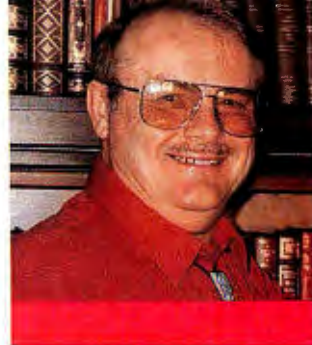
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WHAT'S HOT, WHAT'S NOT

It's January, which means this is my annual year-end column, because I stubbornly insist that a year ends on December 31. Of course, that means you are reading this in late March, and the issue is dated April. Such is publishing. Anyway, it's time for the 1992 User's Choice Awards and the annual Chaos Manor Orchid and Onion Parade.

According to my business newspaper, "1992 was the year of the personal computer." This was the year that "analysts say it became abundantly clear business moved away from the big computer systems supplied by multinationals like IBM, Digital Equipment Corp., and Wang," and "computing power shifted to the individual...." Two cheers for the industry analysts who finally figured this out, and one cheer for IBM for finally catching on to what most of us here in Microland have been saying for years. Last year, Apple almost caught up to IBM as the world's largest seller of personal computers; three cheers to Apple for getting their act together, and none for IBM, who, after all, have had since 1982 to see the light—even without reading this column.

Which isn't to say all divisions of IBM are the same. Two cheers to IBM for OS/2. I wish it could be three and an Orchid. OS/2 is definitely a better DOS than DOS, and if you work mostly in DOS and use Windows applications only once in a while, you really should consider a switch to OS/2. Its installation ease ranges between simple and sheer murder (and there seems to be no way to predict which it will be). Drivers for CD-ROM drives, WORM drives, rewritable optical drives, fast video cards, local-bus video, TV-viewer boards, fax modem coprocessors, and so forth appear from time to time. Some of them work, with some products. Some don't.

IBM really is working on letting you use such assets, and I look forward to working with the next release of OS/2, which is supposed to have a module that makes it compatible with Windows 3.1. That's a neat idea, since Windows compatibility is a moving target. The next version of OS/2 is just in beta testing and will be shipping Real Soon Now. I wish them well, but I do wonder how long we'll wait this time.

Two cheers to Lotus for making Agenda highly useful and then abandoning it as a product. Agenda is a task and time management program that incorporates a simple form of AI. It looked like a good path toward more practical applications of AI. Agenda isn't at all easy to learn, and there's no Windows version, but it will run in DOS under Windows and has no problems with OS/2. If you're an OS/2 user, you'll probably like Agenda. (Tiger

Software is selling Agenda at a special price of \$79.95. The original list price was \$249. You can contact them at 800 Douglas Entrance, Executive Tower, Seventh Floor, Coral Gables, FL 33134, (800) 888-4437; fax (305) 529-3438.)

If you do use Agenda, you'll want President's Planner from Phase III Computing. Agenda has a macro capability so rich that it might as well be a programming language, and President's Planner is a set of macros that makes Agenda learnable and more useful. It calls itself the first "do what I mean" time and information planner, and that's pretty close to the truth. I can't quite see giving a User's Choice Award to a program that supports an orphan, so President's Planner will have to settle for a big Chaos Manor Orchid. If Lotus was really smart, they'd buy President's Planner, bundle it into Agenda, run it over Notes, and reissue the product as Agenda for Notes.

User's Choice

I began the User's Choice Awards well before everyone else began handing out awards. Now there's a standing joke that you cannot find a Comdex booth without at least one product that has one of the better-known awards; but my purpose was to drive the industry in directions I wanted it to go. In those days, there weren't all that many products that deserved awards. Sometimes, "best of the year" wasn't what I could call good enough, so I deliberately didn't have fixed categories.

Nowadays there's a different problem: there are too many products that are good enough, and quite often the "best" choice isn't very clear-cut, either. As a result, I've slowly changed the nature of these awards. I generally don't and can't say that the winner is the "best" in its category, because there's no possible way I can even be aware of all the products in this industry, much less try

The annual Orchid and Onion Parade issues forth from Chaos Manor



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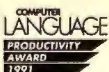
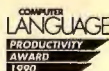
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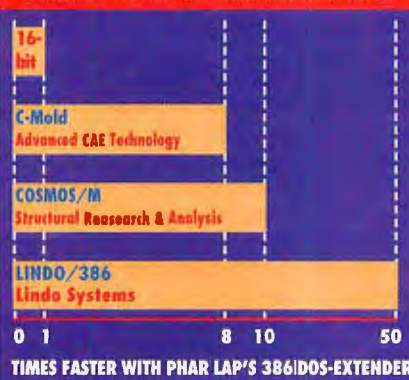
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them out. Instead, a User's Choice Award says that this is a product I have used and liked. Generally, it's one I use now, and if not there's always a reason, such as I don't need to do whatever that product does, or I'm trying out something that may be better, but I haven't made up my mind.

In any event, the User's Choice Award goes to something I have personally tried and find good enough for the job it claims to do. I don't guarantee there's not something better. As always, while I discuss these with my colleagues and BYTE distributes the certificates, the User's Choice Awards remain my sole responsibility.

Operating Environment

Last year, the contest was between Windows and Desqview. Desqview is as good as it ever was, which is good indeed, but I fear it hasn't kept up with its rivals. In particular, it hasn't kept up with OS/2, which will run just about everything Desqview does, run it much faster, and do a passable job with Windows applications as well.

Windows, meanwhile, just keeps getting better and better. Equally important, most of the really high-powered software development people have jumped aboard the Windows bandwagon, with more to come. Many of the exciting new applications are now written for Windows first and then DOS, if at all. Meanwhile, most DOS applications run well in Windows, if you take the trouble to write a PIF (program information file) for them. The real rivals for Windows are Apple's Mac and Windows for Workgroups (W4WG for short), with OS/2 lurking in the wings.

I've been using W4WG for several months now. My first experiences were somewhat frustrating. Most of that ceased when W4WG went from beta testing to a shipping product, but some frustrations remain. The other day, for instance, I decided to retire the machine that was host to the Pioneer Minichanger CD-ROM drive and read/write optical drive and move those assets to my old Cheetah 386/25, which was already running on the W4WG network. The Cheetah would then be loaded down with other useful peripherals and put back out of the way in the cable room as a network server. Those Pioneer drives run off one CorelSCSI board, and it wasn't much of a problem getting them to work with the Cheetah under DOS.

When I brought up W4WG, I had previously defined that Cheetah's drive F to be the D drive on the 486/25 Larry Niven uses when he comes here to write. Alas, I had forgotten that. Since the Minichanger was installed as the Cheetah's F drive and had become a local CD-ROM drive, there was now a conflict. The intuitive way to fix

it—going into File Manager and canceling the F-drive assignment—didn't work. Fixing that took half an hour, a phone call, and two iterations of exiting Windows and resetting the machine. (You first go to File Manager and turn off the Reshare at Start-up box; exit File Manager; exit Windows; restart Windows; go back to File Manager and erase the network-drive assignment; and exit and restart Windows. You don't really have to reset the machine, but I always do.) The moral of that story is that if you change the configuration of a networked machine, you must kill *all* its network connections and make certain they don't try to reconnect on start-up.

However, now that it's all done, it works just fine. It's pretty nice to have six CD-ROM discs and a 600-MB (300 MB per side) optical drive available at all times. Network access is just about as fast as if those drives were local to my own machine. It all works, too.

Well, almost all. Alas, some CD-ROM discs seem to have been hard-coded to believe they're playing off a local drive. They curl up and die at odd moments. Quanta's Desert Storm CD-ROM won't open its sound files across the network. Another

one apparently looks at the Cheetah's video board (an elderly VGA) and tries to adapt to that rather than take my word that we've got an ATI Technologies' Graphics Ultra Super VGA board over here on this machine. In both cases, of course, I'm trying to run *programs* off the CD-ROM drive. I don't have any trouble retrieving images.

At worst, I can put a recalcitrant CD-ROM disc into the Multimedia Upgrade Kit CD-ROM drive that's local to my main system. A few discs won't run under Windows even there, but so far I haven't found one that runs under Windows that won't also run under W4WG.

The main feature of W4WG is the ease of both setup and use. Other networks give power, notably LANtastic for Windows (which will link in Macs, too), but getting other networks set up requires study of the manuals and considerably more work; many establishments will need a network manager. On the other hand, W4WG can be set up and running in a couple of hours by anyone generally familiar with Windows. The network boards are pretty well self-installing, *most* of the operations are intuitive (not all; some applications

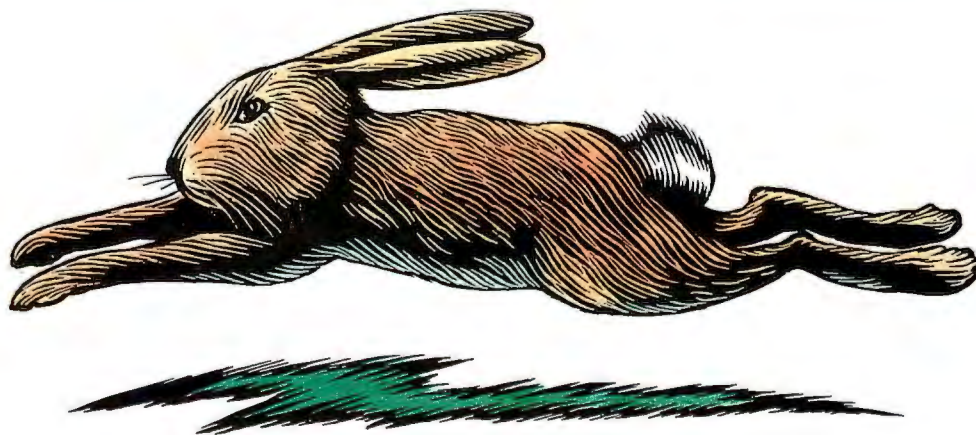
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| Total Revenues | 3,778,800 | 4,143,640 | |
| Operating Expenses | | | |
| Marketing | 94,500 | 102,060 | |
| R&D | 77,600 | 84,024 | |
| Maintenance | 69,400 | 74,952 | |
| Purchases & Supplies | 17,400 | 18,792 | |
| Rent | 188,440 | 203,515 | |
| Depreciation, Building | 6,400 | 7,168 | |
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require you to check cancel to get out of them once you've done everything, others want OK, and one wants you to close it), and almost any user can begin elementary networking very quickly.

In my case, I have a number of assets on a remote machine, and when Niven and I work on a book together, we can trade files without having to save off on a floppy disk. I can also write each of the versions to a WORM drive, so that we'll never lose text due to version clashes. That alone justifies networking for me.

Windows has gone a long way to flatten out the PC learning curve. Richard, one of my Mac-using sons, was forced to use an NCR 3170 because he needed a laptop and no Mac PowerBook was available. He has now completely gone over to Windows because he found it easy enough to learn and there's a wider variety of software for Windows (or DOS under Windows) than he found for the Mac. That's particularly true of communications, but there are also business applications like Franklin Ascend that he uses constantly. Richard reports that he wouldn't want to learn DOS, but Windows and File Manager let him do what he needs to without DOS. He now prefers the NCR 3170 to his Mac.

(Of course, a visit to a large Mac show will convince you that there's a great ferment there, too. Many PC applications are being ported to the Mac, and while there are more Windows software developers, there's no dearth of Mac developers. The truth is, there are exciting developments in both fields.)

Meanwhile, we've thoroughly converted all our PC operations to Windows here in Chaos Manor; and for all my talk about networking over the years, W4WG has given me a practical network that I can maintain, use, and add to without much work. This year's User's Choice Awards for Operating Environment go to Windows 3.1 and W4WG; and the User's Choice Operating Environment of the Year is W4WG.

Computer of the Year

First, it's now clear that if you can possibly afford it, you ought to get a 486. This does not mean that the 386 systems are obsolete, and for that matter, you can get by with a 386SX if that's all you have; but if you're going out shopping for a new system, it's prudent to invest in a 486 and have done with it.

A lot of new computer systems passed through Chaos Manor this year, and we could have had more if we'd wanted them. One stands out. The Gateway 2000 4DX2-66V, a 66-MHz 486DX2 with local-bus

video, right out of the box is the fastest machine we've ever had here. It has withstood being transported to the beach house and back. It has been a test-bed for sound boards and CD-ROM and SCSI devices, and it has worked fine with them all. It's a well-built machine, and the case is attractive. There's plenty of room to install an internal CD-ROM drive. Its younger brother, a 50-MHz 486DX2, has survived being a test-bed for OS/2, DR DOS, seven different sound boards, four different CD-ROM systems, two drive controllers, and any number of video boards; and like the Energizer rabbit, it just keeps going and going.

You expect local-bus video to be fast; but experienced visitors to Chaos Manor find that they didn't expect the 66-MHz 486DX2 to be *that* fast. As an example, the ships in Berkeley's Star Trek Screen Saver for Windows flow across the screen smoothly without jerkiness; we don't get that on any other machine here. Windows don't just pop up, they explode. Windows has been criticized for slowing your machine way down. If you don't have enough memory, it surely will; but even with lots of memory, Windows can drag.

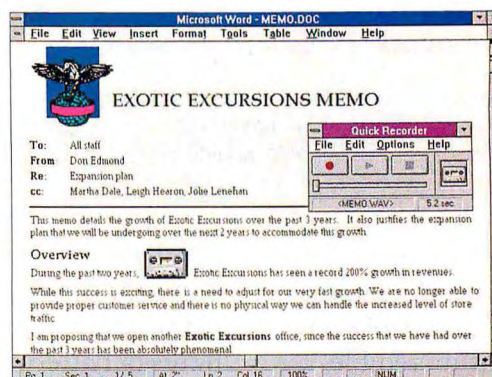
Not on this machine.

What we have is the standard configuration of the Gateway 2000 4DX2-66V. If I were buying one, I'd make one change. The Crystal Scan monitor that comes standard with it is more than good enough, but you can do better elsewhere. Both my NEC and Nanao monitors look absolutely gorgeous with the Gateway 2000, and I'd recommend getting one of those. Understand, though, it's a preference, not a requirement.

I took the still-crated-up 4DX2-66V and Crystal Scan monitor down to the beach house to do some serious editing on *Prince of Sparta*. There was absolutely no problem about setting it up. Everything was in there—a programmable keyboard with settable key-repeat rates, programmable macros, and even a Microsoft Mouse. Windows was already installed, so all I had to do was add Microsoft Word and the draft of my book. The computer performed flawlessly, and the speed was impressive. It's very useful to have that much speed for editing. It's also easy to get used to it so that you become impatient with anything else.

The only real negative feature is that,

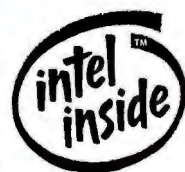
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unlike the 50-MHz 486DX2, the 4DX2-66V uses an odd memory form factor I've never seen before. The machine comes with 8 MB, but you really need 16 MB, and the only source I know of is Gateway 2000. Fortunately, so long as the Department of Commerce keeps its hands out of the machinery, memory is cheap, and Gateway 2000 sells memory for the 4DX2-66V at reasonable prices.

I have no hesitation in giving a User's Choice Award for the Most Useful Computer at Chaos Manor this year to the Gateway 2000 4DX2-66V.

Sound and Multimedia

Multimedia was a disappointment this year. Several new products tried to take advantage of multimedia. Some were more successful than others, but the problem has been that the "multimedia standard" hasn't proved to be a standard at all, making it much harder to do multimedia applications. The sound scene has the worst confusion.

The best sound board for quality and high-end usefulness at reasonable cost has been the Turtle Beach MultiSound. This board has sound quality surpassed only by units that are quite a bit more expensive. It has an on-board DSP (digital signal processor), a special sound-processing chip that lets it generate sounds from a number of different sources and play them all simultaneously. You can have a classical-music CD playing in the background, add a game with sound effects, and still be able to use sound alarms. You can also associate sounds with user actions. Just like Mac users, you too can have Mr. Spock tell you "That should prove interesting" when you go to read a floppy disk, or Captain Kirk say "We better start the evacuation" when you leave an application.

If you're a serious musician, you're likely to know more about sound boards than I do, and you'll probably want one of the really high-end sound boards and speaker systems. But if you're just getting into computerized composition and sound editing, and you want to try your hand without making a really serious investment, the MultiSound is a great deal more than good enough. Incidentally, I've seen test copies of a new program that will let you scan in sheet music: it reads it and then plays it on the MultiSound. It's not out yet, but watch for it.

That's the good news. The bad news is that the MultiSound was built as an MPC board. This means that programs written for Windows will have no problems with it, since it supports the MPC sound standard and has all necessary drivers for that. You can build Windows sound objects and

DLLs with no problem. However, most games weren't written for Windows. Most games were written for DOS. Nearly every game has support for Ad Lib and/or Sound Blaster sound systems; but Turtle Beach never tried to be compatible with Sound Blaster, and few games have multimedia standard drivers. The result is that a great many of the most popular games won't work with the MultiSound.

The second drawback to the MultiSound is that the output isn't powerful enough to drive speakers directly. It must be fed into an amplifier, which means either batteries or yet one more power cord to your computer system. You can also feed the MultiSound output into your stereo system, which is probably the right thing to do anyway.

If you want high-quality sound and don't care about games, or you can live with your game using the PC's internal sound system, or you believe as I do that it won't be long before the most popular games will come out in Windows versions, you shouldn't hesitate to get the MultiSound. With that reservation, Turtle Beach gets a User's Choice Award for the MultiSound.

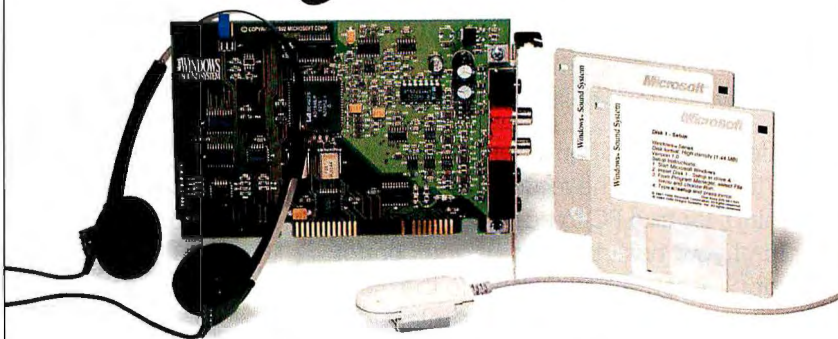
Converting to Multimedia

If you don't need really high-quality sound, the Creative Labs Sound Blaster Pro board is good enough. This burst on the scene a couple of years ago and swept everything before it; now it's pretty well the standard for all sound software except high-end composition systems, and even those will often have hooks to let their output play through a Sound Blaster Pro.

I'm not as picky about sound quality as most people, and I find Sound Blaster Pro's sounds generally good enough; but fair warning, my musical friends think I have a tin ear. Sound Blaster Pro puts out enough power (4 watts) to drive unamplified speakers: I tend to use inexpensive ones from Radio Shack. Of course, they hardly show off the sound quality to best advantage.

Sound Blaster Pro is certainly good enough for game players and for those not too fussy about music quality. It does voice quite well. There's no DSP chip, meaning the board can be overwhelmed by simultaneous sound inputs. That's not fatal, given what you're likely to be using a Sound Blaster Pro card for; it just means that instead of playing multiple sound sources,

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it stops all but the one that it's outputting.

The best thing about Sound Blaster Pro is that you can get it with Creative's Multimedia Upgrade Kit, which consists of a CD-ROM drive using Sound Blaster Pro as a controller and a whole bunch of software (see my March column). This is probably the most painless way to upgrade your system to multimedia specifications. Sound Blaster Pro is compatible with nearly every DOS game, so you'll have sounds for those, provided you play them in DOS.

Many elaborate DOS games will play in Windows, provided you use a memory management program to give yourself large DOS windows, and most will find the Sound Blaster Pro board.

However, not all of them will do that, and with W4WG I get an even stranger situation. A game like Darklands will come up, and then suddenly I'm back at the Program Manager with a message that some other program is using the sound board, so there won't be any sound; and my game

has been iconized. If I double-click on that icon, the game comes up again, and there's sound as if none of that ever happened. Alas, Civilization, a DOS game that played just fine under Windows 3.1, gets locked up when I try it under W4WG. Microsoft is trying to figure out why.

A multimedia game like Sherlock Holmes, Consulting Detective, works just fine under Windows 3.1, and many games will play across the network in W4WG. The Creative Labs CD-ROM drive can be shared across the network to other stations. Creative has an active BBS and often offers updated drivers. The Multimedia Upgrade Kit is compatible with more software—DOS, Windows, and multimedia—than anything else out there.

The Creative Labs Multimedia Upgrade Kit and the Sound Blaster Pro sound card both win User's Choice Awards.

Supra Modems

I've used a lot of modems over the years. The most useful one this year was the SupraFaxModem 144 PB with error correction. This is small enough to stuff into checked luggage and take along on trips. I always do that now, because even if my portables have internal modems, the Supra with error correction works far better over the noisy connections I always seem to get when I have a critical upload to perform.

I've written about Supra modems in other columns, so it just remains to award the SupraFaxModem the User's Choice Award as Most Useful Modem of the Year.

Satisfaxtion

I know I just said the Supra was the most useful modem of the year, but the Intel Satisfaxtion is a bit more than just a modem, since it has its own CPU chip and memory. The Satisfaxtion will send and receive fax messages invisibly in the background without stealing cycles from your CPU. It works over many networks. Alas, one thing it will not do is work over a Novell NetWare network underlying W4WG running over ARCnet. No one is quite sure why, and it may be fixed by the time you read this; the problem was just discovered and reported by my son Alex yesterday.

There aren't a lot of other limits on the usefulness of the Satisfaxtion, which gets a User's Choice Award as Communications Coprocessor of the Year.

Mapping and Painting

There are a lot of drawing and painting programs for Windows out there, and most of them are pretty good. Windows Draw works well. Aldus FreeHand for Windows is excellent. If you have really elaborate

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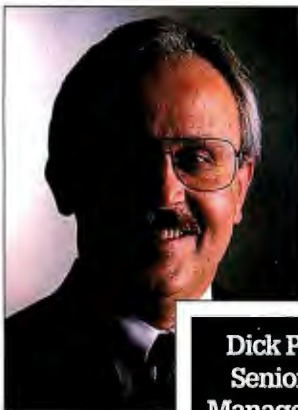
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Dick Patefield,
Senior Project
Manager for Store
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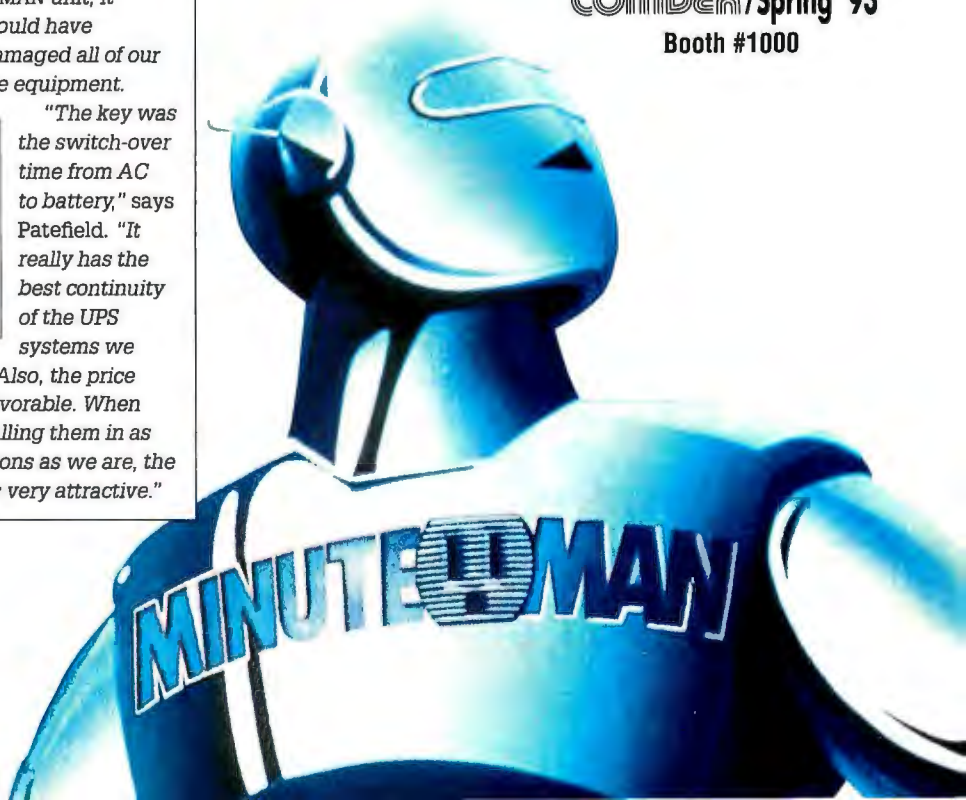
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drafting work to do, you can't beat AutoCAD, but like Lotus Notes, AutoCAD is almost a way of life. Every one of these has good features. Alas, each works in a slightly different way from the others, so you restart on the learning curve every time.

CorelDraw has more features than any of the other programs but AutoCAD, and it even has a few that AutoCAD doesn't have. CorelDraw has both drawing and painting capabilities. It's not particularly easy to learn, but it's not *that* much harder than the others; and once you have learned CorelDraw, you have available a mountain of resources and features, enough to accomplish just about everything you'd want to do.

That, at least, was my reasoning when I set out to look for a program to use for drawing maps and illustrations for my stories. I did the maps for *Prince of Mercenaries* in MacPaint, and they were pretty good. But publisher Jim Baen uses a PC, and lately I've taken to shipping him everything through E-mail rather than the mails, so I wanted a PC-based drawing program. I have a wide variety of mapping needs, from the rather stark military-

style sketch maps I use for the Falkenberg series, to the much more fanciful pictorial maps I'll need when I get going on a major heroic fantasy. It seemed to me that the right way to go was to learn CorelDraw, because that way I'd be able to do a lot more than just maps. I have hopes of doing some equipment illustrations, and I might think of something else.

I've had no reason to regret the decision. The learning curve is a bit steep, but I'm managing, and CorelDraw comes with a great number of canned images, many of which I can incorporate directly into my maps. Certainly CorelDraw is powerful enough, and while the published price is fairly steep, the street price is quite reasonable. I'll have more to say on this as I go along, but I've had enough experience to give CorelDraw a User's Choice Award.

Cool It!

The new 486 chips, particularly the OverDrive versions, can get plenty hot. PC Power & Cooling, which so far as I am concerned is the only company to go to for a power supply, now sells a little fan, the CPU-Cool, you can attach to the chip and plug into your PC's power supply. If

you have one of the new 486 OverDrive systems, let it run for a couple of hours, turn it off, very quickly open the case, and put your finger on the CPU chip. If it's too hot to leave your finger there, you need a CPU-Cool.

A properly ventilated OverDrive chip run in a normal-temperature environment may not need one of these; but then you never know when your room will get overheated. Anyway, look into the PC Power & Cooling CPU-Cool, which gets a User's Choice Award.

The Amiga Is Back

When the Amiga first came out, the machine was well ahead of its time and had the best video imaging of any machine on the market. It was also the first of the low-cost true multitasking systems. Unfortunately, Commodore lost most of those advantages: their video-accelerator chip set is good but no longer in a class by itself.

The good news is that Commodore is back and with a vengeance. The Amiga 3000T-040 is a good machine (see my September 1992 column). The new Amiga 4000-040 is even better: fast, flexible, and, perhaps more to the point, fun. The

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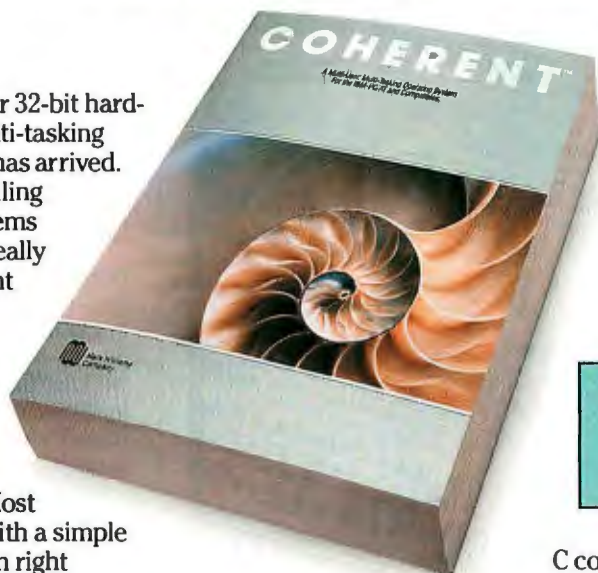
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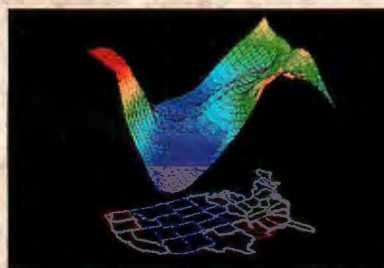
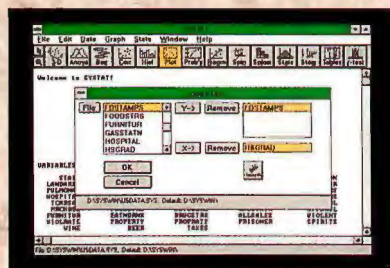
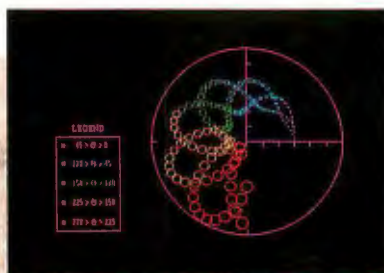
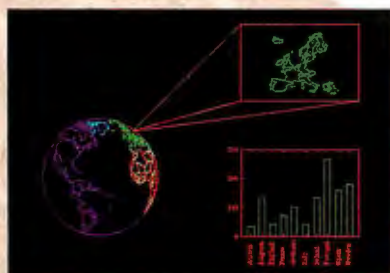
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unreliable current and works in odd circumstances; it let our son get his letters done in rather trying circumstances. Seiksha has since replaced the SP-2000 with the SP-2400AP, but the Seikosha pizza box still deserves a User's Choice Award in the Affordable Printer category.

The Ecosys is a rugged, high-end LED printer that doesn't use expensive cartridges. It turns out quality printing at good speeds and does it economically. Also, as the name implies, it doesn't waste any re-

sources. It wins the User's Choice Award as Printer of the Year.

Orchid of the Year

Consider AT&T: a company that only a few years ago I said couldn't market eternal life; a company with a century of experience at bureaucratic infighting, where getting ahead didn't mean pleasing the customers but, instead, understanding rules and regulations and being able to move within them. Ma Bell, The Phone Com-

pany. Look how they've changed!

They bought NCR to learn marketing, and it worked. They've brought out a string of new products, with their Safari laptop (since renamed the NCR 3170) one of the best designs around, incorporating Bell Labs technical skills with NCR marketing pizzazz. I regret the need to turn Bell Labs into a product-oriented outfit—it used to be the nearest thing to the long-range planning group for the human race—but it seems to be happening without destroying much of the spirit of the place.

I look for great things from the new AT&T. And for proving that big ships may turn slowly, but they can turn, I give the Chaos Manor Orchid of the Year to the aggressive new AT&T/NCR combo.

Mystat and Systat

I mentioned Mystat, an introductory course and tutorial on statistics using Systat, in the January column. The package is designed specifically for use by educators. That mention sparked a lot of interest.

Keith Reehl at Systat tells me that you can now purchase Mystat directly from them. Academic users can purchase the package from NACSCORP (528 East Lorian St., Oberlin, OH 44074, (800) 321-3883). Warning: NACSCORP deals only with campus bookstores.

Winding Down

I've run out of space before I got to all the products on my list. This will be continued next month, with optical character readers, CD-ROMs, and many more software and hardware products that deserve special mention.

The book of the month is by *Fortune* contributing editor Daniel Seligman: *A Question of Intelligence: The IQ Debate in America* (Birch Lane Press, 1992). Excellent.

The computer book of the month is by Geoffrey Mandel, *Essentials of Word for Windows* (Peachpit Press, 1992). Thin, readable, and I have learned more about Word from this than from a dozen other thicker works. Highly recommended.

Of course, you should get *The Gripping Hand* by Niven and Pournelle if you haven't yet, and my *Prince of Sparta* (Baen Books, 1993) should be in stores about now.

I have three games of the year: MicroProse's *Civilization*, which won my Game of the Year Award last year, has held up; it's a big game of military and industrial strategy, and, remarkably, after a year it's still played at Chaos Manor. The other game is a mini card game from the Microsoft Entertainment Pack for Windows. It's called *FreeCell*, and I would hate to have to tell you how much of my time it

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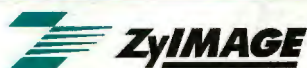
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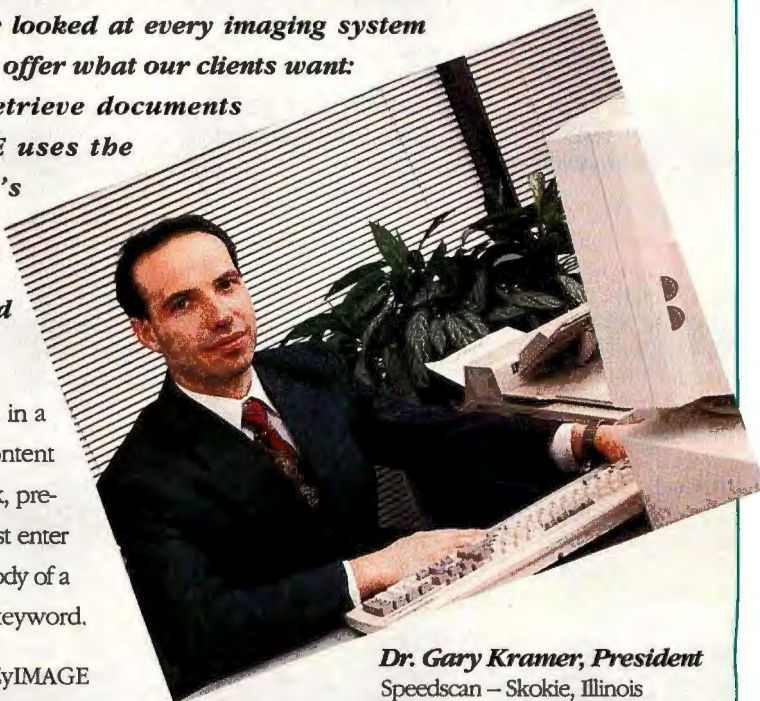
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has consumed. Finally, Hardball III from Accolade is the Sports Game of the Year. I'm no computer baseball fan, but my son Richard is, and he likes this one a lot.

Next time I'll also discuss critical technologies, particularly video compression and PCMCIA. I'll also give the Chaos Manor Onions of the Year.

It was a good year here at Chaos Manor. I hope 1993 will be as good for you. ■

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 opin-

ions. 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 "jerry."

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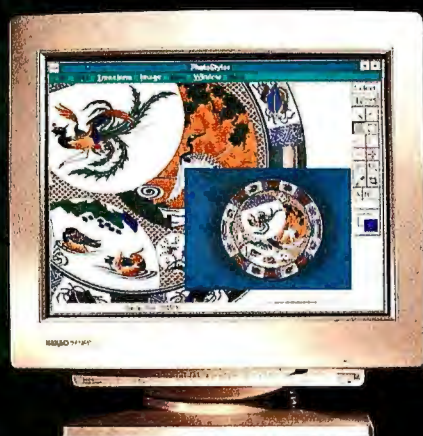
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Fighting Fatware

Today's big, bloated software means big problems.
What can you do about it—now, and in the future?

ED PERRATORE, TOM THOMPSON,
JON UDELL, AND RICH MALLOY

Item: Dave Brown, a Keene, New Hampshire-based entrepreneur, got his Christmas wish last year—a copy of Microsoft's Access relational database manager for Windows. Excitement turned to disappointment, however, once Brown tried to run the program. Despite the fact that his system had the 4 MB of RAM that Microsoft recommends, Access was "hideously slow." A call to Microsoft technical support revealed the truth: He needed at least 8 MB of RAM to achieve acceptable performance. Now Brown has two options: He can spend \$200 for more RAM or wait for version 1.1, which Microsoft claims will run better with 4 MB.

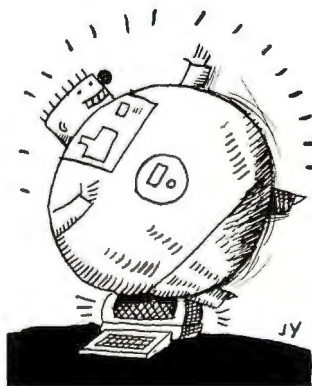
Item: Most users would find two 200-MB hard drives to be more than enough storage space. But not Dave LeFevre, technical marketing manager for WordPerfect for Windows. LeFevre is a heavy user of multimedia. Even after compressing his 600 MB of files, he has only 63 MB of disk space free. "I needed to buy a second computer, in part because there was no more room," he says.

Like the carnivorous plant in the movie *Little Shop of Horrors*, today's popular applications software cries out to users, "Feed me!" More RAM, more hard disk space, more CPU speed—it seems like you never have enough.

The problem is likely to get worse before it gets better. Lotus 1-2-3 for DOS has doubled in size every four years, from fitting on two 360-KB floppy disks in 1983 to 5 MB today (see figure 1). During that time, spiraling hardware requirements for 1-2-3 and other popular applications have driven the typical base configuration of a PC from 64 KB of RAM and a 360-KB floppy drive to a minimum of 4 MB of RAM and a 100-MB hard drive (see figure 2).

Fat software feeds a vicious cycle of upgrading. At Hughes Aircraft (El Segundo, CA), Jack Baumann, a manager of computer systems and networks, says users ask for hardware upgrades about two months after getting new software. Then when they get new hardware, they want software with more features (see the text box "When Bigger Is Better" on page 101).

One way to combat software bloat is for users to take simple stopgap measures, such as file compression





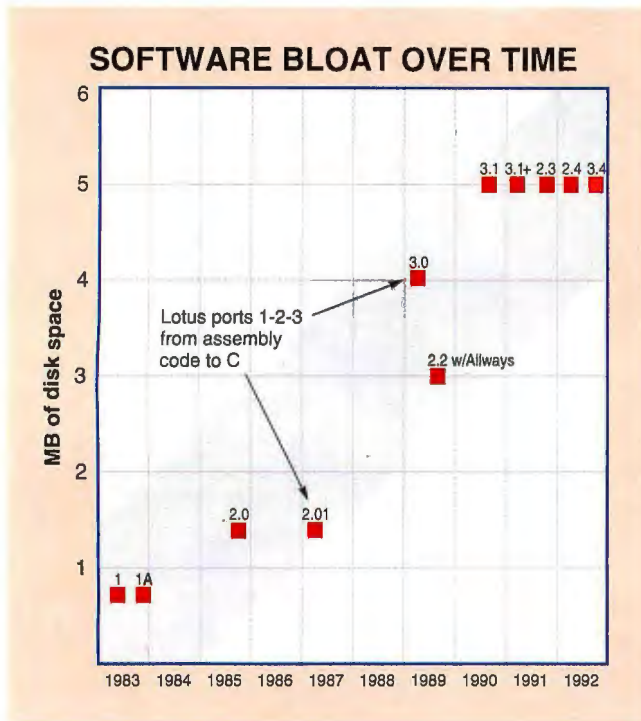


Figure 1: Since it first appeared in 1983, Lotus 1-2-3 for DOS has grown in size from fitting on two 360-KB floppy disks to 5 MB—in effect doubling in size every two years. (Data from Lotus Development)

or pruning unnecessary programs and modules (see the text box “Software-Bloat Antidotes” on page 104). The real solution, however, is to make operating systems and applications that are designed to reuse code rather than force applications programmers to re-create the same functions over and over again. Platforms such as Windows 3.1, Unix, and the Mac’s System 7 permit code reuse, but object-based operating systems such as Apple’s and IBM’s Taligent and Microsoft’s Cairo promise to make reusable application modules a more significant reality by as early as 1994.

Fat Factors

A vendor adds features to its software to stay competitive. Consumers use feature lists to evaluate different software packages. Computer magazines fuel the feature wars by publishing side-by-side feature comparisons.

Some vendors have tried offering slimmed-down, feature-light versions of their software, only to see users respond unenthusiastically. Products like Microsoft Write and WordPerfect’s LetterPerfect, both scaled-down versions of their more full-featured word processing brethren, “are not becoming runaway best sellers,” says David Tremblay, Software Publisher’s Association’s (Washington, DC) director of research. Quark (Denver, CO) marketing communications manager Peter Warren says that users didn’t want a

stripped-down version of QuarkXPress desktop publishing software for the Mac, and they proved it after Quark released the doomed QuarkStyle in the fall of 1988.

Vendors have another incentive to add features to their software: the lucrative upgrade market. Microsoft, for example, receives revenue of about \$45 to \$50 from each DOS 5.0 upgrade, as opposed to the ballpark \$20 to \$25 it earns per copy selling the original versions to system developers at \$35 a pop. Application upgrades, historically composing one-fourth to one-third of a software vendor’s revenue, have also undergone an upward shift, says Bill Higgs, vice president of microsystems software at market researcher InfoCorp (Santa Clara, CA). Increased competition among software vendors has pushed the percent of revenue each receives from upgrades toward 40 percent to 50 percent, he says.

Most of the large vendors now provide custom-installation routines that let users install only those features they most want. The problem with this solution, says Pete Higgins, vice president of desktop applications at Microsoft, is that users are often unsure which features they really need. The result, says Higgins, is that “everyone installs everything.”

Development Issues

Poor management of software development is another important contributor of flab. Good management would prevent programmers from spending countless hours reinventing wheels, all of which end up on your hard disk. Applications built by large teams have a lot of redundant functionality, says Martin Heller, author of *Advanced Windows Programming* (John Wiley & Sons, 1992). “Developer A doesn’t know about developer B’s function,” he says, “and developer B knows about developer A’s function but thinks it sucks rocks.”

One controversial aspect of the software-bloat problem is the increased use of high-level languages, particularly C and C++. While assembly programming can produce very tight code, the common belief is that with C or any other high-level language the code will be larger. However, a good programmer, says WordPerfect’s LeFevre, can minimize the growth of code while making the most of a high-level language’s advantages.

Lotus Development (Cambridge, MA) ported 1-2-3 from assembly to C between versions 2.01 and 3.0. Consequently, the code size nearly tripled, from 1.4 MB to 4 MB. Not all of that

TYPICAL PC BASE CONFIGURATIONS

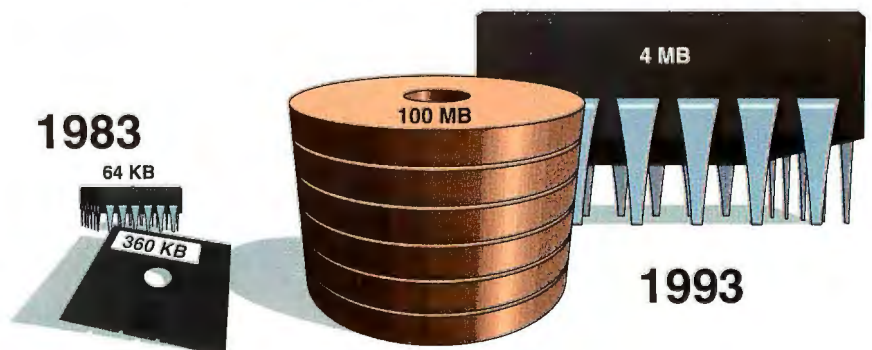


Figure 2: In 1983, the typical RAM and storage configurations for a base IBM-compatible PC were 64 KB and 360 KB, respectively. Today, a PC with less than 4 MB of RAM and 100 MB of hard disk storage is considered inadequate.

When Bigger Is Better

TOM THOMPSON

Not all software bloat is bad. Some factors that can add bulk to a program offer long-term benefits to the user. These include robust code, code that's designed for easier maintenance, and the ability of some applications to span several platforms.

For example, a vendor might choose to implement OOP (object-oriented programming) in its application designs. One of OOP's strengths is the concept of reusable code; this ultimately reduces the vendor's development and maintenance costs once a suite of proven code objects is written. OOP typically uses high-level languages, so the object code generated by high-level-language (e.g., C++) compilers won't be as compact as code generated by, say, assembly language programs. However, because code writing has become a slow and costly process, OOP's ability to let a vendor quickly fix bugs and add needed improvements to an application far offsets the code girth it incurs.

An application designed to operate on two or more platforms, such as Aldus PageMaker or Adobe Photoshop, is bigger than a single-platform application. The Photoshop 2.5 image-editing program, for example, started life as a Pascal program on the Mac in 1989. When it came time to port the application to Windows, the engineers completely redesigned the application and rewrote it in C++. OOP was used heavily for both data abstraction and code reusability. Much of the application code was written as highly abstracted *core code*.

Core code is so named because it implements an application's core operations: In the case of Photoshop, this means color space conversion, image

filtering, channel manipulation, pixel editing, and other functions. Core code doesn't deal with the user interface, the operations of which are typically platform-specific. The use of core code enabled Photoshop's engineers to write most of the core functions in portable C++ code. Porting Photoshop then became a matter of compiling the core code on the target platform and wrapping it in a layer of highly optimized user-interface code (for either the Mac or Windows).

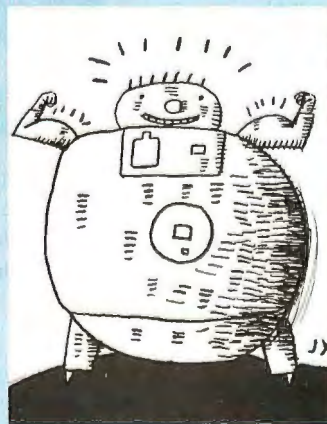
According to Steve Guttman, senior product marketing manager for the Macintosh at Adobe Systems (Mountain View, CA), this technique offers tremendous economies of scale. First, you write the code only once. Second, a bug fix in the core code fixes the application across all platforms, because they use the same code. As in the case of the OOP example above, the core code is written in a high-level language, and it does not take advantage of any specific hardware. The end result is a larger amount of object code, but it makes the cross-platform implementation and support manageable.

Another factor that contributes to the bulk of a cross-platform application is that inevitably you must add support code to supply certain features that are absent on a particular platform or to overcome a limitation. For Windows, the Photoshop programmers had to write their own memory handler to overcome a limitation in the Windows memory management scheme.

A future concern for software vendors is migrating programs to the RISC-based microcomputers that are now coming down the pike. To date, Windows NT has been ported to the Mips R4000, DEC Alpha, and Intel Pentium, and the Mac OS is being ported to the PowerPC. Windows NT will ship sometime this year, and the PowerPC is slated for a 1994 release date. Vendors want their applications running on these new systems the moment they ship.

Planning for this transition affects program design. Normally, an application is written completely in a high-level language first. A team of assembly language programmers then rewrites specific sections of the program into fast assembly language code. By optimizing crucial code sections, a dramatic boost in the application's performance can be achieved without reducing the entire program to assembly language code. Unfortunately, these same optimizations tie the application to specific hardware. To temporarily avoid this problem, a vendor might choose not to fine-tune the high-level-language code at all in order to expedite moving the code to, say, a RISC machine. The result is a bigger, slower application, but the vendor is ready to port the application code rapidly when the time comes.

Application growth is not necessarily due to vendors' piling on unneeded features. It may actually be a result of the vendors' attempts to give you what you want: stable code, prompt bug fixes, and cross-platform operation.



growth is attributable to the difference between C and assembly—version 3.0, for example, included the printing utility Allways and had significantly more features—but it was a major contributor. The resulting product would not run acceptably under DOS until the company delayed its release to compress and optimize the code.

Program code eats up RAM, but clip art, sample documents, form letters, tutorials, and help programs feverishly devour disk space. As programs begin to include sound and video files, the required disk space will mushroom—a commonly used sample 15-second clip of the B-2 bomber, for instance, requires 2.14 MB of space, even in compressed format. Furthermore, much

of this data is never used. Joel Diamond, technical director for the Media, Pennsylvania-based Windows Users Group Network, says the users he speaks with on several CompuServe forums install thousands of pieces of clip art but use "maybe 20 pieces of clip art a year."

In the name of usability, many applications now include on-line help files. Microsoft's Wizards on-line help, for example, takes up half a megabyte for Access alone. A multimedia tour of Lotus 1-2-3 release 1.1 for the Mac takes up 3 MB. And Autodesk's AutoCAD release 11 Extension for Windows has an optional hypertext version of the reference manual. The size: 12 MB.

The single most cited case of disk glutony is spelling checkers. You could have separate spelling checkers for your word processor, your desktop publishing application, and your spreadsheet, each taking up about half a megabyte on your hard disk before you add custom dictionaries. "If Windows publishers would agree on a dictionary," says Terry Currier, program chairman for the Orange Coast IBM PC User Group (Costa Mesa, CA), "we would probably save 2 or 3 MB."

The use of GUIs encourages software to expand. The Windows development process, for instance, requires an overhead that doesn't exist in the DOS environment. Windows' dialog boxes, bit maps, and graphical nature in general all consume RAM, disk space, and CPU cycles. Take WordPerfect, for example. Version 5.1 for DOS requires a minimum of 384 KB of RAM and 2 MB of disk space. By contrast, WordPerfect for Windows expects a system with at least 4 MB of RAM and 4.2 MB of disk space. Maximum space for the complete program is 15 MB, including bundled Adobe Type Manager and Reference Software's Grammatik spelling checker. For Unix, the Motif version of WordPerfect requires 5 MB of disk space, 66 percent more than for the character-based version (see figure 3).

As entrepreneur Brown discovered, software vendors are often loath to indicate the true system requirements for acceptable performance so as "not to scare people off," says LeFevre, whose company recommends a 386 with 4 MB of RAM for WordPerfect for Windows 5.2 even though it will run, however painfully, on a 286 with 2 MB.

The BYTE Lab tested nine popular software packages to gauge performance at minimum configurations. The result: All nine ran, but performance was so bad that the packages were virtually unusable (see the text box "Recommended Hardware Allowances" on page 105).

Productivity Lost

Big software also entails a tremendous cost in human resources, most of it hidden. Consider the amount of time that's involved

WHICH PLATFORM HAS THE BIGGEST APPLICATIONS?



Figure 3: The amount of disk space taken up by applications and operating systems on a 200-MB hard drive varies depending on the platform. The areas shown for operating systems represent a full installation.

each time a network administrator installs and then troubleshoots product upgrades across several hundred workstations. It can take up to 2 hours per PC to install and configure a program like Microsoft Word for Windows, says Hughes Aircraft's Baumann. You can expect to add up to 8 hours for additional training of less experienced users if the upgrade is a major one.

In addition, companies do not take into account how much training is actually needed for feature-heavy software. "Nontechnical management has the impression of, 'Oh, now we're in a windowing environment, so people don't need training anymore,'" says Loretta Weiss Morris, editor in chief of the *Microcomputer Trainer* (Secaucus, NJ). A GUI like Windows, she adds, still stops DOS-unaware users cold the first time a file like `c:\mydir\myfile.doc` needs to be retrieved.

Training is still going on, but in subtle yet expensive ways. Users informally train themselves by trying out various features, although unfocused self-help can result in lost work time. David Harris of SBT Accounting Systems (Sausalito, CA) published a study showing that each user spends an average of 5.1 hours a week "futz around"—learning programs, helping coworkers, and performing other activities that are indirectly associated with their own jobs.

Many users have reported that flabware impairs usability, and vendors are beginning to agree. "If you just have a lot of features and you're not focused on usability," says Betsy Fortin, director of graphics-products marketing at Lotus, "you have what I call a 'bag of tools.' And the more tools you have, the harder it is to pick out which one to use."

Lotus, Microsoft, and a growing number of other companies have set up usability labs to determine how to make each product's benefits more accessible to users. "With most products, most of the features that you'd want are there," says Brian Moura, finance director and assistant city planner for San Carlos, California, and a frequent beta tester. Ease of use is "the next frontier," he says. The problem is that features for enhancing usability often add even more bulk to the code.

Answers in the Operating System

Software bloat is closely related to the underlying platform. If an operating system fails to make its services available in an efficient way, then each application has to include additional chunks of code to enable them. Interestingly, applications on the Mac, with its integrated GUI, are only one-third to one-half as large as corresponding applications under Windows, which grafts a GUI onto DOS (see the text box

"Managing Memory and Features on the Mac" on page 106).

Advances in the operating system can allow some programs to shed bulk. For example, version 2.0 of Microsoft's PowerPoint presentation software once required 50 MB of disk space if you

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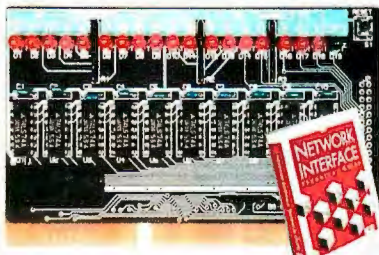
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Software-Bloat Antidotes

You can take steps now to minimize the effects of fatware. The nine steps listed below are not cures, but merely treatments to keep the condition easier to live with.

Buy as much speed, RAM, and storage space as you can afford when purchasing a new system. Upgrading later will be more expensive.

Buy integrated software, which includes common functions such as word processing, database management, and spreadsheet capability in one package, if you don't need a full-featured, single-task program.

Buy a CD-ROM drive on which you can retrieve files such as fonts or symbol libraries.

Centralize as many applications as is practical on a large network file server.

Compress files using both an on-the-fly compression utility for commonly used files and an archival compression utility for rarely used data files.

Delete tutorial files once you are familiar with a program.

Delete bundled applications, such as Windows Write or Windows Filer, and their help files, if you don't use them.

Identify your needs to make sure an upgrade meets them before making the switch.

Note disk space and memory recommendations on software packages.

loaded all its Bitstream fonts. But now that Windows itself includes the TrueType scalable fonts, PowerPoint weighs in at only 14 MB, a 72 percent weight loss that would make even Richard Simmons envious.

Sophisticated new features in Windows 3.1 and Apple's System 7.1 hold the best near-term promise of reversing the bloat in applications software. These operating systems provide a messaging mechanism that lets applications request services from other applications and exchange information. This capability allows an application to tackle complex tasks by farming out portions of the job that it can't handle to other applications on the system or network.

For example, a page-layout application would divide and conquer the job of creating a shareholder's report by asking a spreadsheet application to generate tables from numeric data for one page and asking a charting application to generate graphs of these

numbers for another page. When confronted with a scanned image file in an unknown format, this application might ask a graphics application to extract the image, scale it, and then crop it before dropping the image into the document.

This ability of one application to take advantage of the talents of others should help to end the era of monolithic, Swiss-Army-knife software. Rather than piling on features to handle every conceivable user demand, vendors will be able to tailor their code for specific purposes. Such tailored applications let vendors concentrate on writing code in their areas of expertise. Because a tailored application's code is smaller, the tasks of debugging and optimizing for specific platforms are both simplified. Sharing functions also conserves an even more precious resource—users' knowledge of their tools. Once you've mastered that drawing program, you want to get as much mileage out of it as you can.

Under Windows' OLE and System 7.1's IAC (Interapplication Communication), applications communicate in a client-server fashion. These functions are not rigid; the same application that asks for a service (as a client) at one point might provide a service (as a server) to another application later. Because providing both client and server capabilities takes a lot of work, you can expect many vendors to supply only client or server forms of their applications.

System 7.1 keeps trim, too, by integrating network awareness, eliminating the need for extra modules. For OLE to establish network communications, however, you must have Windows for Workgroups whether or not you need its workgroup applications.

OLE Improves

Despite some drawbacks, OLE is the most ambitious and widely accepted interapplication communication tool. OLE 1.0 works sluggishly and doesn't support the seamless integration that would enable external components to compete successfully with intrinsic ones. However, the forthcoming OLE 2.0, available to developers now in beta form and possibly to users by this fall, addresses both of these problems.

By ditching Windows' cumbersome DDE protocol in favor of a proprietary form of interprocess communication, Microsoft hopes to gain enough performance to make OLE-enabled suites of applications credible alternatives to monolithic integrated programs such as Lotus's Symphony. Vendors, however, find the move to OLE 2.0 a difficult one. "We are all for the OLE vision of the world," says Steve Adams, product manager of Corel-Draw at Corel (Ottawa, Ontario, Canada), "but it's not a nice baby step from OLE 1.0."

On the other hand, OLE 2.0 makes life easier for users. Suppose, for example, that you've embedded a range of Lotus 1-2-3 cells in a Word for Windows document and you want to change the value in one cell. OLE 1.0 requires two radical context switches to accomplish this task: 1-2-3 must first take foreground control, and then Word must regain it. With OLE 2.0, Word mingles fleetingly with 1-2-3 while the embedded cells have focus; it then regains its natural appearance.

But even if OLE 2.0 lives up to all expectations, it will provide just the starting point for a solution to software bloat. The real challenge then will be to build pluggable components. Today's integrated packages offer compelling advantages. In Interleaf Publisher, for example, all objects share common protocols so that a style change can ripple down through a document and apply to both text and graphics in ways appropriate to each. That object architecture is proprietary to Interleaf and is a key competitive advantage.

Although OLE 2.0's notion of "property negotiation" could

Recommended Hardware Allowances

STEVE APIKI

According to what it says on the box, you can run Microsoft Access on any 386-class machine with at least 2 MB of memory and 8 MB of free disk space. Indeed you can—provided you can live without SmartDrive, you can successfully coerce Windows 3.1 into enhanced mode on your 2-MB system, and you have a few extra megabytes of disk space for a swap file. But once you've tuned the configuration and you have a state-of-the-art application running on hobbled, two-year-old technology, how far can you go with it?

If you're extremely tolerant, you can probably complete just about any task with such a setup. But if your patience is less than saintly, you may run into a few problems. I ran a series of Windows applications (see figure A) on an 8-MB 486DX/33, a 16-MHz 386SX with 2 MB of RAM, and the same 386SX with 4 MB of RAM. The idea

was to compare the performance of a typical modern configuration to that of one that barely met the minimum vendor-required hardware. All the applications I tested will at least run on machines that meet the minimal requirements. But they typically run at only about a tenth of the speed at which they run on a 486DX/33.

Of course, a slower, older machine won't perform as well as a modern system. Less processor horsepower means slower memory access; low memory means frequent swaps to a slow hard disk. What's telling is the surprising ratio between performance levels on typical versus minimal machines. If you have a feel for running Windows on a 486/33, you can judge for yourself the utility of a system that takes 10 times as long to respond.

Running large programs on a minimally configured system is frustrating. For example, Microsoft Access takes

over a minute just to start up. A mistaken activity bar selection in Software Products International's WindowBase might leave you waiting 15 seconds to get your mouse pointer back. Scrolling a page in WordPerfect for Windows can take over 10 seconds. With any interactive application, response time is critical. When the response time of a low-end system drops an order of magnitude from that of a typical system, interactive software becomes unusable.

Although you can make it work, getting anywhere near the minimum hardware requirements for a Windows application is a bad idea. It's better to upgrade the machine or to simply forgo buying the latest software to ensure a hardware/software combination you can live with.

Steve Apiki is senior editor and director of the BYTE Lab. You can reach him on BIX as "apiki."

WINDOWS APPLICATIONS AT MINIMAL CONFIGURATION

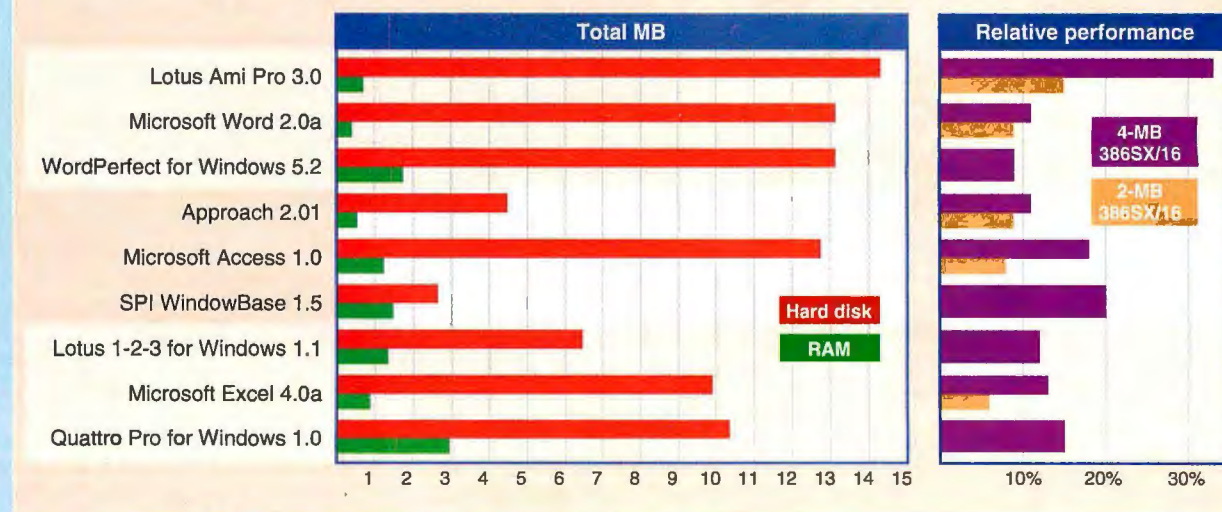


Figure A: The disk-space figures represent a full installation. The memory used includes the opened test document. The performance figures are given as a percentage of performance on a more fully configured system (a 486DX/33 with 16 MB of RAM). Four of the applications—SPI WindowBase, WordPerfect for Windows, Lotus 1-2-3 for Windows, and Quattro Pro for Windows—have either a 3-MB or 4-MB minimum RAM configuration. For these applications, we list only the performance rating for a 4-MB system.

Managing Memory and Features on the Mac

TOM THOMPSON

It's bad enough when your operating system hogs disk space, but its demand for even more memory later on adds insult to injury. For example, at first Apple claimed that System 7 required only 2 MB of RAM. However, Apple now admits that System 7 needs a minimum of 4 MB of RAM, a fact reflected in the base RAM configuration of its computers.

System 7's use of this extra memory is justified by the fact that it provides important new features: TrueType fonts for the on-screen display of high-resolution typefaces, File Sharing for peer-to-peer transfer of files, AppleTalk Phase 2 (required for operating on large networks), and IAC (Interapplication Communication). Still, to make System 7 of more interest to users, Apple's engineers designed it to make more effective use of the memory it occupies.

The solution takes a two-tiered approach. First, System 7 is a modular architecture that allows you to add only those services you need. For example, QuickTime (which provides the Mac with multimedia handling capabilities), MacTCP (which implements a TCP/IP protocol stack), WorldScript (which

provides support for the display and storage of documents composed in foreign languages such as Arabic and Japanese kanji), and ColorSync (which provides a foundation for systemwide color matching among applications) are currently Extension files.

Extension files, if present in the System folder or the Extensions folder, install at boot time and patch the operating system to extend its capabilities. This technique consumes memory because the additional code supplied by the Extension file must be loaded and locked in RAM. However, if you don't require the services of QuickTime, MacTCP, WorldScript, or ColorSync, you simply don't copy the files to your System folder, thus saving memory.

Apple intends to introduce many of this year's additional operating-system services, such as AppleScript (a scripting mechanism for the batch control of applications), the Open Collaborative Environment (a mail and document verification facility), and QuickDraw GX (an advanced graphics engine), as System 7 Extensions. When enough users demand them, Apple will then integrate these services into a new revision of the op-

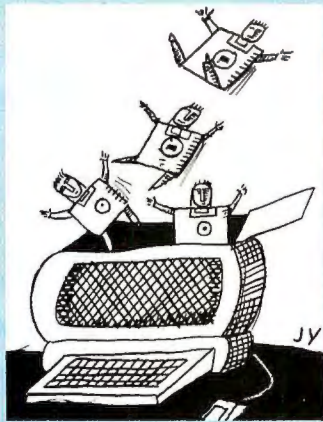
erating system.

The second part of the solution is to load and unload certain service software to and from memory only when it's needed. This solution exploits capabilities built into QuickTime's Component Manager. The Component Manager's original function was to bind a software component (typically a driver or a data compressor/decompressor) to specific multimedia applications or hardware (typically an expansion board) at run time. The Component Manager can search for specific components and open multiple channels to a component, which allows its services to be shared.

These same capabilities enable the Component Manager to function as a dynamic library loader. For example, in the case of AppleScript, an Extension file installs a 5-KB stub into memory.

When an application requires AppleScript, the Component Manager loads an additional 250 KB of code, which comprises the AppleScript services. This memory is released when AppleScript is no longer required by the system. This operation is analogous to Windows' use of DLLs.

While AppleScript's size seems meager compared to today's multimegabyte applications, it gives the Mac OS the ability to effectively manage future services that will make larger demands on memory.



enable Interleaf to partition its application, a non-Interleaf application would need to know an awful lot about an Interleaf component to use it as effectively as an Interleaf client could. The more complete and specific this knowledge becomes, the less likely it is that an application could freely swap in an equivalent part from another vendor's application.

What you'll likely see, therefore, are families of products that share common protocols. Within one vendor's product family you'll achieve better synergy than if you cobble together an equivalent multivendor solution. At the same time, you'll see the emergence of vendors whose entire business is providing

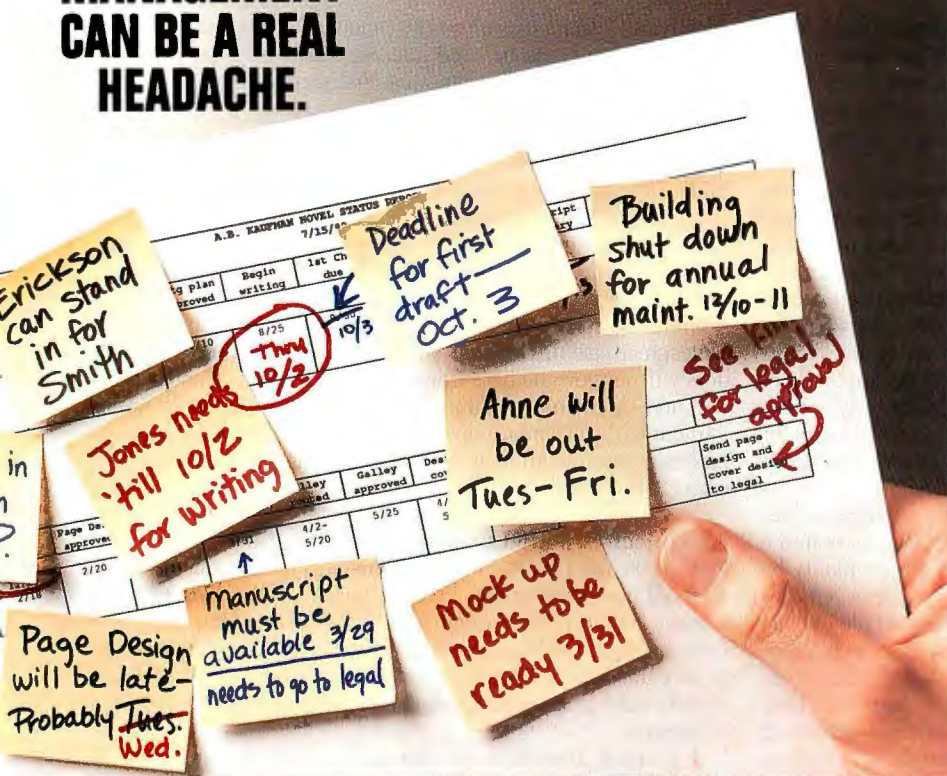
components. A great example today is the Pinnacle Graphics Server from Pinnacle Publishing (Kent, WA), a DLL that several popular Windows databases use to graph data. Another is Tools & Techniques' (Austin, TX) Data Junction, a universal file-format converter.

IAC's Different Tack

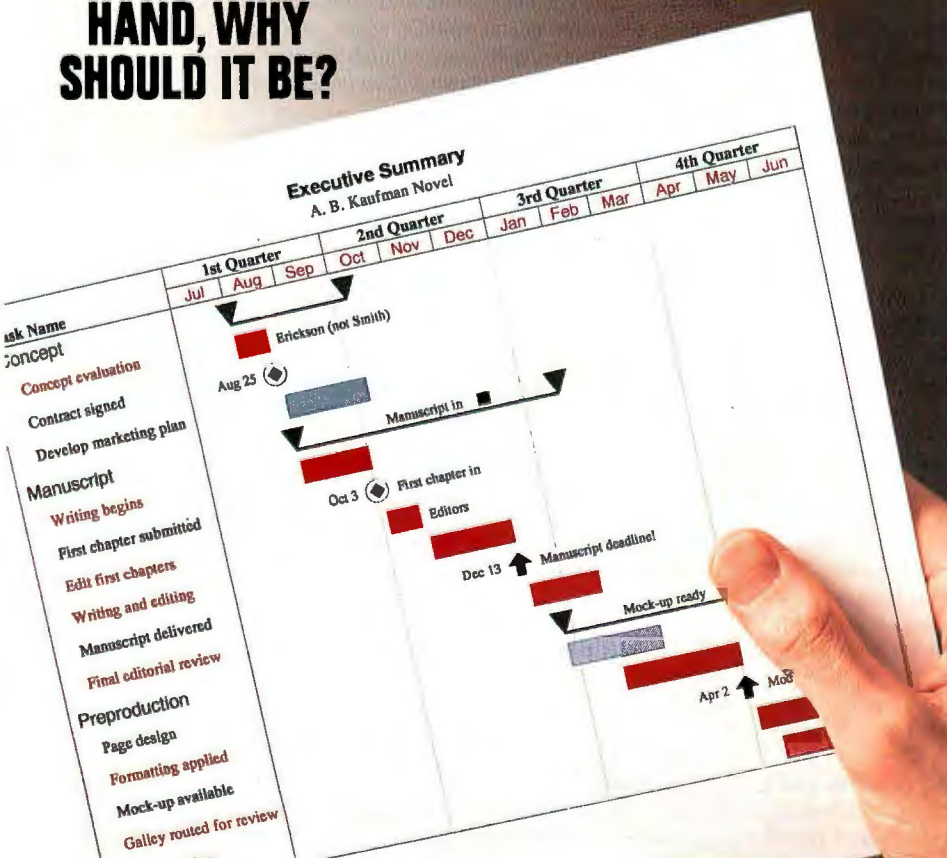
OLE defines an API that programmers use to implement communication services. Users implement OLE services by writing the appropriate function calls. IAC takes a different tack: A Mac application requesting a service first generates an Apple Event.

continued

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The Apple Event gets passed to the Event Manager (the portion of the Mac OS that processes user events such as mouse-clicks, window updates, and keystrokes), which then routes the Apple Event to the recipient application. The target application then calls handler code to process and act on the message encapsulated within the Apple Event.

One interesting aspect of IAC is that while the communications mechanism is well defined and in place, the message structure isn't. This situation is similar to having radio sets but no Morse code by which to transmit information. This wasn't an oversight on Apple's part: The idea was to encourage vendors to cooperate and define classes of actions, or *verbs*, that applications will respond to and to define their format. Apple defines a set of *core events* that all applications must respond to: open application, open a document, print a document, and quit. Currently, a 500-page Apple Event Registry document describes suites of verbs for QuickDraw, text, tables, and database events. Other event suites are still under development.

Apple Event verbs might request operations as simple as selecting a menu item or as complex as dropping numbers into a row of spreadsheet cells. Mac applications will ultimately be redesigned, or *factored*, so that the event-driven interface is decoupled from its code and communicates only via Apple Events. This allows you to automate a job by using AppleScript to monitor the chain of events that occur as you work. AppleScript records these events into a script file and can play them back later to repeat the task just executed. AppleScript can also serve as a useful intermediary on complex jobs. For example, it can query several different databases (on several networked computers) for information and then have a word processor consolidate the results into a single document.

Aldus Takes the First Step

Even assuming that vendors will agree on IAC verbs or implement OLE function calls, there's a significant problem in this divide-and-conquer scenario: Why should vendors bother? In a market populated by several species of spreadsheets, drawing packages, word processors, database managers, and so on, a vendor differentiates its product from the others by pitching its unique capabilities or feature set. Reducing an application to just its basic capabilities and then offering these capabilities to any other application that happens to call it might not prove to be a marketable concept.

Aldus has taken the first step in this area. In April the company will announce a version of Persuasion for both PCs and Macs that breaks its charting engine out into a single-purpose, stand-alone application, or *applet*. This charting applet will act as an OLE server and use OLE 1.0 on both platforms to provide finished charts to those applications that request its services. (Microsoft currently provides software that implements the OLE protocol only on the Mac.)

You'll have to purchase Persuasion to obtain the charting applet, but once you do, its services are available to all applications that act as OLE clients. The charting applet understands Persuasion's layout, so it can maintain the format and layer control of Persuasion documents when it generates a chart. Private messages allow Persuasion and the charting applet to relay color information back and forth while you work on a graph. What all this means is that you will get better coupling between Persuasion and the charting applet than you would get with other applications.

This implementation of Aldus's charting applet seems like a reasonable compromise in exploring how to market a server application without giving away the crown jewels. It also points out two divergent futures that OLE and IAC can make possible.

Ideally, all vendors would write practical client and server applications that could be used interchangeably. You would then be free to select whatever applications you prefer to get the job done.

However, it's also likely that vendors will use private OLE messages or IAC verbs that allow their own applications to communicate extensively with one another, while talking poorly—if at all—with applications from other vendors. In this scenario, you'd have to purchase one vendor's suite of applications to fully use the features of all of them.

The latter scenario is likely, according to InfoCorp's Higgs. "Neither technical nor marketing realities in the industry make the widespread use of modular software practical," he says. Vendors will support the bare-bones communications standards but will add extensions to them. Higgs cites Unix as an example. Although it's a standard operating system, numerous variations of it exist because different vendors supply custom features or their own GUI.

An Object-Oriented Future

Perhaps the most promising development is the coming of object-oriented operating systems (see "Objects for End Users," December 1992 BYTE). The upcoming Taligent operating system from Apple and IBM, along with Cairo from Microsoft, promises to save unnecessary code by providing the user with a series of objects that can be purchased, enhanced, and linked together as necessary.

A preview of what these object-oriented operating systems will be like is provided by Oberon, a new operating system and language developed by the designer of Pascal, Professor Niklaus Wirth at the Eidgenössische Technische Hochschule in Zurich, Switzerland. According to Wirth, today's software has become grossly oversized, inefficient, and potentially unreliable. Versions of Oberon that run on PCs, Macs, Sun Sparcstations, and IBM RISC System/6000s are available now. [Editor's note: A *more in-depth look at Oberon will appear in an upcoming issue of BYTE.*]

Wirth's solution is extensibility. Using the Oberon programming language, users can enhance and customize a simple tool, such as a text editor, for particular applications. These customized versions would save space because they use the same underlying basic text-editor code.

Another important feature of Oberon is the way that it allows data to be viewed. Oberon has viewers that you can use to display documents. Documents consist of text and graphics and contain commands that change the document's contents. When a change occurs, the document sends a message to all viewers so that they can update their views of it. This separation of document and viewer allows users to create new types of documents and viewers without duplicating any of the operating system's existing code.

Although Oberon is a complete GUI-based operating system with its own compiler and text-editor functionality, the PC version takes up only 1.5 MB of RAM, including source code. In contrast, Windows 3.1 consumes 9 MB. ■

Editor's note: *BYTE* senior editors Gene Smarte and Tom Halfhill and news editors Pat Waurzyniak and Dave Andrews also contributed to this article.

Ed Perratore is a BYTE news editor. Tom Thompson and Jon Udell are BYTE senior technical editors at large. Rich Malloy is a BYTE executive editor. They can be contacted on BIX as "eperratore," "tom_thompson," "judell," and "rmalloy," respectively.



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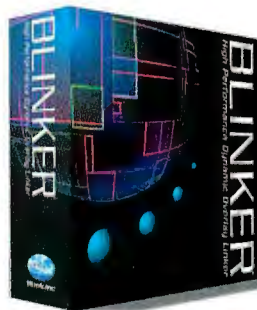
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Putting Fuzzy Logic into Focus

When dealing with ambiguous data,
desktop fuzzy-logic applications deliver precise results

JANET J. BARRON

Fuzzy logic has long excelled at delivering exact results from imprecise or ambiguous information, and its primary use has been in embedded controllers. Now fuzzy logic is entering the mainstream with a wide range of desktop applications.

Apronix's (San Jose, CA) FIDE (Fuzzy Inference Development Environment) lets you develop fuzzy-logic-based applications. It runs under Windows on 386/486 machines and costs \$1495. FIDE includes a fuzzy inference language, a fuzzy-system standard environment, a graphics editor (with which to draw graphs of membership functions), debugging tools, and a real-time code generator.

Another company, FuziWare (Knoxville, TN), makes several products, including FuziCalc for Windows, FuziQuote, FuziCell, FuziChoice, and FuziCost. These products are used as management decision-support systems for custom, turnkey, and off-the-shelf applications, as well as software techniques to implement both fuzzy logic and fuzzy math.

FuziWare's forecasting, estimating, and modeling software—FuziCalc for Windows—sells for \$995. Using it, you can make decisions based on complicated combinations of hard (well-understood) and soft (fuzzy) factors. It produces answers that are mathematically verifiable and easy for people new to the field to model and interpret. FuziWare claims that if you have an appropriate application, you can improve your productivity some 30-fold.

Other vendors of fuzzy-logic products include the following: Motorola (Austin, TX), Omron (Kyoto, Japan), Togai Infralogic (Irvine, CA), National Semiconductor (Santa Clara, CA), HyperLogic (Escondido, CA), and NeuraLogix (Sanford, FL).

Even though fuzzy logic is used worldwide, it is most popular in Japan (see the text box "Jap-

anese Leaders in Fuzzy Logic" on page 116). Its acceptance outside Japan has been slow—some people blame the name itself, which Lotfi A. Zadeh (developer of the field and currently professor emeritus of electrical engineering at the University of California, Berkeley) chose to call the technique.

Using Fuzzy Logic

Fuzzy logic is a multivalued logic that allows for degrees (e.g., normal versus slow or fast) of set membership—a more practical way to deal with the issues you face in the real world. Unlike binary (yes or no) information, fuzzy logic emulates your ability to reason and make use of approximate



Fuzzy-Logic Glossary

At first glance, the words pertaining to the technology of fuzzy logic often seem fuzzy; however, with a few clues, you'll find them straightforward.

crisp logic Another name for traditional logic to differentiate it from fuzzy logic. In crisp logic, the three logic operations AND, OR, and NOT return either a 1 or a 0.

crisp set The traditional definition of a set in classical or symbolic logic. Traditional or crisp sets have strict membership criteria in which an object is either completely included or excluded from the set. They are mathematical sets with definitive boundary points (e.g., 400°F is hot; -400°F is cold).

defuzzification A process in which fuzzy output is converted into crisp, numerical results.

fuzzification The process of fuzzifying an element by combining actual values (e.g., the temperature of a liquid) with stored membership functions to produce fuzzy input values.

fuzziness A term that expresses the ambiguity that can be found in the definition of a concept or the meaning of a word or phrase. The terms *high temperature* or *very soft* qualify as fuzzy.

fuzzy logic The process of solving problems that deal with ambiguous data (e.g., that in the real world) using a multivalued logic to represent a crisp-logic system. Fuzzy logic holds that all things are a matter of degree (e.g., warm versus cold or hot). In fuzzy logic, the three logic operations AND, OR, and NOT return a degree of membership that is a number between 0 and 1.

fuzzy set A nontraditional type of set that allows an element to have gradual or partial degrees of membership. In fuzzy logic, the traditional Boolean values of true and false (1 and 0) are replaced by continuous-set membership values ranging from 0 to 1.

fuzzy inference The process of using the degree of truth in production rule premises to select an appropriate rule to execute.

genetic algorithm A process for optimizing the suitability of a function to some observations.

membership The degree of inclusion in a set. Fuzzy sets have values between 0 and 1 that indicate the degree to which an element has membership in the set. At 0, the element has no membership; at 1, it has full membership.

set A collection of objects.

data to find precise solutions.

Among fuzzy logic's benefits are fault tolerance and the ability to provide accurate responses to ambiguous data. According to David Brubaker, president of the fuzzy-logic and embedded-systems consulting firm Huntington Group (Menlo Park, CA), products designed with fuzzy logic have simpler controls, are easier to build and test, and provide smoother control than those using conventional systems.

The largest commercial uses for fuzzy logic are as controllers for tasks such as managing temperatures and energy efficiency in heating and cooling devices and regulating timing and fuel flow in automobile engines. Controllers also are used to make constant operating adjustments to subway trains, home appliances, cameras, and elevators.

In the next few years, fuzzy logic will enter domains such as computer chips, computer graphics, software development, financial planning, information processing, sales analysis, speech recognition, machine vision, and character recognition (see the text box "Fuzzy-Logic Applications" on page 114). It will improve speed, maintenance, extendability, and efficiency. Ac-

cording to Earl Cox, CEO of the Metus Systems Group (Chapqua, NY), a fuzzy-logic and fuzzy-neural network consulting organization, the use of fuzzy logic can dramatically reduce product development times for a range of embedded control applications from the idea to the prototype stage.

Cox cites an example of a fuzzy-logic application that he developed for a bank. The application runs on PCs with Windows 3.1 and Excel, and it analyzes and rates the complexity of a software development project. This program takes into consideration function point, code density, and the total operational interface.

The application calculates complexity indicators in software, such as the number of IF...THEN...ELSE statements, nested IF...THEN...ELSE statements, GO TOs, and comments. You use these rough figures to calculate ratios and statistical measures and feed them into a fuzzy-evaluation model.

Previous attempts to measure complexity relied on sharp boundaries between what is and what is not complex. The fuzzy approach more closely models the way that managers think in degrees such as somewhat, moderately, and highly complex.

continued

FUZZY-LOGIC ADVANTAGES

- requires no complex mathematical constructs
- uses natural language
- is easy to set up
- provides accurate results
- works well in tandem with other techniques

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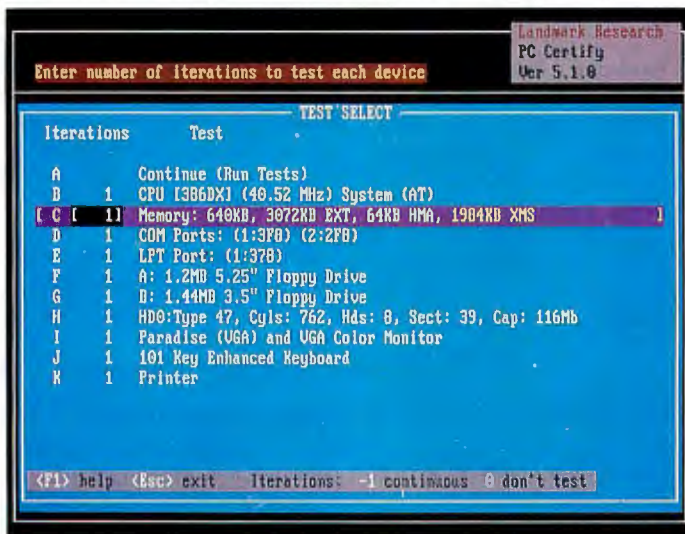
COM (1, 2, 3, 4), LPT (1, 2, 3, 4), internal loopback, identifies addresses.

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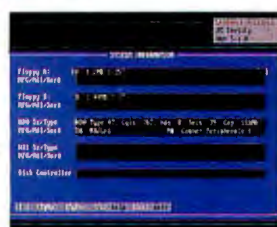
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Fuzzy-Logic Applications

Currently, fuzzy logic is most often used for controllers; however, the technology is finding its way into other applications.

computers—embedded computers, chips, sensors, signal processing, data/information processing, software development, and speech recognition

transportation—automobile components (e.g., transmissions and braking systems)

military—aerospace

industrial—robotics, pattern recognition, and machine vision

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Listing 1: *Overlapping membership ranges often used in fuzzy-logic applications. A mock traffic-control system could use fuzzy rules to control the main artery traffic in a city. A speed of 10 miles per hour might be assigned to both the Sluggish as well as the Moderate category. The actual value for green-light time is derived from the combination of several rules executing.*

Problem:

IF main artery traffic is blocked
THEN traffic-light sequence is probably inadequate

Solution:

IF traffic is blocked
THEN increase main artery green-light time

Fuzzy rules:

IF traffic flow is Sluggish
THEN green-light time is Long
IF traffic flow is Moderate
THEN green-light time is Extended
IF traffic flow is Normal
THEN green-light time is Normal
IF traffic flow is Fast
THEN green-light time is Reduced
IF traffic flow is Maximum
THEN green-light time is Restricted

Crisp vs. Fuzzy

The concept of crisp sets comes from traditional, or classical, logic (see the glossary on page 112). Crisp sets have rigid membership requirements where every object is either completely included or excluded from a set. In contrast to this true or false scenario, fuzzy sets allow for continuous-set membership values ranging from 0 to 1.

Bart Kosko, professor of electrical engineering at the University of Southern California, says, in his book *Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence* (Prentice Hall, 1991), this type of multivalued logic was first explored some 60 years ago by Jan Lukasiewicz, a Polish logician who also defined reverse Polish notation. Max Black, a quantum philosopher, furthered Lukasiewicz's work and created the beginning of what people now think of as fuzzy-set membership functions.

In the early 1960s, Zadeh enhanced the original research. He subsequently developed what people know as fuzzy-set theory, introducing the term *fuzzy* into our language to deal with what Black had referred to as *vagueness*. In 1965, Zadeh published a seminal paper on the subject, entitled *Fuzzy Sets*.

A Fuzzy-Logic Model

The fuzzy-logic procedure consists of analyzing and defining your problem, creating your sets and logical relationships, converting your information to what are called fuzzy sets, and interpreting your model (see listing 1). You can use a number of criteria to determine whether a fuzzy-logic approach would lend itself to solving your specific problem. These prerequisites include the level of ambiguity of the data (determined mathematically) and the required accuracy of the output.

To use a fuzzy-logic model, you would

- analyze your problem, making sure you understand it fully;
- define your problem by identifying your membership functions (i.e., the degree of inclusion in your prescribed sets);
- convert the language of the problem into a rule;
- set up an appropriate procedure for fuzzifying and processing the problem;
- learn to interpret the model and evaluate your results; and
- fine-tune the results if they are inappropriate or unsuitable.

Before you perform your calculations and build your model, you should make sure that a fuzzy model is an appropriate way to deal with your problem. If another model would be more suitable, you will find that you can't understand or evaluate your results.

Why Fuzzy Logic?

You can set up a fuzzy system for the same purpose you set up any other computing system—to map inputs to outputs. Basically, it consists of three stages: fuzzification, rule evaluation, and defuzzification.

Fuzzification is a process that combines actual values (e.g., barometric pressure) with stored membership-function data to produce fuzzy input values. Rule evaluation, or fuzzy inferencing, is a way of producing numeric responses from linguistic rules based on system input values. In the last stage—defuzzification—a fuzzy system combines all its outputs and obtains a representative number.

To see if this number solves the original problem and gives you an accurate answer in all cases, Fred Watkins, president of HyperLogic, a firm that produces fuzzy-logic development tools, says it's necessary to come up with a performance measure (theoretically, an ideal correct response). You can then run the engine

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Japanese Leaders in Fuzzy Logic

JEFFREY D. SHEPARD

The Japanese recognized the potential of fuzzy logic more quickly than people in other parts of the world. One of the reasons for the explosion of fuzzy-logic applications in Japan was the success of Japan's Sendai automated railway system.

When it opened in 1987, the Sendai Metro used a Hitachi fuzzy control system. An earlier study by Hitachi had shown that a fuzzy control system was superior to a conventional one in a number of ways—increased accuracy in stopping at a platform, greater rider comfort (smoother acceleration and braking), and lower electric power usage. The performance of the Sendai system was so impressive that within 12 months, over 50 Japanese companies were working to develop fuzzy-logic technology.

The result has been the application of fuzzy technology by Japanese companies in a wide range of products, including computers, cameras, automobiles, and home appliances. In 1991, Japan captured nearly 80 percent of the several-billion-dollar-per-year world market for fuzzy logic, according to Market Intelligence Research (Mountain View, CA).

Computers Will Benefit

The Japanese are setting their sights on the application of fuzzy techniques to produce future generations of high-performance personal computers and workstations. The advent of more powerful personal computers and workstations has created a demand for faster seek times in hard drives. The seek time is limited by the performance of the ac-

tuator moving the head, as well as by the control method.

A fuzzy-logic algorithm has been applied to a controller for a 3½-inch hard drive, improving seek times by about 20 percent to 30 percent over that of conventional controllers. The algorithm was developed at the Information Equipment Research Laboratory of Matsushita Electric Industrial (Osaka, Japan).

Someday, you may even find fuzzy logic regulating the output voltage of the switching power supply in your new personal computer or workstation. A team from Kumamoto University and Kumamoto National College of Technology (Kumamoto, Japan) has developed a new control system using fuzzy logic. The group implemented this experimental fuzzy controller in software on a personal computer.

OKI Electric Industry (Tokyo) recently introduced a new fuzzy-inference IC that is expected to improve the performance of fuzzy controllers by an order of magnitude and substantially reduce the controllers' cost. Another Japanese company, Omron (Kyoto), holds over 700 patents for fuzzy products and already offers a VLSI fuzzy-controller IC. These chips represent second-generation designs.

Other Projects

The Laboratory for International Fuzzy Engineering Research (LIFE), a six-year project of the Ministry of International Trade and Industry, is developing future fuzzy-logic applications in decision support, robotics, and fuzzy computing (including fuzzy associative

memories). At the independently funded Japanese Fuzzy Logic Systems Institute in Iizuka, a fuzzy neuron has been used in an experimental handwriting-recognition system.

A fuzzy neuron is analogous to the neuron in neural computing except that it takes fuzzy sets as inputs and yields a fuzzy set as an output. A number of people in the Japanese research community expect neural and fuzzy technologies to complement each other and to evolve together into a "neuro-fuzzy" technology.

A team at the Hiroshima Institute of Technology has demonstrated an optical fuzzy-inference device. In this case, light passes through translucent plates on which are inscribed the membership functions of fuzzy sets representing a rule's premises, and the amount of light emitted is measured to derive the rule's conclusion. Fuzzy optical computing could provide real-time recognition of moving images.

LIFE has developed a fuzzy flip-flop circuit. Currently, a study is under way to define the architecture of a fuzzy-logic-based workstation. The machine is expected to embody both fuzzy (multilevel) and classical (binary) processing in the same architecture. You would use the machine to tackle problems such as natural language and image understanding—applications that are difficult to implement with conventional personal computers and workstations.

Jeffrey D. Shepard is a freelance writer living in Norco, California. You can contact him on BIX c/o "editors."

in a variety of contexts. If the number doesn't turn out to be a good solution, you tune the system parameters until you reach a satisfactory conclusion. Even as the rules of a fuzzy engine become more complex, says Watkins, the general concepts remain the same.

According to Emdad Khan, manager of fuzzy and neural networks for the Embedded Systems Division of National Semiconductor, you can construct a PC-based fuzzy-logic system (e.g., to use in a simple management project) using software alone. However, general-purpose or dedicated microprocessors

are available for more complicated applications (see the figure).

Cross-Fertilization

Fuzzy logic, neural networks, expert systems, genetic algorithms, and OOP (object-oriented programming) are some of the ways of efficiently handling problems that are rife with ambiguity, although each method handles uncertainty differently. If you use a blend of these technologies, the results are sometimes more than the sum of their parts.

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According to Khan, combining both fuzzy logic and neural networks results in a synergy that improves speed, fault tolerance, and adaptiveness. A neural network can convert knowledge into fuzzy rules and membership functions, and fuzzy logic can optimize the number of rules that the neural network learns.

NeuraLogix's senior software engineer David Ratti says, "In tandem, you gain fuzzy logic's ability to deal with inexact measurements and input data, and a neural network's ability to learn." The fuzzy approach assumes a priori knowledge and leverages it without the significant training times of neural networks. In and of themselves, fuzzy systems aren't adaptive, he says, but neural networks are. By observing what the fuzzy system does, the neural network can adjust the parameters of a fuzzy system and can tune it.

You might want to build a fuzzy system using an expert system if you need a simple method for encoding nonlinear data, such as market forecasts or the financial stability of an organization. Fuzzy expert systems can handle both incoming and already computed information in either a crisp or fuzzy format. They perform well at relatively high speeds on conventional computers and specialized hardware. This type of combination system produces results similar to the way humans intuitively handle most kinds of real-world problems.

Huntington Group's Brubaker says that most fuzzy systems are rule-based, but the rules in a fuzzy expert system execute to different degrees. "Rather than an all-or-nothing response," he says, "the fuzzy rules produce 'shades of gray' responses depending on the degree of belief in the premise of each rule."

Several efficient fuzzy systems have been created using genetic algorithms. Metus's Cox says that combining these technologies provides a good way to address difficult and often intractable problems. It also offers one of the best techniques to handle nonlinear problems that are normally addressed by statistics and advanced mathematical models.

Ralph Wiggins, president of Ryan, a data-analysis consultancy based in Hartford, Connecticut, began using fuzzy logic two years ago. In combination with genetic algorithms, he found the technology a valuable way to handle applications such as financial forecasting and abstractions for data interpretation or machine learning. When performing machine learning, for instance, Wiggins found that the use of fuzzy logic greatly simplified the ways of representing data; thus, he was able to find solutions to problems that had previously defied analysis.

The blend of fuzzy logic and object orientation has proponents and opponents. "You can build a fuzzy system using object-orientation technology where rules are objects," says HyperLogic's Watkins, "but it isn't necessary to use these two technologies together."

In a combination fuzzy-logic, object-orientation system, objects themselves can be fuzzy. A given object can have only partial (a degree of) membership in its class. Wiggins says to solve very complex problems, a fuzzy-logic/object-oriented system might be the answer.

Nonuniversal Acceptance

Cox says that fuzzy sets are easy to design, build, validate, and tweak, and for several reasons, such as their fault tolerance and capabilities for parallelism, they are extremely robust. But some people are unwilling to use fuzzy-logic systems because they believe that creating, verifying, and refining them is too difficult, or that the systems are unstable.

While Ed Katz, a member of the technical staff at Hewlett-Packard Laboratories Division (Palo Alto, CA), is a proponent and user of fuzzy logic, especially in the noncontroller domain, he says

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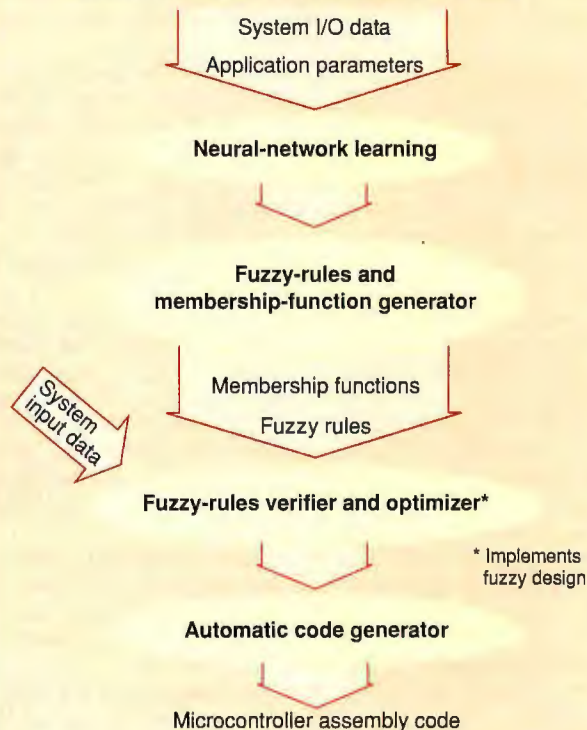
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FUZZY LOGIC

COMBINATION FUZZY-LOGIC/NEURAL-NETWORK SYSTEM



National Semiconductor's NeuFuz system combines fuzzy logic and neural networks, which learn the system behavior based on I/O data, and a rules generator, which creates fuzzy rules and membership functions based on the neural-network learning process. A fuzzy-rule verifier validates and optimizes the number of generated rules and functions. Finally, an automatic code generator converts these rules and functions into an embedded controller's assembly code.

that there are trade-offs to the technology. One problem lies in the area of refining your membership functions. No procedure exists for determining what a membership function looks like or for adjusting it, he says.

One issue being debated is whether fuzzy models provide ambiguous or accurate results. According to Cox and others, the use of fuzzy logic offers the same kind of deterministic results that you can expect from many other conventional systems. Cox says, "Boolean logic is to fuzzy logic as a light switch is to a dimmer switch."

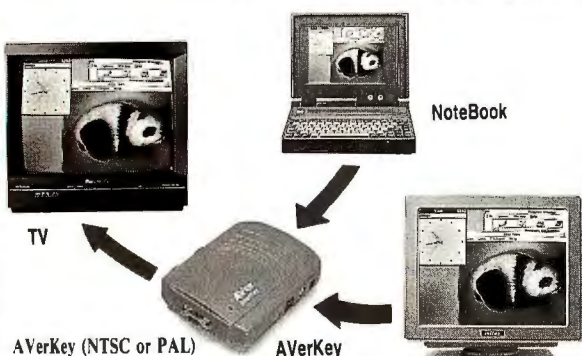
Problems in the real world are imprecise. You seldom can solve them with either a yes or no. Fuzzy logic dramatically improves people's knowledge-modeling capabilities in vague areas such as economics or behavioral science. According to Cox, "[it] brings the way a computer reasons closer to the way that people think." ■

ACKNOWLEDGMENT

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Janet J. Barron is a BYTE technical editor. You can reach her on BIX as "neural" or on the Internet at neural@bytepb.byte.com.

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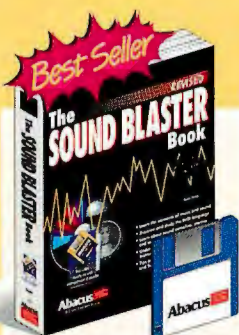
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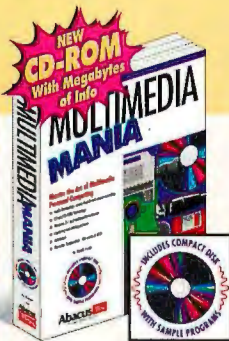
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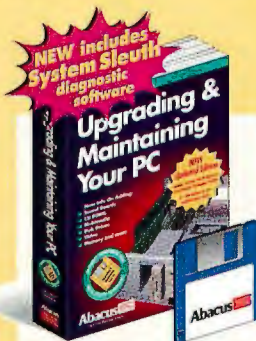
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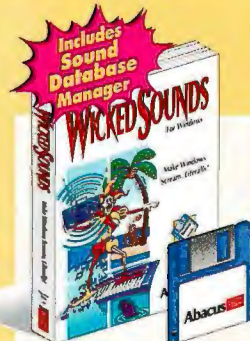
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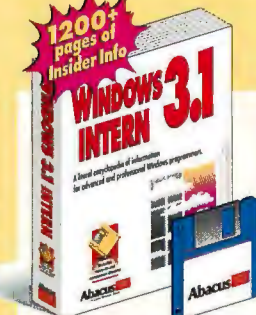


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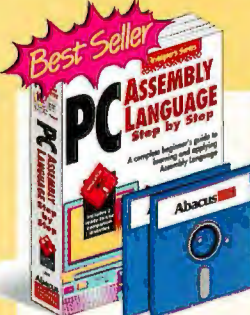
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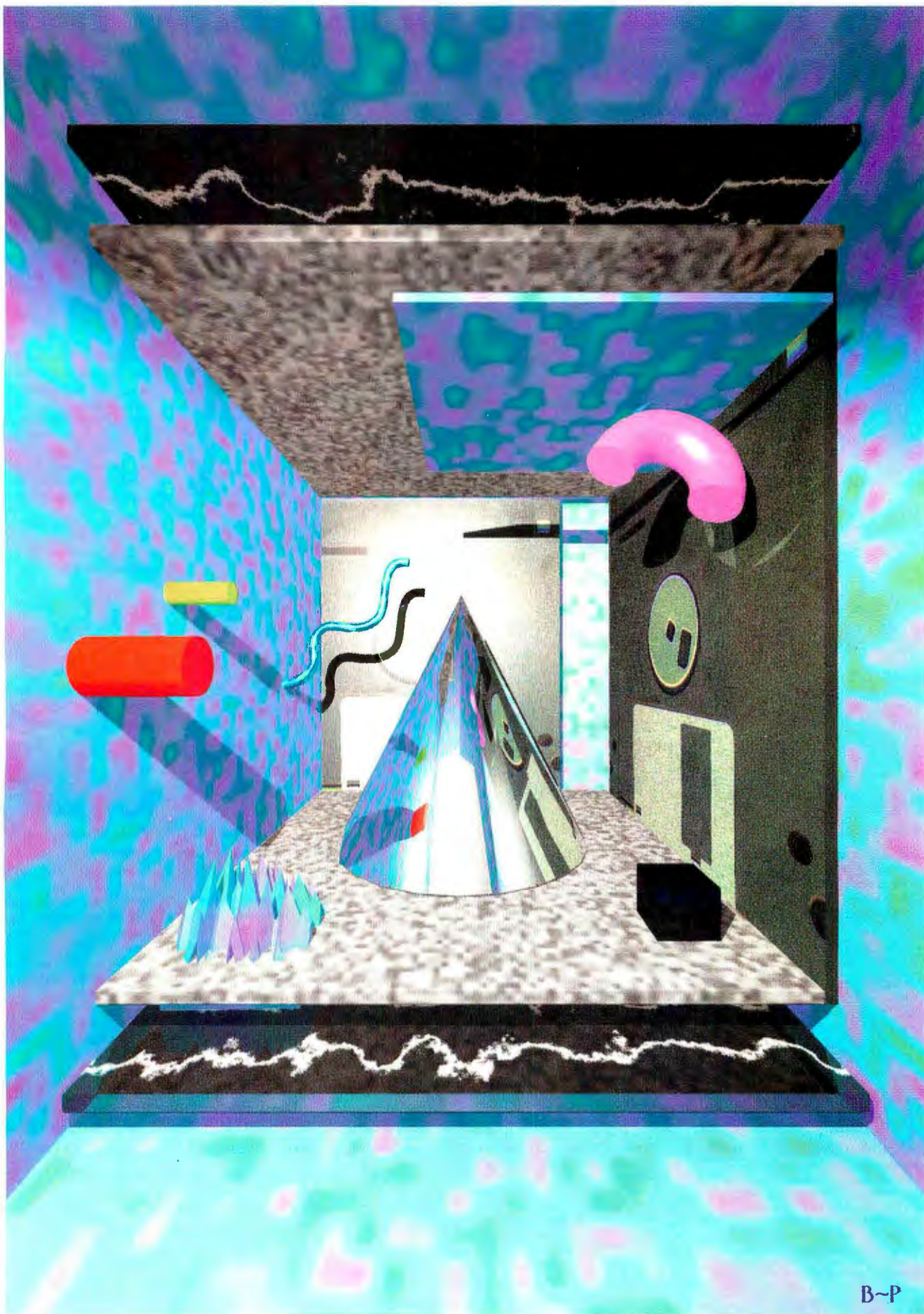
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VISUALIZATION: SEEING IS BELIEVING

Grasp and analyze the meaning of your data by displaying it graphically

JACK WEBER

Imagine a Wall Street scene. People shout, screens scroll, and adrenaline flows. But one broker stares intently at a computer screen showing what appears to be a field of wheat waving gently in the breeze. Bizarre? Yes, but real.

This image is one example of a growing force in computer applications called *data visualization*. When information overload means that you can't see the forest for the trees, visualization offers a way of identifying and analyzing the underlying patterns in data. For example, convert the prices of individual stocks into the motion of vertical stalks, plant several hundred of them on a computer screen, and watch as market trends are revealed in the shimmering crop before you. It's called Biz Viz.

Data visualization is about comprehension, not graphics. Think of it as a range of techniques that enable you to display abstract numerical data and statistics in graphical form.

After all, you comprehend information most intuitively through your visual senses. With half the neurons in the brain dedicated to visual processing, images provide the greatest mental bandwidth. Thus, by offering a picture of the data and its internal relationships, visualization makes it easier for you to understand information that's too complex to perceive numerically.

New techniques bring new possibilities. Scientists use visualization to analyze the results of experiments in fields as far-flung as pollution studies, semiconductor physics, and drug design. In engineering, visualization can provide rapid solutions in design, development, and production planning. Civic and voluntary organizations can use visualization to obtain demographic data. And in business, the use of visualization techniques can reveal buying patterns, sales penetration, or investment returns. Investors can benefit from visualization's ability to explain performance rather than just track it. The advantages of sharper financial analysis or faster product prototyping are increasingly important (see the text box "Visualization Applications" on page 126).

Tim Bartel, a researcher at Sandia National Laboratories

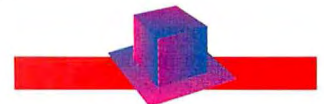
(Albuquerque, NM), is using visualization to develop a boat that the U.S. Coast Guard can safely drop into the water, complete with crew, from a helicopter. He's using Tecplot software from Amtec Engineering (Bellevue, WA) on both PCs and Unix systems to animate the boat hitting the water, submerging, and resurfacing. "Without this kind of visualization tool," Bartel says, "the task of analyzing the huge amounts of data from the simulation would be almost impossible."

Until recently, only super-computer users had access to visualization's full potential. Now anyone with a PC or a Mac can produce sophisticated and meaningful visualizations with off-the-shelf software (see screen 1).

Visualize This

Many elements combine to make up data visualization technology. Among them are animation (rapidly changing still images used to create the illusion of movement), 3-D graphics (an illusion of depth produced by using perspective), and rendering (computer images created to represent the surfaces of 3-D objects, complete with shading and texture).

Visualization is often used in conjunction with simulation, but there is an important distinction between the two. Simulation is any technique that allows you to mathematically



Visualization: Seeing Is Believing

BY JACK WEBER

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Navigating the Data Flood

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Image Building

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The Difficulty with Data

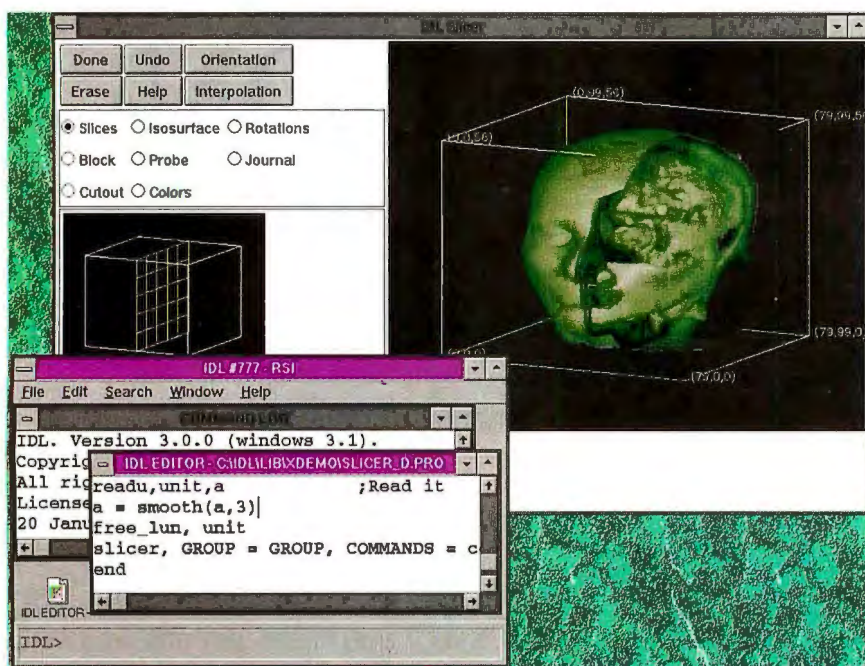
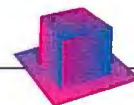
BY NAHUM GERSHON AND JEFF DOZIER

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Screen 1: A sophisticated 3-D visualization produced with IDL (Interactive Data Language) for Windows from Research Systems (Boulder, CO). In this example, the data comes from a magnetic-resonance scanner, but such cutaway 3-D images are used in many areas of engineering and science.

model the behavior of a physical or abstract system in such a way that you can analyze the response of the system (e.g., Flight Simulator). The results of a simulation are usually numerical rather than graphical and often are fed into a visualization environment to obtain graphical representations in various dimensions.

A simulation must be valid and correct in its own right, but the choice of a visualization technique will vary according to the purpose of the job. Visualization can reveal flaws in a simulation model that were invisible in the numerical output, and it can guide the development of the model as well as the analysis of the results.

Systems You Can Use

A small proportion of the most demanding visualization is performed on dedicated machines, such as the Princeton Engine, developed at the David Sarnoff Research Center (Princeton, NJ). This supercomputer is a scalable parallel machine, with up to 2048 processors, that was designed for fast graphics processing and visualization.

But many users want to do visualization on the machines they have at hand, and they can do so. According to Mike Peery, president of Amtec, 35 percent of his company's customers use PCs. The rest use workstations because that's what they have on their desks.

Whether you use a Mac, a PC, or a workstation, the main requirements for visualization are fast math-processing capabilities and high-quality graphics (see "Image Building" on page 137). To perform most kinds of visualization, all you need is a 25-MHz 386 or 486 PC with VGA graphics or a Mac IIvx. The more powerful the machine, the more sophisticated the visualization application can be. If you plan to add animation, you may want a video output card so that you can dump sequences to videotape.

The Right Software

Choosing the right visualization software is a challenge. You can perform modest data visualization with almost any popular spreadsheet, but spreadsheet charts are usually restricted to 2-D data sets and offer few options.

Statistical programs provide a step up

Visualization Benefits

- analyze numerical data graphically
- view data multidimensionally
- comprehend complex information more easily

in functionality. Products such as Systat from Systat, Inc. (Evanston, IL), or Statistica from Statsoft (Tulsa, OK) give you a wider range of charting options and make it easier to display 3-D data sets than to do spreadsheets. Beyond this category, you encounter the dedicated visualization packages, which offer access to more specialized techniques.

An example of a specialized technique often used in financial visualization is *heat-mapping*. This procedure produces a surface plot in which you use height and color to represent different variables. For instance, the height of any point on the plot can represent the price of a stock, and a color can represent the age of the data—current information can be red, and more dated values can cool off toward blue (see screen 2). The technique is simple but not readily available outside of dedicated visualization software.

Many aspects of visualization software are changing. One trend is toward graphical interfaces and visual programming (see "Navigating the Data Flood" on page 129). Most high-end visualization products are specialized programming languages, and many are moving to icon-based techniques that make it possible for you to customize the software.

The Application Visualization System from Advanced Visual Systems (Waltham, MA), the Iris Explorer from Silicon Graphics (Mountain View, CA), and the Data Explorer from IBM (Hawthorne, NY) offer visual programming for assembling program modules. Some products, such as PV-Wave from Precision Visuals (Boulder, CO), are available in two formats—a command-language version and a point-and-click version.

At this most advanced level are workstation programs that offer animation, transparency, cross-sectioning, and real-time visualization of multidimensional data sets. But you can carry out some of these techniques on more humble hardware.

Doing animation on PCs is possible, says Robert Simons, president of CoHort Software (Berkeley, CA), but you must compress the data when it's first loaded and use two pages of video RAM. His company's CoVis software performs real-time, animated visualization on a PC. The software draws each frame to the off-screen page and swaps pages.

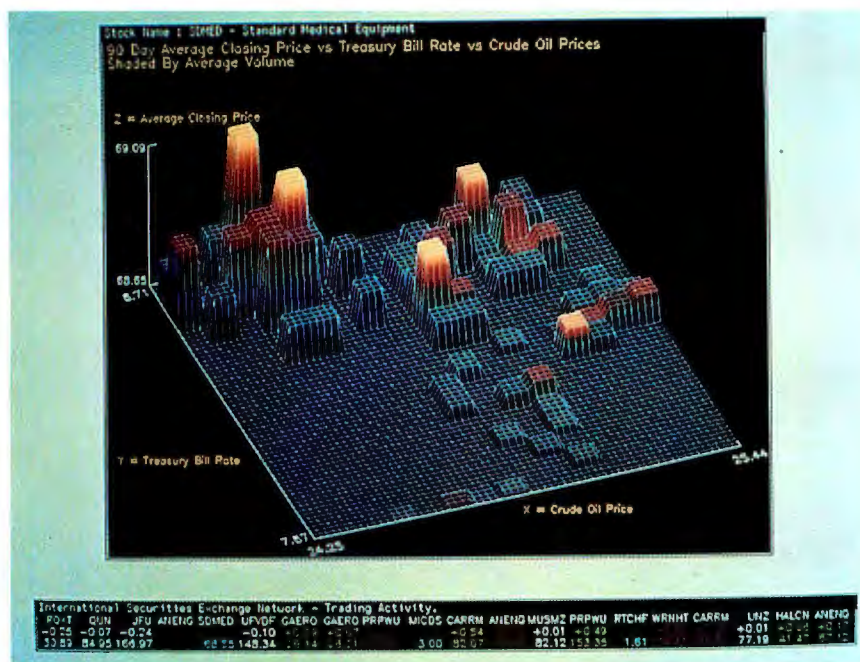
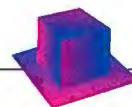
The price you pay for the real-time action is the loss of options such as logarithmic axes and hidden-line removal. On the other hand, a program such as Mathematica from Wolfram Research (Champaign, IL) creates and stores all the frames in advance. Animations in Mathematica

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Screen 2: This real-time financial visualization in PV-Wave from Precision Visuals (Boulder, CO) uses heat-mapping. Shown are stock prices represented in a bar graph, with colors overlaid to indicate the age of the data. By using time and color in this way, you can display two additional dimensions of data.

can take longer to produce (depending on the clock speed of the machine and the amount of RAM that it has), but they impose almost no limits on the visual complexity of the result. For instance, you can fly through your data with full control over virtual lighting on the surfaces using a 386-based PC or a color Macintosh.

Applying the Technology

Two projects being carried out at the Georgia Institute of Technology's Graphics, Visualization, and Usability Center (Atlanta, GA) reveal the potential of visualization technology. John Stasko, an assistant professor of computer science at Georgia Tech, is using visualization to analyze algorithms and programming techniques. "We are trying to use animations to help researchers get a better understanding of very complex algorithms," he says. "These people often deal with large problems, and frequently, to conceptualize, they doodle—they draw pictures to get ideas." For example, Stasko's colleague Walter Rodriguez, an associate professor in the school of civil engineering, is working on the Construction Visualizer, a program to help contractors plan site layouts by visualizing the movements of materials, machines, and trucks as the project develops.

Even in the traditional field of scientific visualization, the range of applications

is expanding. Until now, many of the people performing this type of work used the paradigm of a spreadsheet or statistical charting program. But that's not the only way to look at numerical data. The National Research Council (Ottawa, Ontario, Canada) is using data from the flight recorder of a plane that crashed to produce an animated movie of the events that led to the accident. By adding information from radar and eyewitnesses, they can verify whether the witnesses were able to see what they reported in their accounts.

One application that is experiencing rapid growth is medical imaging. Stephen Pizer, a professor of computer science at the University of North Carolina at Chapel Hill, says that the need to interpret data from magnetic-resonance devices and CT (computer tomography) scanners has led to volume-rendering techniques that are used to visualize many types of 3-D data.

Financial visualization provides no physical objects to be modeled. In this field, you must identify abstract data patterns. Spreadsheets can provide numerical, or quantitative, information; however, that is no longer enough. "For me, visualization is there to gather and generate qualitative information," says a New England financial analyst. "I will see something [e.g., a stock market trend], and I'll immediately use the mathematics in Mathematica to analyze it. I can't perform that function

with Lotus 1-2-3."

Critical Challenges

A major issue in visualization is determining the most meaningful way of representing data. You can use color, texture, animation, stereoscopy, sound, and touch as part of your visualization toolkit. These elements aren't just gimmicks; they represent dimensions of your data.

One of the biggest hurdles to be faced in visualization is finding enough ways of representing multidimensional data (see the text box "Inside Multidimensional Data" on page 132). Although a simple line graph is drawn in two dimensions, mathematically the data is considered to be unidimensional because it has one independent variable. Similarly, 2-D data needs to be shown in three dimensions. You could plot it as a contour or surface graph using color or perspective to stand in for the third display dimension. Beyond that, you run out of simple graphing tricks. Animation can help; so can slicing the data or using transparency to reveal what lies inside an image. But the choice is much more difficult and subjective than with visualizations with fewer dimensions.

A typical example of 3-D data might be the results of a demographic survey showing how voting behavior across the country relates to age (one dimension for age, and two dimensions for geographical location). But that's hardly a complex example. Many sociological and business-oriented applications are more demanding. Scientists are developing ways of visualizing systems with more than 100 dimensions.

According to Mike Garrity, president of Jaguar Software (Winchester, MA), a company that develops visualization software, it's common to see financial data represented in five or seven dimensions (i.e., different variables). Some financial users are considering 50-dimensional data sets. Coping with such demands is one of the critical challenges facing the field of visualization in the near future.

Another hurdle faced in visualization is the need to establish standards (see "The Difficulty with Data" on page 143), which is a consequence of the downward migration of the software from supercomputers to workstations and PCs. Just like spreadsheets, off-the-shelf visualization products need to provide a wide range of import/export options. But unlike spreadsheets, these products have to deal with multidimensional data sets, handle data primitives that can't be represented on a regular grid, and output results in all kinds of graphics and video formats. You can implement these types of visualizations with some of the

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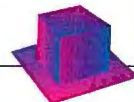
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Visualization Applications

MAXINE D. BROWN

Scientific visualization provides researchers with an invaluable tool for scientific insight and understanding. But this tool is more than just a visual representation of data that results from a computation; it's also a visual representation of data during a computation.

Using this methodology, you can distill huge amounts of numeric data into a single image or a series of images over time in animations. This capability is vital to scientific discovery and to the communication of those discoveries.

In recent years, a new generation of scientists and engineers has emerged that relies on the computer as its primary tool for discovery. These scientists and engineers develop mathematical models to simulate the behavior of the physical or theoretical worlds that they study. They work in numerical laboratories, which are environments with graphics workstations that may or may not be networked to supercomputers.

Scientific investigators, technologists, and visualization experts—commonly referred to as interdisciplinary teams—form close collaborations. These result in effective and reusable tools that are shared with scientists and engineers in other research areas.

Scientists have always posed the question "What if?" Today's computational researchers want to drive the discovery process and navigate, or steer, their calculations in near real-time. They want to interact with their data and further explore the many possibilities that their simulation models can forecast. When they change parameters, resolution, or color representation, they want to see the effects.

Shown here are visualizations in three fields: engineering, financial analysis, and science. In each case, you can read about the visualizers' goals and the data that he or she used to create the representations.

ENGINEERING FOR DESIGN

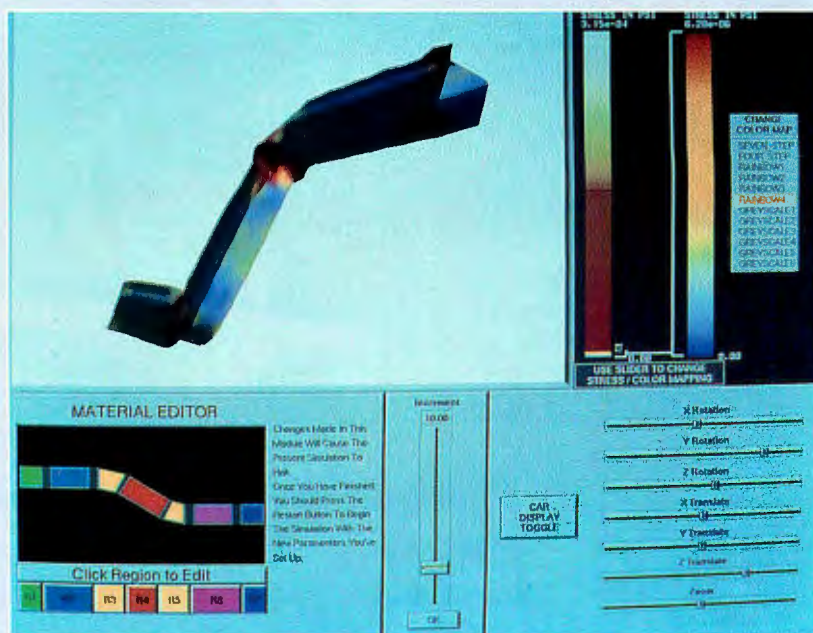
Until recently, the availability of commercial software for scientific analysis has been limited. But computer visualization technologists are developing the necessary tools to make the hardware and software more accessible.

Using computers, engineers can investigate the potential of new designs by dynamically altering and tuning simulation parameters. In addition, they can monitor the progress of a simulation and terminate poor design directions. Results of this type of research are paving the way for new, reusable scientific and engineering tools.

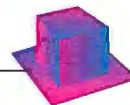
In the screen below, an engineer is using scientific visualization to optimize the design of a front-end automobile component from the perspectives of weight, cost, and manufacturability. From a local workstation, the engineer

can define the size and material properties of a structure and invoke a crash (i.e., impact) simulation running on a networked supercomputer. The engineer can then visually examine the resulting stress levels and modifications to the structure.

After a simulation has been executed, the engineer sees the resulting stress contour superimposed on the deformed component. Selecting a rainbow color map and a stress (force-per-unit area) range, where regions of high stress are red and regions of low stress are blue, the engineer notes that the bent areas, with high stress and extensive deformation, are critical sections. The engineer can move the structure around to study it from different vantage points or display the component in the context of the entire automobile.



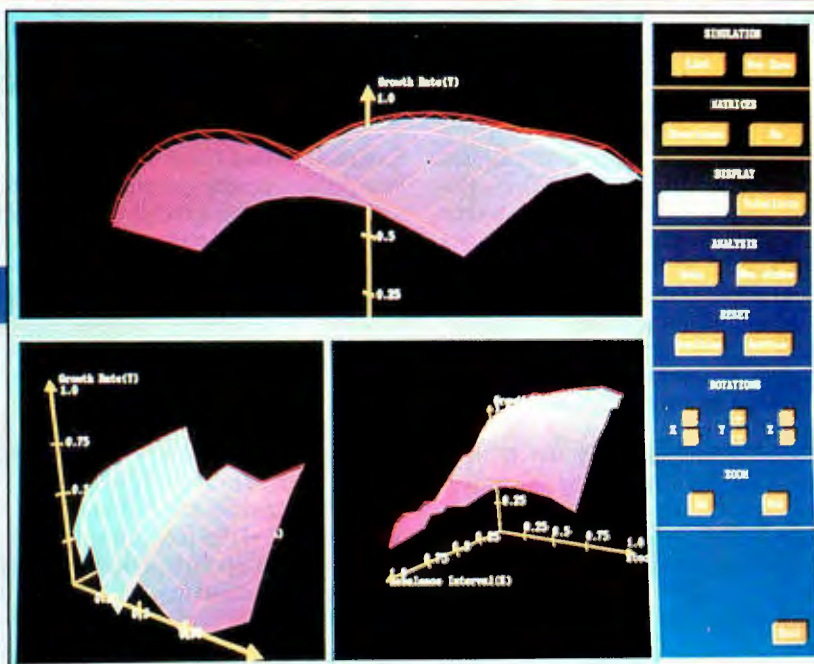
Front-end automobile component (Screen courtesy of Edward Plaskacz, Steve Karlovsky, and Fred Dech of the Argonne National Laboratory)



FINANCIAL ANALYSIS

A research analyst studying investment strategies can use financial models and visualization techniques to aid his or her analysis. In the portfolio management example in the screen on the right, an analyst investigates trading strategies and examines the resulting changes in the growth rate of a portfolio.

The financial analyst plays a number of what-if scenarios before deciding which strategy will make the most money for the client. In search of the optimal investment strategy, an analyst interactively defines the characteristics of a portfolio—the number of stocks, the percentage of each stock in the portfolio, and the stock prices. In this visualization, the analyst is also defining the investment risk factor (i.e., the



Portfolio investment analysis (Screen courtesy of Carolina Cruz-Neira, Andrew Morton, and Stanley Pliska of the University of Illinois at Chicago)

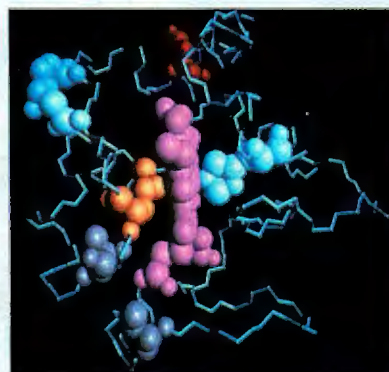
volatility), the period of time before re-balancing, and the cost of trading at each portfolio's rebalance.

This simulation uses the asymptotic

growth-rate model. This is a model in which each year's growth rate is random, but over the long run, the average growth rate converges to the theoretical value of the strategy.

The problem becomes more complex as the number of stocks in the portfolio increases. A portfolio with three stocks is a five-dimensional problem, encompassing the value of the portfolio, the length of time of the investment, and the varying investment percentages of each of the three stocks.

Because a 2-D workstation display can't show a multidimensional chart without cluttering the image, the diagrams are simplified to show the growth rate (the y axis) over a period of time (the z axis) using one of the stocks as a reference (the x axis). In other words, the x axis represents different percentages of the investment in a stock, from 0 percent to 100 percent. The surface's color represents volatility: Red means a strategy with high risk, and blue means a strategy with low risk.



Molecular modeling (Screen courtesy of Christina Vasilakis and Emanuel Margoliash of the University of Illinois at Chicago and Edwin Westbrook of the Argonne National Laboratory)

ogists with greater insights into the mystery of how this protein transfers electrons.

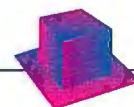
Maxine D. Brown is codirector of the Electronic Visualization Laboratory at the University of Illinois at Chicago. You can contact her on BIX c/o "editors" or on the Internet at maxine@bert.eecs.uc.edu.

STRUCTURAL BIOLOGY

Interactive graphics is an integral part of academic and industrial research on molecular structures and interactions. Scientists are successfully carrying out the process using supercomputers to model complex systems, such as proteins and DNA. The pharmaceutical industry is increasingly using molecular modeling to design modifications to known drugs and to propose new therapeutic agents.

Structural biologists, working with a visualization expert, created the visualization of cytochrome C shown in the screen on the right. Their goal is to better understand the properties and functionality of this protein structure.

The line drawing represents the amino acid backbone structure of the protein. The colors (other than the orange, which represents iron atoms) are used to highlight various properties of the amino acids that compose the protein. Visualization provides structural biol-



software packages now on the market (see the Resource Guide on page 148).

Much confusion has come about because visualization grew out of many fields, each of which brought its own file formats. Meteorology has BUFR (Binary Universal Form for Representation) and GRIB (Gridded Binary Form) files. Remote sensing has ERDAS (Earth Resource Data Analysis System) images. CAD uses IGES (Initial Graphics Exchange Specification) files. And the DICOM (Digital Imaging and Communications in Medicine) format is being developed for medical images. Dozens of other file formats exist—most of which are incompatible with each other.

"The standards are really awful," says Garrity. "The field's not going any further until they start taking on a more permanent form." And what will cause the standards to crystalize when they are in such flux? Garrity's bet—and that of other industry representatives—is on the HDF (Hierarchical Data Format) developed by the National Center for Supercomputer Applications (Champaign, IL). HDF is extensible, available in the public domain, and capable of handling data and images as

well as scaling information. The fact remains, however, that if you are an advanced visualization user, you'll probably always be drawn to formats developed for your own needs.

Excitement and Caution

Powerful new desktop computers and workstations are enabling the development of new software products to serve increased demands for visualization. Novel uses for this technology are appearing on a regular basis.

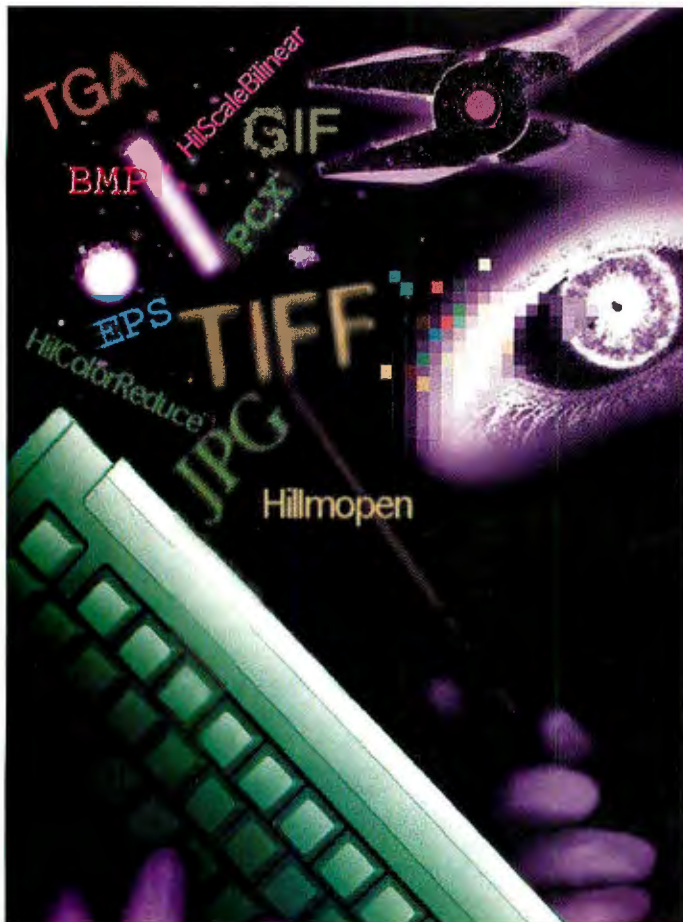
Even the nature of visualization is changing. At the University of North Carolina at Chapel Hill, researchers are adding virtual-reality techniques to visualization to simplify drug design. Using a force-feedback arm, they are able to pick up a molecule visualized on a screen and push it onto a biological receptor. An easy fit implies that the drug can be effective at that site. Physical resistance shows that the shape or distribution of electrical charges would make the drug ineffective at that site.

There is a need for a degree of caution, though. Precisely because it allows you to see the invisible, the capabilities of visu-

alization, with its pizzazz and drama, can also blind you to what it reveals. To watch the dynamic ebb and flow of market forces or to reach out and touch an enzyme molecule is a seductive experience—so seductive that you can easily forget the approximations and interpolations that went into it.

"One of the problems with data exploration and visualization," says Paul Velleman, president of Data Description (Ithaca, NY), a maker of visualization software, "is that these technologies make it easy to find patterns that may or may not be real." Color, shading, sound, and other dimensions that add realism to visualization are equally capable of making the unreal seem more plausible. But used intelligently, visualization can change the way people use computers to analyze and interpret numerical data. ■

Jack Weber is a TV producer working for the BBC, making documentary films and producing the weekly prime-time science-and-technology program Tomorrow's World. You can contact him on BIX c/o "editors" or on the Internet at jweber@cix.compulink.co.uk.



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NAVIGATING THE DATA FLOOD

Create a visual road map to maneuver through your data

WILLIAM RIBARSKY

For 10 years or more, people have been digitizing all types of data, from images to simulations to scientific and engineering observations. And this trend will continue. For example, in six years, NASA's Earth Orbiting System satellites will become functional. As a result, the data on atmospheric chemistry, weather patterns, and ocean currents and temperatures will increase at a rate of 1 trillion bytes per day.

To facilitate easy access to and understanding of this data, a number of software and hardware makers are mapping database management and query strategies on to parallel and distributed architectures. Among these companies are Oracle (Redwood Shores, CA), Sybase (Emeryville, CA), and Kendall Square Research (Waltham, MA).

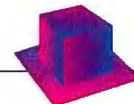
However, the results of these undertakings will be of little use if your desktop computer is overwhelmed by the sheer volume of the data. According to Barbara Mihalas, a research scientist at NCSA (National Center for Supercomputing Applications, Urbana-Champaign, IL), "We must learn to drink from a fire hose."

But a flood of data is not the same as the spray from a fire hose. Unlike water, each particle of data is unique and carries with it links to other data. Context is everything, and you must explore and reveal the underlying meaning of the data if you are to understand what you have retrieved.

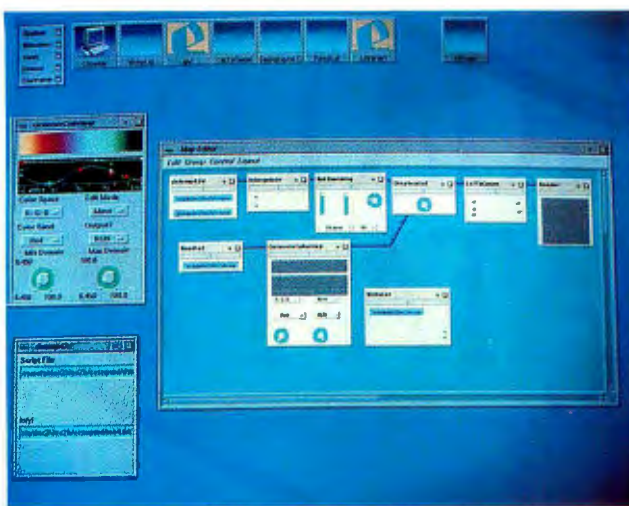
Interacting with Your Data

There are two main categories of software in visualization technology. To an extent, both methods allow you to display and manipulate data quickly without having to





Screen 1: *The GUI of the Iris Explorer shows the graphical network (i.e., the map editor) and the color-map module menu for an application. Note the interactive buttons and dials on each module.*



perform graphics programming.

The first category is characterized by a point-and-click approach. The interface uses an iconic representation and mode of interaction similar to that found on a Mac, in which you select menu options with a mouse. It includes pull-down, scrollable menus and additional windows.

After a data display appears in the window, you are able to rotate, pick, probe, and animate the material (as a sequence of still images). From the extensive task menus, you can choose visual representation operations, such as probes, annotations, scales and colors, and views of data around a central window.

With this type of software, beginners can often convert, display, and analyze their data within a few hours. In addition, the interface allows you to take full advantage of your workstation's windowing capabilities. Examples of this kind of software include DataVisualizer from Wavefront (Santa Barbara, CA), PV-Wave from Precision Visuals (Boulder, CO), and IDL from Research Systems (Boulder, CO).

The second category of software uses a data flow approach. The tool sets allow you to build your own applications by constructing graphical networks of modules (e.g., modules for data input, filtering, pseudocoloring, and rendering). The links between the modules in the graphical display represent the flow of data through the network. Each module is a program that performs an operation on the data (e.g., filtering or pseudocoloring) and passes the results to the next module (see screen 1). When you execute the visual program underlying the network, the system causes the connection of modules and the exchange of data. AVS from Advanced Visual Systems (Waltham, MA), Iris Explorer from Silicon Graphics (Mountain View, CA), Data Explorer from IBM

(Hawthorne, NY), and Khoros from the University of New Mexico (Albuquerque, NM) are a few of the products that fall within this category of software.

The data flow approach incorporates elements of visual programming, which uses graphical symbols to represent program elements. But it lacks important components, such as flow control, a feature that deals with how data travels through your program and branches at certain points.

The power of data flow and similar environments lies in their flexibility, extensibility, and interactivity. Because they use a Unix pipe-and-socket construction, the modules can be distributed across a network of disparate computers, such as Crays and graphics workstations (e.g., Sun's Sparcstation, DEC's DECstation, and Silicon Graphics' Indigo). In addition to using preprogrammed modules, you can program your own modules in FORTRAN, C, or C++ and incorporate them into your data flow environment.

Besides giving you the ability to create new modules whenever you need them, the extensibility of this approach also makes data flow environments movable feasts, with an unending supply of new modules available from expert users. Some organizations, such as the International AVS Center (Research Triangle Park, NC), are already furnishing a mechanism for collecting, organizing, and publicizing the new modules. Finally, these tools allow you to participate at each stage of execution, because each module in a data flow network can have its own control panel, with its own interactive dials, sliders, and widgets.

Data Flow Environments

The real power of data flow environments lies in the concept of building customized applications by focusing on the flow of

data through modules that can exchange data with one another. These environments provide a strong, attractive framework on which to hang new interaction or analysis capabilities (by creating new modules), because they retain the rich functionality of all their existing modules.

As a result, data flow environments are becoming the favorite foundation for visualization and usability researchers and third-party applications developers. This attractive development arena offsets the shortcomings of this set of tools.

Among the shortcomings are the lack of a full visual programming language, inefficiencies in the handling of both distributed computing and large amounts of data, and the tendency in more complicated applications for the data flow network to grow bewilderingly complex. One strategy to overcome these problems is to optimize the data flow execution model for large amounts of data and to provide new structures (e.g., hierarchical groupings) for the data flow network.

How will you use these tools to modulate data flow? Researchers are developing methods that will allow you to take data from any source (e.g., observations, simulations, or accumulated databases), automatically transform it into a common data format, and display the data from different sources together (see the text box "Inside Multidimensional Data" on page 132). This satisfies the two most important criteria for finding the correlations and interdependence of data: easy access to data and side-by-side comparison.

Glyphs for 3-D Data

Another important area in visualization is the use of glyphs to portray 3-D data and its interrelationships. *Glyphs* are objects whose attributes (e.g., shape, position, color, size, and orientation) are bound to independent data variables. Examples of simple glyphs are the spheres in molecular structures or dynamics calculations.

The work of Georges Grinstein, Haim Levkowitz, and their colleagues at the University of Lowell (Lowell, MA) provides another example of glyphs. These scientists are mapping data to the angles, lengths, or coloring of simple stick-figure glyphs. Their images of satellite or MRI (magnetic-resonance imaging) data, with pixel values mapped to tens of thousands of glyphs, show the information in the images (e.g., vegetation patterns or tumor structures) as subtle textures or color patterns. If you generalize the glyph concept to include the binding to data of surface structures (and their coloring) and volume elements (and their transparency), you have encompassed most of today's visualizations.

continued



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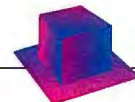
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Inside Multidimensional Data

LLOYD A. TREINISH

Visualization implies creating a pictorial form for data. The geometry composing such a picture, like your data, can be classified by its dimensionality. To visualize data appropriately, you must understand its characteristics. To grasp the nature of data, consider its five key attributes: dimensionality, parameters, rank, mesh structure, and aggregation.

Data is a function of independent variables, or dimensions (e.g., space, time, and energy). Some complex data can have five or more dimensions. A parameter is the data (or function) itself or dependent variables and can have more than one value (or rank). Rank 0 is a scalar (i.e., it has one value), and rank 1 is a vector (i.e., it has three values in three dimensions). Some complex data can be rank 2 or greater.

Often there is an association between the dimensionality of data and its geometry, which is called a mesh, or a grid. This association describes the relationship of the size, shape, and organization of the data to the physical coordinate structure (see the figure).

DIMENSIONALITY OF VISUALIZATION GEOMETRY

Table A: *The dimensions of typical geometries used to compose visualization images.*

| Dimension | Geometry |
|-----------|----------|
| 0 | Point |
| 1 | Line |
| 2 | Polygon |
| 3 | Volume |

Collections of data can be aggregated. For example, weather data might consist of temperature, rainfall, and barometric pressure measurements. A time series can be composed of a decade of monthly sales figures. And a hierarchy can embody the structural organization describing the parts of an airframe.

Multidimensional Techniques

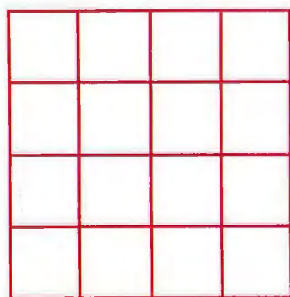
Table A lists several visualization geometries with their dimensionality.

Table B shows a number of visualization techniques (categorized by dimensionality and rank) that you can use with multidimensional data. For example, time is a data dimension that can be mapped into a visual dimension. Similarly, you can treat animation as a visual dimension for sequencing other techniques.

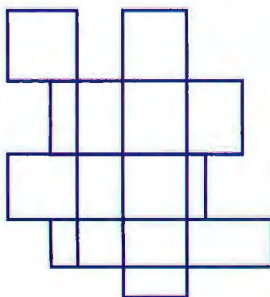
You can combine these techniques to represent multiple parameters. It's possible, for instance, to embed a lower dimension in a higher dimension, such as inserting a line, plane, or surface in a volume. The dimensionality of a visual representation can be different from that of the data (see screens A and B).

The size and complexity of data are growing faster than the speed at which desktop systems are increasing in power. From a hardware perspective, the problem is not how much raw floating-point speed and bulk storage you have but whether your system can achieve efficient processor utilization and rapid access to the data. From a software perspective, the problem is not rendering an

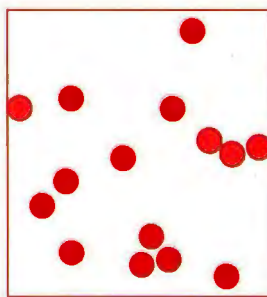
EXAMPLES OF 2-D MESH STRUCTURES



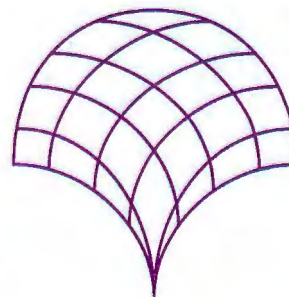
a) Regular grid



b) Irregular grid



c) Ungridded



d) Deformed regular (structured grid)

These mesh structures portray relationships between the dimensionality of data and its geometry: (a) a regular grid, such as a temperature map; (b) an irregular grid, such as several satellite images with gaps in coverage; (c) ungridded (scattered points), such as sales figures or rainfall in specific towns; and (d) a deformed (curvilinear) grid, such as the pressure on an airframe. The data can have one or more variables dependent on the dimensions.

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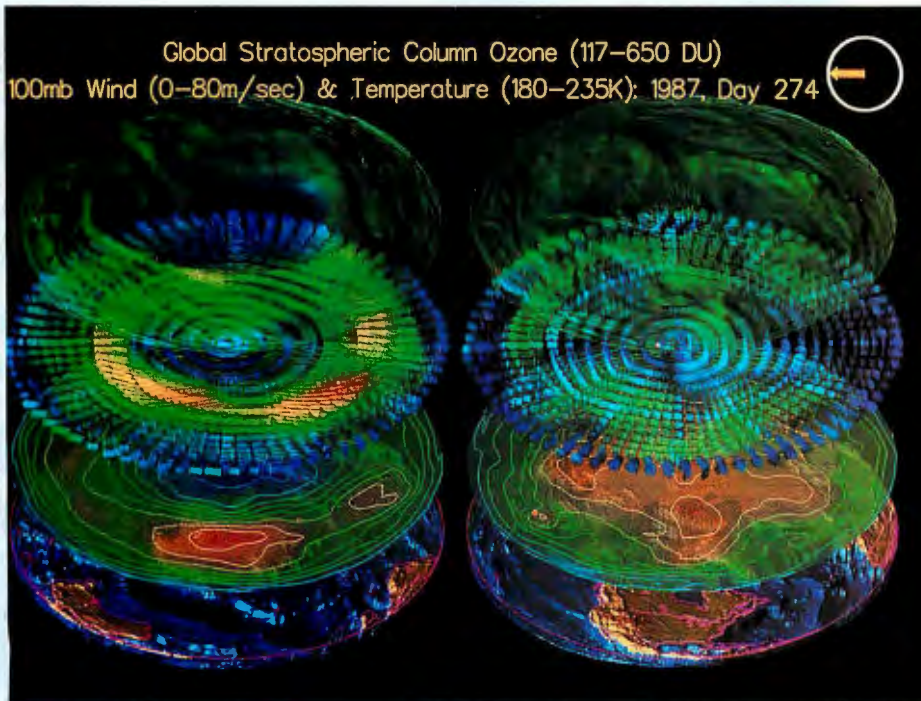
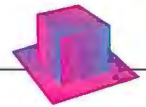
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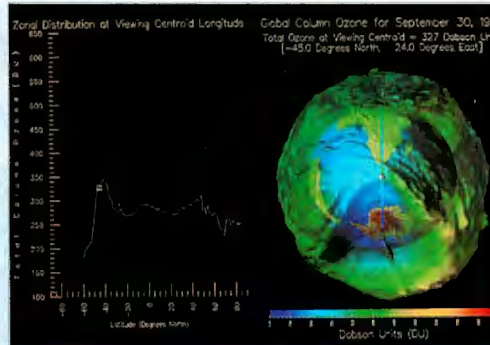




Screen A: The relationship between ozone depletion and atmospheric dynamics on October 1, 1987. The images are produced from five 2-D data parameters and two sets of 2- and 3-D objects. On the left is the southern hemisphere, and on the right is the northern hemisphere. In each stack, from top to bottom, you see a colored surface indicating ozone density, arrows showing wind velocity colored by speed, a colored disk with contour lines reflecting temperature, magenta lines representing coastlines and national boundaries, and a surface map delineating the topography. (Copyright 1992 IBM. All rights reserved. Data courtesy of NASA/GSFC-NSSDC)

image. It's selecting strategies to create effective visualization and storage structures for data of varying dimensionality, parameters, rank, mesh structure, and aggregation.

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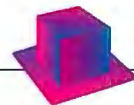


Screen B: A 1- and 3-D representation of a 2-D parameter—column ozone density. On the left is a line plot of ozone versus latitude at a specific longitude. On the right, the ozone is shown as a translucent surface covering a globe. (Copyright 1992 IBM. All rights reserved. Data courtesy of NASA/GSFC-NSSDC)

DIMENSIONALITY OF SAMPLE DATA AND VISUALIZATION TECHNIQUES

Table B: Shown here is a sampling of visualization techniques appropriate for data of different dimensionality and ranks. This table illustrates the diversity of data and some ways it can be visualized.

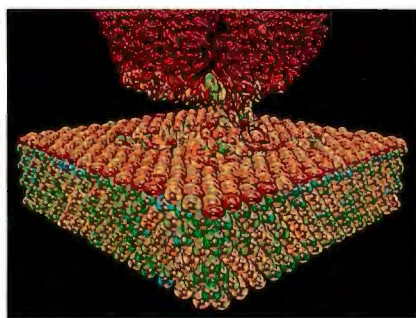
| Dimension/rank | Example of data | Discrete technique | Continuous technique |
|----------------|-------------------------|--------------------------|----------------------|
| 0/0 | Sales | Histogram | |
| 1/0 | Sales history | 2-D scatter plot | 2-D line plot |
| 2/0 | Ground temperature | Multiple x-y plots | Isocontours |
| | Medical image | 3-D scatter plot | Pseudocolor image |
| | | Colored 2-D scatter plot | Surface/height map |
| 2/1 | Ocean surface currents | Arrows | Streamlines |
| 3/0 | Atmospheric temperature | Colored 3-D scatter plot | Volume rendering |
| | Stacked medical images | Isosurfaces | |
| 3/1 | Atmospheric wind | Arrows | Streamlines |



Glyphs are a powerful medium for distinguishing and comparing several variables at once. They take advantage of your eye's ability to perceive small differences in shape or position and to discern properties such as color and shape. As a result, you have at your command several attributes (the most quantitative being spatial position) that you can bind to variables while still being able to see each of the attributes separately. This capability is necessary for the quantitative comparison and correlative analysis of data.

Glyphs also fit naturally into the landscape of 3-D displays and virtual environments. In such interactive environments, using glyphs allows you to perceive patterns of clustering and details of spatial arrangement in all three dimensions.

To find the limits in the number of variables and the amount of spatial complexity that a multidimensional representation can handle, my colleagues and I have studied the simultaneous binding of several variables in applications such as complex molecular-dynamics structures. Because these calculations are molecular-dynamics simulations, you can designate another dimension—time—via an animation.



Screen 2: Simulation of a nickel atomic-force microscope tip pulling up a gold surface, where shape distortions and coloring of spheres indicate components of atomic stress. (Screen courtesy of Robert Minsk and William Ribarsky, taken from supercomputer calculations by David Luedtke and Uzi Landman)

Visual representations like these are successful in pinpointing the relation between stresses and dynamic behavior. Such a method is general and can be applied to many types of data whose performance can be affected by several variables (e.g., stocks and bonds).

For example, stress buildup can eventually lead to inelastic deformations, flow, and fracture in these systems. Therefore, you have complex structural information, atom types, and six components of a tensor field all depicted in the same image (see screen 2).

If the visualization program you have won't accept and display data in a suitable manner, however, you must address issues in the areas of graphics programming and conversion of data to appropriate geometries. Researchers in visualization and usability are making significant strides in these areas. They are building tools for the data flow environment that allow you to create your own glyphs in a 3-D editor and bind them to your data any way you want. The objective of this work is to develop a highly interactive environment that doesn't need programming.

The interactivity and ease of glyph construction make it possible for you to play what-if testing and compare combinations of variables and visual representations for different data ranges. With this capability, you can recognize and analyze the different characteristics of your multidimensional data.

11x17

FitCenter News

EXERCISE P...

Jim Watts' regular workouts helped prevent permanent heart damage.

FitCenter Profiles:

Jim Watts—
from walking
"time bomb"
to running
inspiration.

Jim Watts has been a FitCenter member for the last 10 years. But it's in the last few months that he's become an even more fervent disciple of fitness. After emergency heart surgery last October...

A MONTHLY

...doctors, Watts is eager to tell to Watts' longstanding fitness regimen, his heart and cardiovascular system were well conditioned. Even though Jim had a blocked coronary artery, his efficient heart was receiving sufficient blood supply to prevent permanent damage. If not for his years of exercising, Jim's only "warning" might have been a heart attack.

The moral? These days, Jim Watts doesn't walk his bike up the hills anymore. He rides up. He also uses a stationary bike and other cardiovascular equipment at FitCenter everyday, without fail, for an hour, and doesn't let anything interfere with his daily workouts. Thanks to his ducking out at lunch everyday to FitCenter—which is across the street from his office—Jim's heart keeps getting stronger, as does his message: "If shortness of breath is a part of your life in any way, don't dismiss it," warns Watts. "Let a doctor decide if it's nothing." Get a stress test. I was a walking time bomb, and didn't even recognize my one and only symptom as a symptom.

He's also giving a valuable message—action to his employees. Mattie Richard & Watts has been providing the FitCenter Wellness Benefit to their employees for the last four years.

FitCenter News

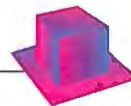
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ANNUAL DEATHS FROM HEART DISEASE

| Country | Annual Deaths |
|---------|---------------|
| Japan | ~350,000 |
| Germany | ~550,000 |
| U.S. | ~750,000 |

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Research to the Rescue

Interdisciplinary efforts are under way to make the navigation of data easier and more efficient. They are taking place in sites such as the Graphics, Visualization, and Usability Center at the Georgia Institute of Technology (Atlanta, GA); Xerox PARC (Palo Alto Research Center, Palo Alto, CA); and the Institute for Visualization and Perception Research at the University of Lowell (Lowell, MA).

Researchers at Xerox PARC and other institutions are developing 3-D visualizers of information structures (see "The Information Theater," November 1992 BYTE). And in many research centers, work on visualizing scientific multidimensional data has much wider implications. For example, the efforts at NCSA and other national supercomputer centers focus on accurate, interactive display and analysis of large data sets derived from supercomputer calculations. The results of these calculations include representations of complex molecular structures, unsteady air flows around aircraft, and loads on bridges. The Environmental Protection Agency is also beginning to visualize the effects that result from its air-quality models.



Screen 3: *The interconnected backbone networks and selected regional networks collectively called the Internet. This representation correlates node connectivity with geographical location. (Screen courtesy of Donna Cox and NSCA)*

With the growing complexity of information stores (e.g., the Internet), symbolic representation must become 3-D to show their full character (see screen 3). To understand the interdependence of the Internet's parts so that you can formulate plans and carry out troubleshooting, you must be able to interactively navigate the network and open windows to reveal deeper levels of its hierarchy. As you can see from this example, the need to find new ways to

perform interactive analysis is growing in an expanding number of areas. ■

William Ribarsky works at the Georgia Institute of Technology (Atlanta, GA). He is the manager of the Scientific Visualization Laboratory and an associate director for service at the Graphics, Visualization, and Usability Center. You can reach him on BIX c/o "editors" or on the Internet at bill.ribarsky@oit.gatech.edu.

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IMAGE BUILDING

Architecture determines visualization software's power and flexibility

PETER WAYNER

Computers can now create complex graphical systems that allow you to examine data in ways that never existed before. The power and flexibility of a visualization system depend on the software architecture that designers develop.

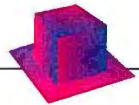
There are two types of visualization software architecture. One is an object-oriented environment, which you program in a straightforward procedural manner. The other is a WYSIWYG environment, which allows you to handle data directly and see the results of your work at each step of the process. Both approaches have advantages and trade-offs, and there are many similarities between the two.

A Common Tool Set

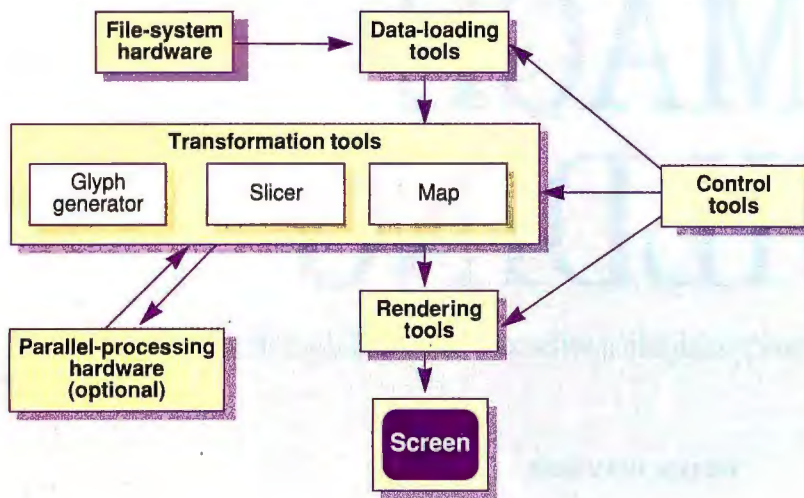
Whatever the architecture, basic visualization software has four types of tools, or routines, that you link to produce an image. These include tools for loading, transforming, rendering, and controlling data (see the figure). Loading tools read data in from a file and construct an internal structure to hold the data. Transformation tools operate on data and refine it. Some transformations can be as simple as smoothing the data by averaging neighboring values; others (e.g., finding contour lines connecting equal-valued points) might create new data sets. Rendering tools use sophisticated hidden-line and rendering algorithms to convert information to pictures. And with control tools, you can modify the actions of the other tools.

When data is loaded, the software must format the values into an internal structure that is robust enough to describe all possible forms that the data can take as it passes through the different tools. Each





A VISUALIZATION SYSTEM ARCHITECTURE



Tools in a system such as this are implemented in software and can use as much hardware as is available. Transformation tools make up the core of the software and do much of the work.

tool knows the structure and reads and writes data into it. This process allows you to connect the tools in arbitrary chains without having to be concerned about whether the tools know how to exchange data—they all read and write the same language.

In some cases, software architects find it easy to let the transformation tool act on all forms of data. A transformation tool that rotates data, for example, works similarly on 1-, 2-, and 3-D data objects. In other cases, though, the architect has to think in more abstract terms.

For instance, a transformation tool that finds contour lines works well in a 2-D image, but the idea does not generalize well to a 3-D image because the outermost contour line is really a 2-D surface that obscures all the interior ones. In such situations, most contour-generating transformation tools produce only one 2-D surface when presented with 3-D data.

The internal data structure allows transformation tools to be flexible. These tools can produce new views of data based on the type of input they receive as long as they output the views in the standard format of the internal data structure.

One such tool might take data representing a 3-D array of the wind and temperature in a region, find the lowest windchill, and output a new data structure consisting of one point marking this location. Another transformation tool might take the same data and construct a set of lines that represents the isothermal con-

tour lines. Both the point and the contour lines are new data sets that other tools can transform farther down the chain.

The large number and diversity of transformation tools are good measures of the power of visualization software. Among the most common transformation tools are map tools, which match up two sets of data and interpolate the results if the sets don't line up exactly, and color tools, which add a layer of color to the data based on a range of values. Other typical tools include arithmetic tools, which perform most of the basic operations on data; glyph generators, which create vectors, flags, and icons at locations scaled to the values in the data; and slice tools, which pull out 2-D slices of data from 3-D data sets.

A rendering tool draws and combines all the data sets presented to it. It can create a weather map by combining the tem-

perature contour lines and the minimum windchill point that the previously described tools produced. Using graphic routines, the rendering tool should allow you to modify variables such as the position from which the data is viewed or the faux lighting used to illuminate the data.

Those who work with visualization usually want to modify images and look at the data in different ways. The simplest control tools inform the rendering tool of any changes in the positions of the images so that you can perform this image manipulation. Other tools send messages back to data-transformation tools to modify their transformations. One control tool might send a value n back to the coldest windchill finder, instructing it to find the coldest n points in the country. Another might send a message to the contour function modifying the interval between the lines.

These four types of tools handle the basic tasks that visualization software must carry out. The way that the architect implemented some of the basic functions may not be obvious.

For instance, many images include axes with tick marks that indicate the scale of a picture. The rendering tool might draw axes, or a transformation tool might create them as a separate data set, in much the same way that the coldest point was found and marked. In this situation, the rendering tool would combine the image data with the new axes' data.

In most cases, both of these techniques are probably just as useful, but the second method is more flexible. If the axes are just another data set, the other transformation tools can be used to color, bend, or transform the axes as they would with regular data.

Software architects must anticipate all these issues when they design tool sets and distribute the various tasks among the individual tools. If they aggregate too much functionality in one tool, you will not be able to link the tools in certain ways. But if the architects split the functionality too much, they create software with thousands of tools that no one can remember.

Many implementations of visualization software are designed to be readily portable to different machines with different configurations of processors. This allows you to run a visualization routine on more than one platform without recompiling it. Some software architects take this flexibility one step further and allow the software to split up the computation tasks necessary to create an image. If a parallel processor is available, the system is able to divide each tool's responsibilities into a number of parts so that you can quickly perform the visualization.

continued

Visualization Architectures

Object-Oriented

- ease of use
- consistent internal data structure
- visually programmed

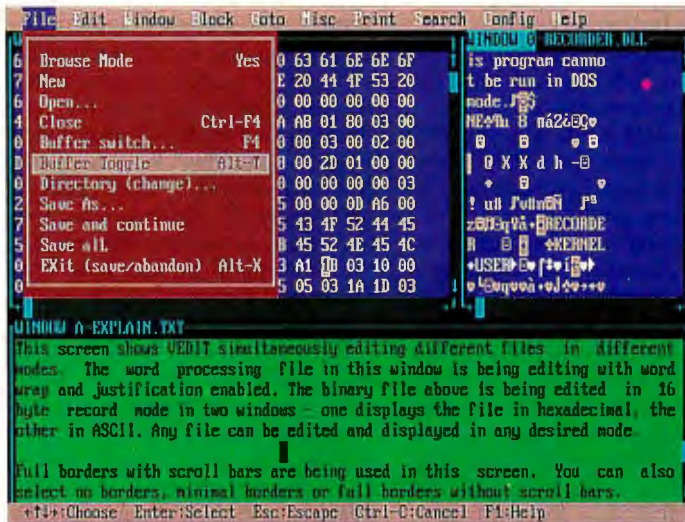
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- ❑ Edit in ASCII, Hexadecimal or EBCDIC, or combination of modes.
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- ❑ Hyper-browse CD-ROM files.
- ❑ Full featured program editor.
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- ❑ Also VEDIT for only \$89.



Until now, data files, such as database files, downloaded mainframe files, Postscript and plotter output, .EXE executables and other non-standard files were a real headache if you ever had to view, patch, search, search/replace or extensively edit them.

Traditional text editors can't handle these files because they are non-standard or too big. Traditional disk utilities allow only the most primitive viewing and patching. Just a single corrupted data file could take days to fix, and you sweated and cursed the whole time.

A new way to handle data files

VEDIT lets you edit data files as effortlessly as text files. Its secret is incredible speed, huge file capacity and special editing modes.

File modes support DOS, Unix and Mac style text files plus data files with fixed length or variable length records. Display modes include five ASCII modes, Hexadecimal and EBCDIC, or split the screen for any combination. Search using pattern matching or regular expressions, cut and paste data files, and much more. Long lines can be horizontally scrolled or wrapped onto multiple screen lines.

Handle nasty "text" files too

Text files may sound easy to edit, but other editors choke when they hit embedded control (null) characters, very long lines or the 400 Megabyte file you are trying to put onto a CD-ROM. VEDIT handles all text files effortlessly and automatically detects the correct file type. With VEDIT you can conveniently edit any file you will ever encounter.

Speed, speed, speed

Only VEDIT has the speed to edit multi-megabyte files. Traditional text editors such as Brief(tm) and Sage(tm) are much too slow to edit files much larger than memory; and Multi-Edit(tm) is 7 times slower than VEDIT. And none of them can efficiently edit data files.

| | VEDIT | Brief | Multi-Edit | Sage |
|------------------------------|-----------|----------|------------|-----------|
| Edit data/binary files | Yes | No | Some | Some |
| Support fixed-length records | Yes | No | No | No |
| Maximum line length | Unlimited | 512 | 2048 | 65K |
| Maximum file size | 2000 Meg | 32 Meg | 32 Meg | 100 Meg |
| Hex/EBCDIC editing | Yes/Yes | No/No | No/No | No/No |
| Multiple display modes | Yes | No | No | No |
| Fast browse of CD-ROM | Yes | No | No | No |
| Global search/replace | | | | |
| In 10 Meg file | 2:49 min | >24hours | 20.0 min | 2:10 hour |

Ultimate programmer's editor

Long a favorite among programmers, VEDIT has every advanced feature you might expect. Simultaneously edit numerous files, split the screen into windows, search/replace with regular expressions. Automatic indent, block indent, parentheses matching and block operations by character, line, file or column speed program development. Word wrap, paragraph formatting, justification, centering and many printing options are ideal for text processing.

Its unique compiler support integrates tools from different vendors and fully supports "make". VEDIT PLUS has the most powerful macro programming language of any editor. It's ideal for translating files from one format to another.

Easy to learn, easy to use

An intuitive user interface with drop down menus, hot keys, mouse support, optional scroll bars, context sensitive help, point and shoot file selection and unlimited keystroke macros make VEDIT PLUS easy to use, easy to learn. Safety features include 1000 level undo, auto-save and optional backup files.

The entire keyboard layout and everything in VEDIT is configurable with easy to use menus. With over 100 configuration parameters you can fine-tune VEDIT to your exact needs and preferences.

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UNIX

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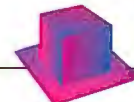
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Greenview Data

VEDIT PLUS - Universal File Editor



Big Blue and Indigo Sky

The IBM Data Explorer is a good example of full-featured, tool-oriented software. The application runs on several platforms—from low-end IBM RISC System/6000 workstations to specialized IBM power visualization computers that feature 32 860 chips and fast 256-bit buses.

Software running on the high-end computer can take advantage of its extra processors and break down the work of each tool into multiple sections. But software running on the low-end machine must use its sole processor to perform all the work. Speed is the only difference that you would notice in the performance of programs running on these machines. The algorithms are easy to express in parallel form, and often a machine with n processors performs n times faster.

The Iris Explorer 2.0 is an object-oriented, tool-based architecture that Silicon Graphics (Mountain View, CA) ships with its workstations, including its Indigo and Personal Iris. The Iris series can include up to eight processors, and on this platform, the Explorer configures itself to use the maximum amount of power available.

Both the IBM and Silicon Graphics soft-

ware packages allow you to use a visual program editor to create a program for converting data into images. In this editor, one window has boxes that represent the tools, and the lines between them represent the data flow. With this kind of editor, you can easily create images from data, because it allows you to choose the tools that you need and connect them in a proper chain. If you want to add more sophisticated features, you can use the appropriate tools and draw more lines.

A second window includes the control tools, which have input fields, sliders, and other input interfaces that allow you to control an image on the screen by sending messages to the transformation tools that dictate the parameters. For example, a control tool might send messages to a slice transformation tool telling it on which plane to slice the data. Another control tool might manipulate the contour-finding selection.

Creating an image from data with an object-oriented tool is similar to programming in a standard language. The format is easy to use because the steps of the process are laid out with boxes and lines instead of in a text file with procedure headers. A consistent internal data structure adds to

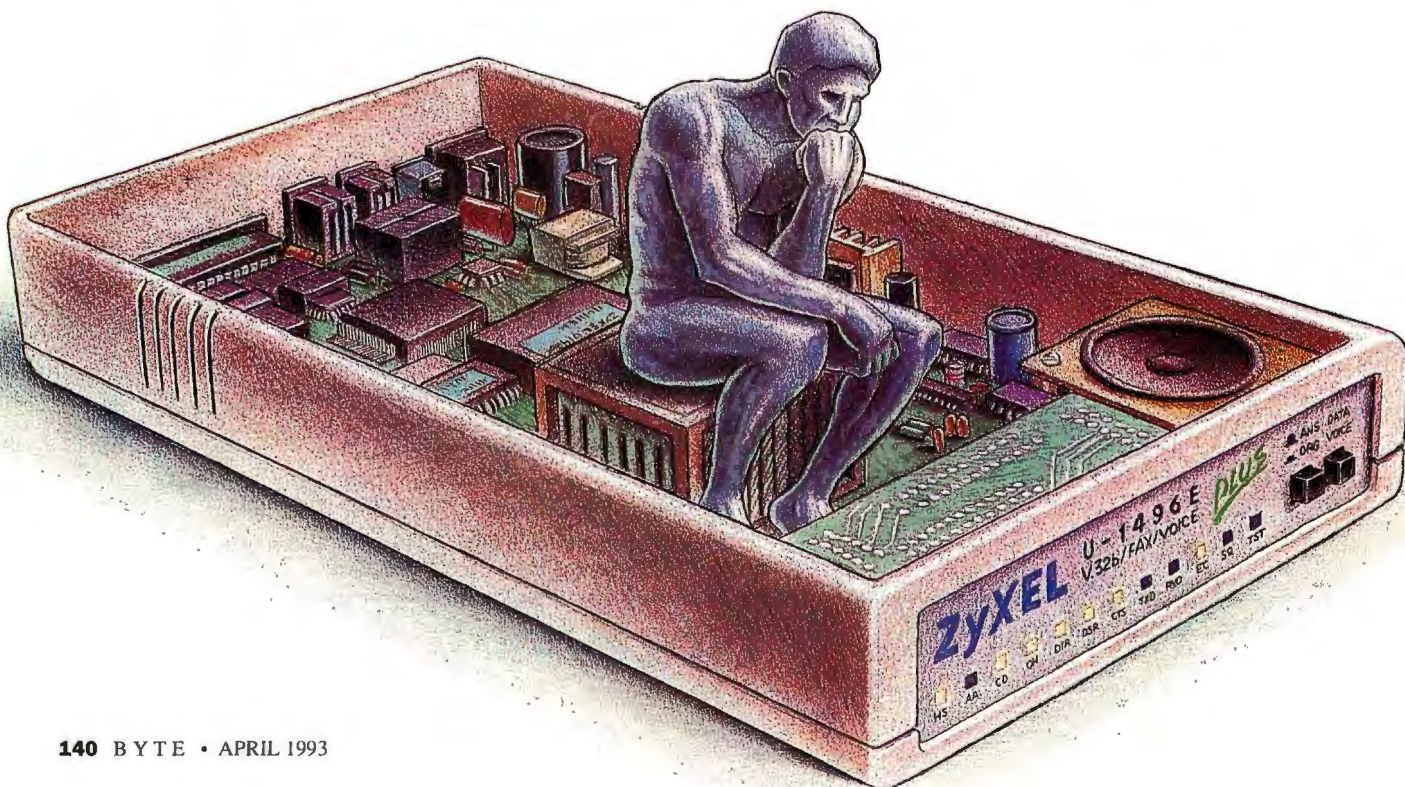
the simplicity of the process because you can connect any tool to any other.

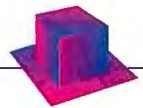
An example of this process can be seen on the screen, which shows a CT (computer tomography) image of a tooth and the program that created it. First, the CT scanner creates a 3-D matrix filled with the density of the tooth at the grid points. Next, a color-map tool changes these densities into colors (yellow for the boundary, red at the crown, and blue at the root). Then a slice tool cuts away half of the tooth so that you can see the interior densities. This kind of view is useful to dentists because the 3-D information can be much more revealing than a 2-D x-ray. The Iris Explorer created this image, which shows how several simple, abstract tools can be joined to produce rich images.

WYSIWYG for Free

NIH Image software for the Mac implements the four sets of tools differently. It was written by Wayne Rasband of the National Institutes of Health (Bethesda, MD) to provide scientists with a free and easy method of manipulating and analyzing 2-D images. It is similar in structure to products like Dicer from Spyglass (Champaign, IL)

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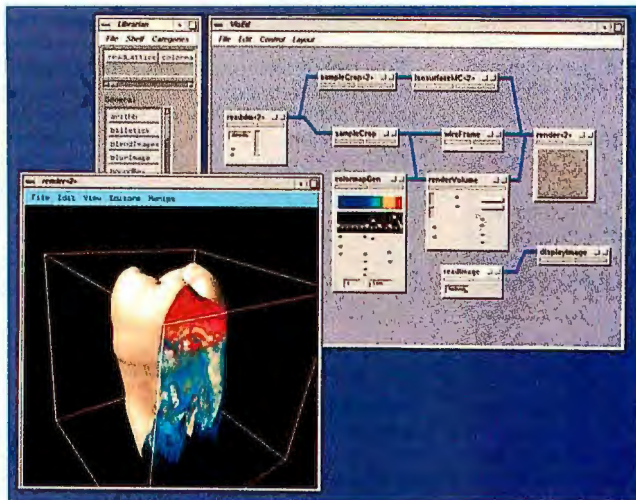
or several tools produced at the National Center for Supercomputing Applications (Urbana-Champaign, IL).

The architecture of the NIH Image software is built in the spirit of Mac-based WYSIWYG word processors. You see the data at all times, and changes appear on the screen as each operation modifies the data. You don't build a program or a chain of tools; you execute a set of commands. The main advantage of this approach is high data interaction. You constantly see the intermediate views of your data and can discover other facets along the way.

Object-oriented, tool-based architectures do not show the image until all the tools have finished their work. Serendipitous results are happenings that visualization software is meant to facilitate. There are many ways to examine data, and you don't have to use the tools in any particular order. The interactive, visual program editors of IBM and Silicon Graphics provide almost the same level of interactivity and experimentation because of the flexibility they have.

Best of Both Worlds

Good visualization software provides simple methods that work together efficiently.



Dentists can use 3-D computer tomography imaging to identify and analyze problems. Slicing the data can reveal abnormalities in the internal structure of a tooth.

Both approaches to visualization—object orientation and WYSIWYG—provide you with a chance to experiment with data.

In the future, you'll see hybrid visualization software emerge, as the two structures grow to imitate each other. WYSIWYG programs will allow you to link many different steps and small programs in much the same way that object-oriented systems

now do. How will all this end? When you can get the picture on your computer's screen as fast as you can imagine what you want to see. ■

Peter Wayner is a BYTE consulting editor based in Baltimore, Maryland. You can contact him on BIX as "pwayner" or on the Internet at pcw@access.digex.com.

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THE DIFFICULTY WITH DATA

Handling the basics of visualization data

NAHUM GERSHON AND JEFF DOZIER

The challenges arising when you work with data must be dealt with if visualization is to become simpler and more efficient. Visualization demands that your system handle huge amounts of data quickly. And that data comes in a wide variety of forms. Raw data enters the process in different formats and from different sources, including surveys, simulations, instruments, and photographic or video images (see screens 1 and 2).

Data is usually accompanied by *meta-data*, which contains information essential to the visualization process (e.g., the name of the data set, the date of generation, and statistical information about the data). Typically, the metadata contains information that describes the data's format, units of measurement, scale, display-color specifications, and relationship to other data sets (e.g., this image of atmospheric temperature is related to an image of atmospheric humidity produced by the same climate model).

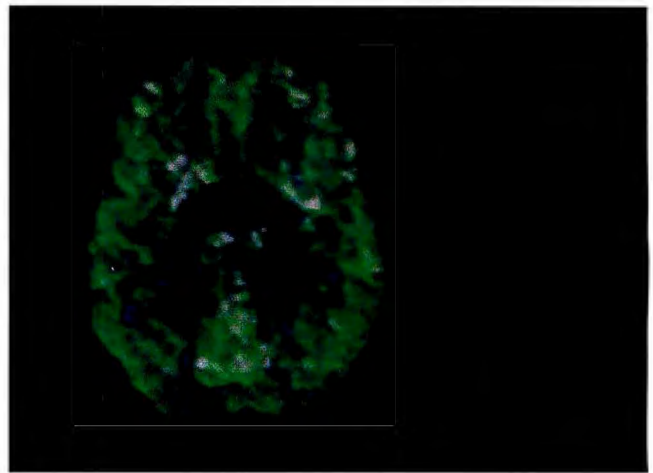
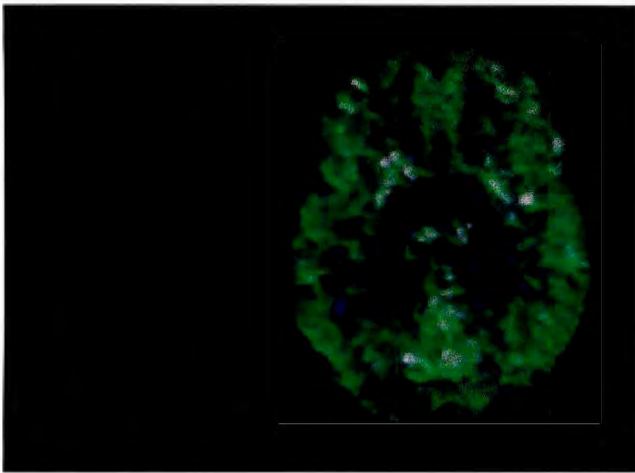
As a result, visualization packages must accept data and metadata input in disparate formats. The data might be expressed as a one-dimensional string of numbers or in multidimensional forms. An image is usually expressed in two dimensions, but data from remote sensing instruments can have as many as six dimensions: *x*, *y*, *z*, time, wavelength, and polarization. And data can be *continuous* (i.e., there are no gaps in the data) or *sparse* (i.e., there are holes in the data). Even data of the same type can have different formats (see the text box "The Faces of Data" on page 147).

Data Formats

Ideally, there should be standards for data formats and metadata that would enable



B~P



Screens 1 and 2: The information in these screens was generated from data obtained from 14 image slices of the brain. Input data was generated by positron-emission tomography and transformed to a format that could be used with a workstation. Then 14 2-D slices were transformed into a 3-D set with its own format. The white, green, blue, and black specify high, medium-high, medium-low, and low grain activity, respectively. To get a stereoscopic view of these images, hold the page about 20 inches from your eyes and move it toward your face until the effect is achieved. (Data courtesy of NIA, NIH)

visualization software to import and export data easily, accurately, and quickly. However, because applications require many types of formats, it's unrealistic to expect that all data sets will be converted into a global data format standard.

However, the SDTS (Spatial Data Transfer Standard) is one attempt to develop a universally accepted data-format standard. The U.S. has adopted this spatial-data standard, and the National Institute of Standards and Technology has approved it as a Federal Information Processing Standard. In addition, the Technical Committee on Computer Graphics of the IEEE Computer Society plans to develop standards for visualization data.

But in the absence of a globally accepted standard, there are good visualization packages that support several common data formats. The University of Pennsylvania has created the domain-rendering program *xv*. You can also use toolkits that are able to convert many data formats. For example, SDSC (San Diego Supercomputer Center) has developed a publicly available format-conversion utility that supports almost 30 image formats. And Mitre (McLean, VA) has recently constructed an extensive conversion capability that integrates conversions, libraries, and utilities. It uses a common API and Carnegie Mellon's Fuzzy Pixmap Manipulation library, SDSC Image Tools, and conversion utilities from Paragon Imaging (North Chelmsford, MA).

An alternative approach used by people associated with the University of California's Sequoia 2000 project is to incorporate the format-conversion capabilities in

a DBMS. In this process, the DBMS understands a suite of formats and can translate a stored format into a desired output format.

Data Storage

Storing visualization data is another problem. If you have only a few data sets, it's convenient to store them in a file system. But when there are many data sets, it's difficult to search for specific and appropriate data, because only limited amounts

the system must be able to recognize the subject. In addition, it's essential for the system to understand the context of the subject (e.g., ozone climatology and spatial contiguity of stratospheric ozone depletion).

To be able to pose queries, you must store at least the metadata of the data sets in a DBMS. And the images themselves must also be accessible to DBMS queries. But in many scientific and engineering domains, data is spatially organized and cannot be stored efficiently in most commercial DBMSes. And when the data volume exceeds the available disk space, you must store parts of the data in tertiary memory (e.g., magnetic tape or optical disks), which takes longer to access.

Most commercial DBMSes don't handle queries across multiple storage levels. However, the Teradata Optical Call Level Interface from Teradata Corp. (El Segundo, CA) handles queries across a DBMS and a storage system. But using the product doesn't necessarily permit optimal storage-access times. Therefore, you need a DBMS that can handle large objects (e.g., images), tertiary memory, and file systems. The DBMS must also be able to optimize queries directed at all the available data types wherever they are stored (see the figure).

Why Visualization Data Is Complex

- wide variety of data types and formats
- no format standards
- large memory and storage requirements
- potential need for lossless data compression
- huge data sets
- fast processing-speed requirements

of information can be stored under a filename.

Posing appropriate queries against the data requires knowledge of the metadata or the information. For example, to search a large collection of data sets for files containing information about an ozone hole,


Data Compression

To save storage space and to shorten the time required to transmit data, visualization software must compress data and then decompress it quickly to yield an acceptable image. Two types of compression methods are used: lossless and lossy.

With lossy compression, data can be permanently discarded during the process, but files compressed in a lossless fashion retain their data integrity and can be transformed back to their original state. The RLE (run length encoding) and Lempel-Ziv-Welch algorithms are typical lossless-compression techniques.

For some types of analysis (e.g., quantitative examination of scientific data), it's essential that the data remain unchanged. In these cases, you need to compress the data using a lossless compression algo-

Any compression algorithm that you use should protect against propagation of errors in the compressed data.



gorithm. Archiving data ordinarily requires lossless data compression because of the need for an accurate and complete record of the data. Any compression algorithm that you use should also protect against propagation of errors in the compressed data.

Lossless-compression algorithms are also required for such tasks as modeling heat transfer that occurs in the ocean. In this case, you must keep the exact values of sea surface temperature as a function of latitude and longitude.

However, there are rare situations in which lossless-compression methods don't produce acceptable results. For example, when such algorithms are applied to satellite-image data, they generally yield minimal compression—usually no better than a 2-to-1 ratio.

The use of lossy compression methods is acceptable when you can tolerate some loss of precision. For example, suppose you want to browse through low-resolution versions of your data. In such cases, you want to check the appropriateness and quality of particular data sets before obtaining a full version of them for detailed analysis.

Among the most common lossy compression algorithms are MPEG (Moving

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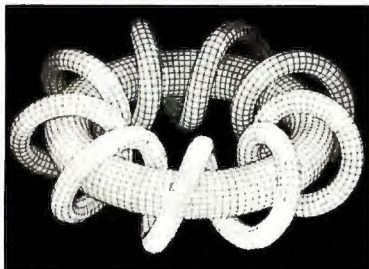
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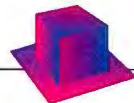
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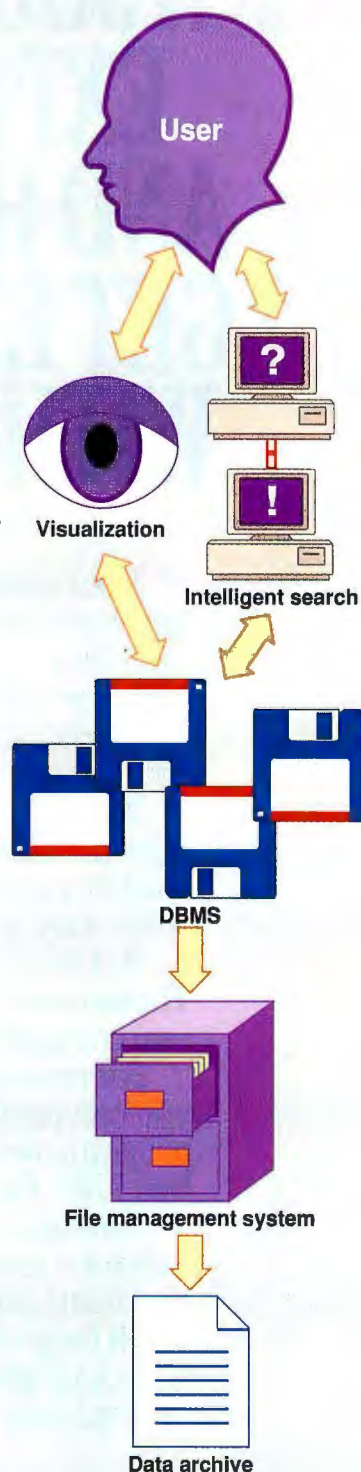
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Pictures Experts Group) and JPEG (Joint Photographic Experts Group) standards, which are specific implementations of the discrete cosine transform. Volume reduction of at least 50 percent is common with lossy compression methods.

Addressing Animation

Animation is a special capability of visualization technology that represents time sequences of data. It's important for applications that describe time-dependent processes.

A typical animation uses large amounts of data. To save space in primary memory, data can be compressed (in space and time) or reduced (e.g., by subsampling). Such compression and reduction schemes are effective only if it's possible to transform the compressed or reduced data back to acceptable images in real time during the animation process.

To further decrease the volume of animation sequencing information that must be placed in memory, you can store just a part of the collection of frames representing the animation loop. To prevent the animation from appearing jerky, real-time fast interpolation algorithms replace the missing frames before or during a viewing. Advanced Visual Systems (Waltham, MA) has created software capable of generating these missing frames.

Visualizing What's Ahead

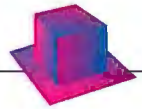
Visualization data comes in diverse types and formats, and no commonly accepted standard formats exist, making management of visualization data difficult. But efforts to develop standards (e.g., SDTS) and new, flexible format-conversion tools (e.g., SDSC image tools) may alleviate some of the difficulties. Fast, effective compression algorithms and the evolution of integrated systems of DBMSes and storage systems promise additional improvements.

The successful implementation of these efforts depends on widespread cooperation. The support of users, vendors, government agencies, and standards organizations is a necessity. ■

ACKNOWLEDGMENTS

The authors would like to thank Jon Dougherty, Jim Green, Steve Hirsch, David Isaac, Don Sawyer, and Ron Zahavi.

Nahum Gershon is a principal scientist at Mitre Corp. (McLean, VA). Jeff Dozier is a professor of geography at the University of California at Santa Barbara. You can reach them on BIX c/o "editors" or on the Internet at gershon@mitre.org and dozier@crseo.ucsb.edu, respectively.



The Faces of Data

DATA TYPES

Analog Video data

Command Data parameters necessary for the execution of a visualization program

Control Data describing a sequence of keystrokes

Derived Data resulting from the processing of raw or simulation data

Digital Digital image

External Input data generated externally, or internal data exported as an output

Geometric Data describing a sphere

Internal Version of the data used in the visualization program

Metadata Information about the data (e.g., data set name or generating instrument)

Nongeometric An image

Raw Data as it comes from surveys or instruments

DATA FORMATS

CDF (Common Data Format) Supports multidimensional scientific data

CGM (Computer Graphics Metafile) Accommodates both graphics and image data

FITS (Flexible Image Transport System) Data standard used in the astronomy community

HDF (Hierarchical Data) Supports multidimensional scientific data

Net CDF (Network Common Data Format) Supports multidimensional scientific data

PICT Bit-mapped graphic format for the Mac

PostScript A page-description language

SDTS (Spatial Data Transfer Standard) Supports vector spatial data

TIFF (Tagged Image File Format) For raster images, including color and subimages

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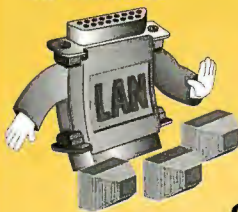
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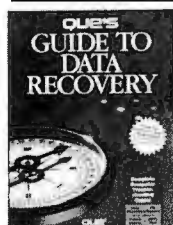
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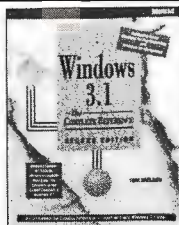
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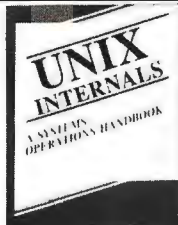




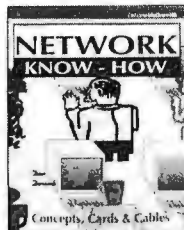
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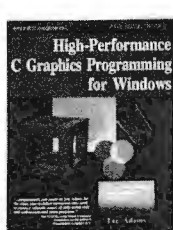
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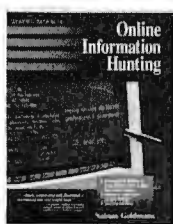
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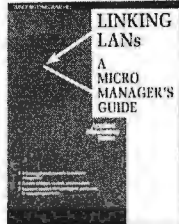
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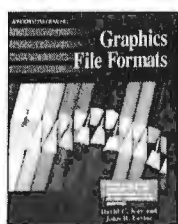
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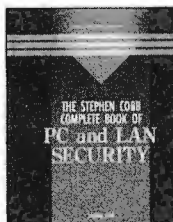
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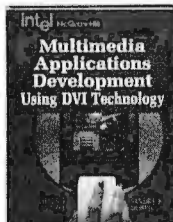
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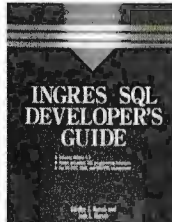
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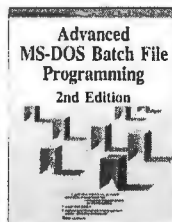
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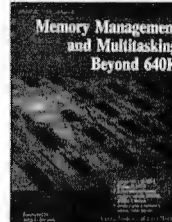
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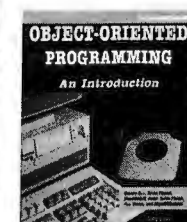
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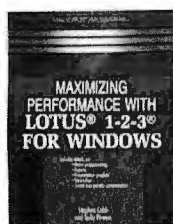
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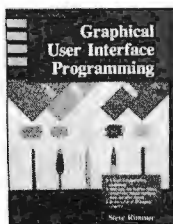
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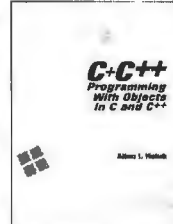
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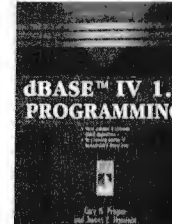
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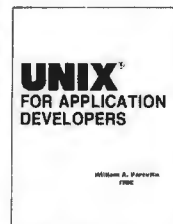
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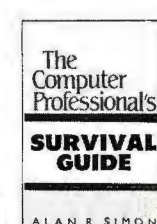
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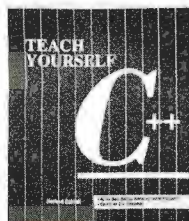
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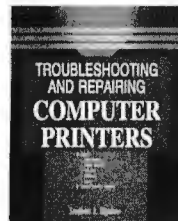
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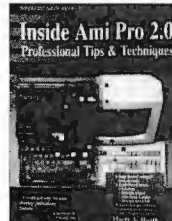
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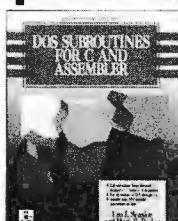
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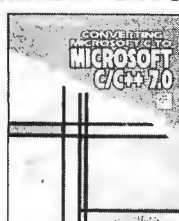
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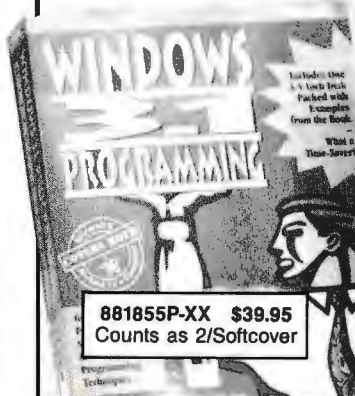


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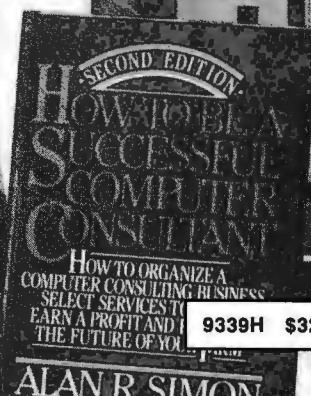
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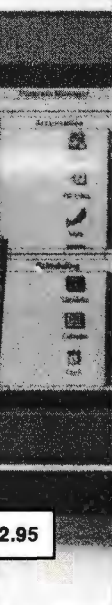
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SHRINK TO FIT

On-the-fly compression software for PCs and Macs fits more data on less hard disk space

**RICK GREHAN AND
STAN WSZOLA**

PKZip, ARC, and LHARC are just a few common utilities for archiving files. These archivers shrink files to conserve space, but you need to manually decompress a file before you can use it. With on-the-fly compression, you can expect to double effective disk space almost invisibly. You're simply presented with the illusion of a standard file system that takes less space.

This month's Solutions Focus concentrates on eight on-the-fly compression packages for PCs and Macs: DoubleDensity 1.0 from Abacus Software, Stacker 3.0 from Stac Electronics, SuperStor Pro 1.0 from AddStor, XtraDrive 1.0 from Integrated Information Technology, AutoDoubler 2.0.1 from Fifth Generation Systems, StuffIt SpaceSaver 1.0.3 from Aladdin Systems, SuperDisk 2.1 from Alysia Software, and TimesTwo 1.0.1 from Golden Triangle Computers. The packages differ a little in their approach: The PC packages trap sector reads and writes to compress data, while most of the Mac packages work on a file basis. However, all eight packages deliver a compression ratio of around 2 to 1 with an average mix of data.

Besides these eight packages, we also took an early look at the compression capabilities of DOS 6. Microsoft's latest DOS release includes a bevy of new features, but on-the-fly compression as an operating-system component is among the most intriguing. For more details, see the text box "Doublespace and DOS 6" on page 156.

Two Advantages

Software compression isn't quite as good as a new hard drive. Your performance will probably drop (although there are exceptions), and you will end up using an

Hard drives keep getting cheaper but for some reason, disk real estate still seems as rare and precious as San Francisco street parking. Data accumulates, bit-map graphics proliferate, and what you need to store grows faster than hardware costs can shrink. On-the-fly data compression offers a real alternative to hardware upgrades, off-line storage, and constant file pruning.

Software compression is nothing new.





BYTE ACTION SUMMARY

- **WHAT ON-THE-FLY COMPRESSORS ARE**
Software packages that increase apparent storage by automatically compressing and decompressing data.
- **LIKES**
Good compression ratios and good speed. Compression is an inexpensive alternative to hardware upgrades.
- **DISLIKES**
Data recovery is more difficult, especially with XtraDrive and TimesTwo. PC setups can require a lot of tweaking of configuration files.
- **RECOMMENDATIONS**
Choose Stacker on the PC and Stuffit SpaceSaver on the Mac.

unusual disk data format that might make recovery more difficult.

But software compression has two big advantages over hardware upgrades. First, it's inexpensive. These software compression packages range in price from \$59 to \$149, and even the most expensive among them is considerably less expensive than a modest hard drive. If you can get reasonable performance, be assured of data integrity, and double the effective capacity of a 200-MB disk, you have obviously saved a bundle.

Software compression's second advantage makes it an especially effective technology for notebook users. It's not always practical to upgrade or add storage to portable machines, but portables are often where the capacity crunch hits hardest. Software compression doesn't require space for additional hardware.

If software compression is the right solution, how do you choose from among the packages on each platform? The measure of effective software compression comes down to the compression ratio and the speed of compression and decompression. We used these two criteria in designing the tests used to evaluate these packages (see the text box "Measuring Compression" on page 153 for a complete description of the tests we carried out). The compression ratio is a function of the type of data and the effectiveness of the compressor; for example, text files might be compressed at a ratio of 2 to 1, while bit-map graphics files (e.g., .BMP) may be squeezed at a ratio of 8 to 1.

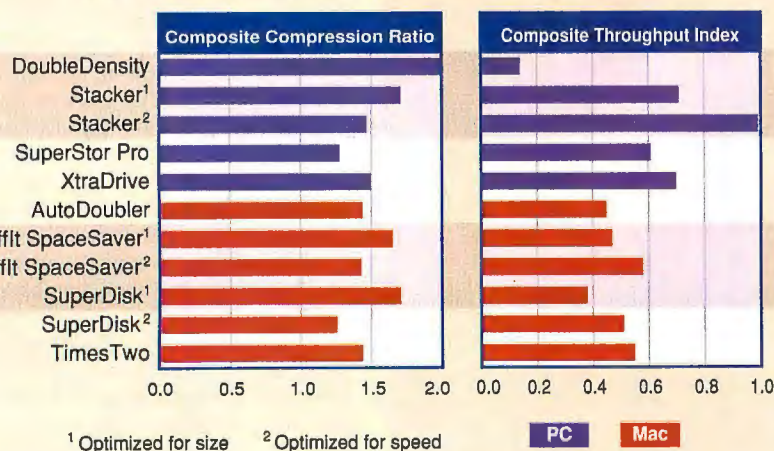
Compression and decompression speed will affect how invisibly each on-the-fly

BENCHMARK RESULTS

Table 1: Compression ratios and throughput indexes for three major application categories. For each application type, the compression ratio describes compression on representative data. Throughput indexes for Word Processing and Database are a combination of results from BYTE's application benchmarks and low-level tests (see the text box "Measuring Compression" for details). Higher numbers are better.

| | WORD PROCESSING | | DATABASE | | GRAPHICS | |
|---------------------|-------------------|------------|-------------------|------------|-------------------|------------|
| | Compression ratio | Throughput | Compression ratio | Throughput | Compression ratio | Throughput |
| PC products | | | | | | |
| DoubleDensity | 2.00 | 0.38 | 2.00 | 0.26 | 2.00 | 0.37 |
| Stacker | 2.06 | 1.05 | 1.92 | 0.95 | 2.10 | 1.02 |
| SuperStor Pro | 1.50 | 0.62 | 1.40 | 0.64 | 1.30 | 0.56 |
| XtraDrive | 1.70 | 0.73 | 1.70 | 0.62 | 1.72 | 0.73 |
| Mac products | | | | | | |
| AutoDoubler | 1.66 | 0.46 | 2.06 | 0.46 | 1.20 | 0.42 |
| Stuffit SpaceSaver | 2.18 | 0.60 | 2.25 | 0.61 | 1.30 | 0.61 |
| SuperDisk | 2.28 | 0.46 | 2.04 | 0.46 | 1.49 | 0.54 |
| TimesTwo | 1.79 | 0.52 | 1.70 | 0.46 | 1.20 | 0.40 |

BYTE COMPRESSION BENCHMARKS



Composite compression ratios (left) and throughput indexes (right). In the composite compression graph, a score of 2.0 indicates a 2-to-1 ratio—disk space is effectively doubled. We tested products that offered a range of settings at their extremes: optimized for speed (i.e., best speed, worst compression) and for size (i.e., worst speed, best compression). For the PC products, throughput scores are normalized against a Compaq Deskpro 386/33L with no compression. Mac scores are normalized against an SE/30 running System 7.0 without compression. Higher numbers are better.

compressor operates. The results of our benchmark tests, which are listed in table 1 and summarized in the figure, illustrate the speed and compression capability of each package.

After these two main factors come considerations such as price, ease of use, minimum system and memory requirements, and the utilities that each compressor includes. We have considered these in each evaluation. For a summary of features, see table 2.

On-the-Fly Compression

Data compression works by translating a representation of data from one set of symbols to another, more concise, series of symbols. On-the-fly compressors use a variety of lossless compression algorithms, and most manufacturers are tight-lipped about the exact techniques. However, the most common algorithms for general lossless compression are variations on dictionary-based schemes such as LZ (Lempel-Ziv) and its patented cousin LZW

(Lempel-Ziv-Welch). For example, Stacker uses a compression algorithm that Stac Electronics calls LZS, for "Lempel-Ziv-Stacker."

Dictionary-based compressors use symbols to represent recurring strings in the uncompressed input. An encoding dictionary maps these symbols to the strings they represent. With most dictionary algorithms, the decompressor can completely reconstruct the encoding dictionary from the compressed data stream—the compressor doesn't need to explicitly include a decoding table.

LZ and similar techniques make for fast compression and decompression, although decompression is usually somewhat faster. Both attributes serve on-the-fly compressors, since speed is critical for invisible operation and read accesses are often far more common than writes.

Like all lossless compression, on-the-fly compression works by removing redundancy in the source data; therefore, it's highly dependent on the input data type. Source data with a high degree of redundancy (e.g., bit maps or mostly empty databases) compress very well, while more random data (e.g., executable binaries or precompressed archives) don't compress well at all. Text files usually land somewhere in the middle.

To complete the illusion of invisible operation, some on-the-fly compressors "lie" to the operating system about used and available disk storage. The accuracy of a compressor's estimate of effective available space depends on the compressibility of the data you'll be adding; if a disk is half full of text files, adding executable files or bit maps to the other half will probably lead to some weird results.

Measuring Compression

We tested each of the eight software packages reviewed here for speed and compression ratio (see the figure in the main text). Our goal was to come up with accurate tests that were as similar as possible for both PC and Mac compression packages.

To test speed, we ran a mix of application benchmarks and low-level tests. We ran the Word Processing and Database elements of BYTE's application benchmarks. For raw speed measurements, we ran random and sequential file I/O operations on various data representing the most common files: text, executable, bit-mapped graphics, database, and precompressed data. On the PC side, our graphics data came from PCX files and our compressed data came from ZIP files; on the Mac side, our graphics and compressed data came from PICT and StuffIt files, respectively. We kept the Mac's disk cache to a minimum during throughput tests.

We also measured compression ratios for each of the five data types. On the PC side, where the compression applications spanned an entire partition,

we filled the partition with data until the system ran out of room. The amount of data we wrote, compared to the physical space on the disk, provided the compression ratio.

It was relatively easy to check the compression ratios for the three file-at-a-time Mac packages. We just moved the representative data into a file tagged for compression and then rebooted the Mac with extensions disabled; thus, we revealed the file's true sizes. This trick didn't work on Alysis Software's SuperDisk, which apparently made more permanent alterations to the file's directory information. However, we found that we could get the file's true size if we moved it into the Trashcan. Apparently, SuperDisk has to report the true size of the file while the file is in the Trashcan; otherwise, throwing away the trash would result in botched volume and directory data.

Golden Triangle Computers' TimesTwo acted more like the packages we reviewed for the PC; therefore, we ran a ported version of the tests we used on the PC to determine TimesTwo's compression ratio. We should point out

that the compression ratios shown for TimesTwo aren't as exact as those shown for the other Mac packages. A Macintosh creates a desktop database file, and since it's virtually impossible to gauge that file's compression, we cannot know for sure how much space was actually left over for user data.

The figure shows the composite compression ratio—the unweighted average of compression ratios for each file type—and the composite throughput index. We derive the latter figures by taking the ratio of each package's throughput to the throughput the test systems achieved without compression. We used a Compaq Deskpro 386/33L as our test PC; our test Mac was an SE/30.

Table 1 in the main text shows extracted compression ratios and throughput for three specific application areas: Word Processing, Database, and Graphics. The Word Processing and Database throughput figures include the low-level tests and the application benchmarks.



DOS Data Compression

All four packages for the PC use a device driver to fool DOS into thinking it has extra or larger logical drives.

When DOS accesses a compressed disk, the device driver intercepts the data stream and compresses or decompresses it on the way to or from the disk.

The compressed disk is actually a single compressed file in the normal DOS file system. With products such as Stack-er or SuperStor Pro, the compression file usually takes up most of the available hard disk space. In addition to the compression file, there is usually only one copy of the CONFIG.SYS file, a compression driver, and some other device drivers in

the normal file space.

One potential problem is that the compressor requires an additional logical drive letter that refers to the compressed file. Unless the compression package provides a driver that swaps drive letters for you, you may need to adjust all your paths to handle the new drive.

Compression occurs when a number of sectors written to disk are compressed to fewer sectors in the compression file. In addition to compressing, on-the-fly compressors are more efficient in their use of disk space. DOS allocates space to files in clusters, where each cluster is composed of two to 32 512-byte sectors. A cluster is the minimum allocation unit—no matter how little data is in a file, each file must be made up of a whole number of sectors. Typical hard drives have 4-KB clusters, which means that DOS wastes 3 KB of space in storing a 1-KB file. Since all the compressor's interaction with DOS is in a

single normal file, the compressor can allocate space on a thrifter sector basis.

There are some drawbacks to the single-file, sector-based compression method. Just reading a single byte requires the compressor to decompress a full physical sector. The decompressor needs some sizable decompression buffers to work efficiently. Also, the compressor must handle the mapping of logical clusters to physical sectors on its own. All this reading and decompression requires some CPU time, system RAM, and time for disk accesses. On a reasonably fast system with fast drives, such as those we used for our benchmark tests, speed is not really an issue. Fortunately, most of the products include built-in caching and can actually provide better performance than an uncompressed disk.

A word of caution for Windows users: None of the programs we looked at could deal easily with Windows permanent swap

ON-THE-FLY DISK COMPRESSORS

Table 2: All the PC products were sector-based (i.e., they compressed an entire volume), while three of the Mac products let you mix compressed and uncompressed files on the same volume. Beyond this fundamental difference, most of the packages share a common set of features. (N/A = not applicable.)

| | PC | | | | MAC | |
|-----------------------------|-------------------|------------------------------------|---|-----------------------------------|----------------------------------|--------------------------|
| | DoubleDensity 1.0 | Stacker 3.0 | SuperStor Pro 1.0 | XtraDrive 1.0 | AutoDoubler 2.0.1 | Stuffit SpaceSaver 1.0.3 |
| Company | Abacus Software | Stac Electronics | AddStor | Integrated Information Technology | Fifth Generation Systems | Aladdin Systems |
| Price | \$79.95 | \$149 | \$149 | \$99 | \$89.95 | \$59.95 |
| Minimum system requirements | MS-DOS 3.2 | MS-DOS 3.2 | MS-DOS 3.2 | MS-DOS 3.0 | Mac Plus | None specified |
| Minimum memory requirements | 512 KB | 640 KB | 640 KB | 512 KB | 1 MB | 2 MB |
| File-/sector-based | Sector | Sector | Sector | Sector | File | File |
| Passwords | Yes | Yes | Yes | No | No | No |
| Adjustable ratio | No | Yes | Yes | Yes | No | Yes |
| Self-extracting files | No | Floppy-based | Floppy-based | No | Yes | Yes |
| Deinstallation | Yes | Yes | Yes | Yes | N/A | N/A |
| Utilities | | | | | | |
| Defragmenter | No | Yes | Yes | Yes | No | No |
| Diagnostics/repair | No | Yes | Yes | Yes | Yes | No |
| Other | N/A | Removable media; Windows utilities | Removable media; Windows utilities; JPEG Workshop | Optional cache | Finder enhancement (CopyDoubler) | N/A |

files. In installing each of these packages, we had to switch to a temporary swap file or make an uncompressed partition that did not interfere with the permanent swap file.

Crashes are somewhat more serious on a compressed disk than they are on an uncompressed one, because it's easier to lose more data. However, if you regularly back up your disk, you shouldn't have much cause for concern. In any case, you should do a complete backup before you proceed with the initial compression process.

DoubleDensity 1.0

Abacus Software's DoubleDensity is a simple, inexpensive compression utility. It is DOS-based, and although it will run with Windows, it has no Windows-related features, as do some of the other packages reviewed here.

To install DoubleDensity, you must first type in the registration number on the floppy disk to get by copy protection. Next, you select an installation subdirectory and the disk you want to compress. (The maximum size of a DoubleDensity volume is 250 MB.) You also have the option of specifying an eight-character password for data protection. DoubleDensity uses `chkdsk` to scan the disk for lost clusters before beginning the compression process.

DoubleDensity's installation automat-

ically modifies your `CONFIG.SYS` file. If you want DoubleDensity to load high, however, you need to make some manual adjustments. The device driver takes up 47 KB of RAM.

The installation doesn't let you select the default compression ratio. DoubleDensity increases capacity by creating a hidden file called `D_D_VOL` that uses all the available storage space. The device drivers create a new compressed disk that's almost twice the size of the original volume. On our test system, DoubleDensity created a 20-MB E drive out of a 10-MB D drive. When the installation process was through, all the software that was on the D drive ended up on the larger E drive, and we had to fiddle with paths by hand.

DoubleDensity is the leanest package in terms of utilities. Its `chkddv` utility is similar to DOS's `DIR`, but it supplies extra information regarding compression and space availability. Also, a `ddexist` utility tells you whether a disk is a DoubleDensity volume, and a `dall` utility shows a list of all the DoubleDensity volumes installed on your system.

DoubleDensity is inexpensive (\$79.95) and more or less easy to use. It has the best compression of any package we tested. Unfortunately, it's also much slower than any of the other compressors and lacks utilities for determining space usage

by file type and error-correction features. Despite its compression prowess, its lack of speed and utilities make it barely usable.

Stacker for Windows and DOS 3.0

Stacker for Windows and DOS, from Stac Electronics, is almost transparent in operation, and it's fast enough that you probably won't notice any degradation in performance. The program has an easy-to-use interface for both DOS and Windows. At \$149, it's not exactly bargain-basement, but for speed and sheer usability, Stacker is unmatched.

Stacker has two installation methods, one for DOS and one for Windows. When installing Stacker, you can tune it to optimize compression and speed or choose a middle setting.

Stacker creates a `STACVOL` file. This invisible file contains all the compressed files in the "Stacked" drive. The `STACVOL` file on our benchmarking partition used 10,376,192 bytes, leaving approximately 100 KB for Stacker to use as a temporary storage area. There are no significant size restrictions—the uncompressed disk can be up to 1 GB in size, and you are only limited to 10 Stacker drives per system.

Two Stacker device drivers map a drive letter to the compressed file and swap drive

MAC

SuperDisk 2.1

TimesTwo 1.0.1

Alysis
SoftwareGolden Triangle
Computers

\$59

\$149

Mac Plus

Mac Plus

1 MB

2 MB

File

Sector

Yes

No

Yes

No

Yes

No

N/A

Manual
(reformat disk)

No

No

No

Yes

N/A

N/A

letters. If you compress the C drive, the compressed drive will still be C, while the uncompressed drive will become D. The device drivers can detect a permanent Windows swap file and configure themselves to avoid the swap file every time you start up the system. The device drivers use from 36 KB to 64 KB of system RAM. You can load the drivers into high memory or configure Stacker to use EMS, reducing system RAM requirements in either case.

Stacker uses a default compression ratio of 2 to 1, but you can set the ratio to a maximum of 16 to 1. Included in the Stacker package is a version of the Norton Speed Disk. Stacker uses Speed Disk to defragment the files. When Speed Disk finishes its job, the setup program scans the entire compressed disk looking for bad sectors.

One nice bonus is Stacker's Windows capability. After compressing the disk, you can create a Stacker Program Group, which gives you icons for the Stacker Tuner, setup options, a readme file, and a utility called Stackometer. Stackometer uses three gauges to display a compression-ratio summary for the compressed disk. A bar chart shows the amount of disk space needed to store files without compression, compared to the space required to store the same files on a compressed disk. A Disk Space gauge displays used and available capacity on the compressed disk. There's also a graph-

ical display of disk fragmentation levels.

However, DOS users aren't left out in the cold. You can get to all the Stacker utilities from the command line. For example, for detailed information on disk usage, you can use the report utility to display a list of all files on the selected drive and their current compression ratios. You can also use a built-in optimizer to rearrange the files on the disk with either a quick optimize, which rearranges only fragmented files, or a full optimize, which optimizes the entire disk.

The Stacker Tuner lets you change the balance between how fast Stacker works and how tightly it compresses the data. Stacker was fast in both configurations. On our tests, when Stacker was optimized for speed, it actually outran an uncompressed disk. Stacker's compression ratio wasn't as good as DoubleDensity's, but it was better than that of the other packages when set for high compression.

A handy Stacker feature is that you can compress floppy or other removable-media disks. You just use the Stacker setup options to mount and compress the selected disk. You can take the compressed removable disk to any other computer, even one that is not running Stacker, and read and write the data. The compressed disk or cartridge will have two visible files on it: instructions in README.STC and the Stacker Anywhere program (STACKER.EXE). You run the Stacker Anywhere program to access the files on the removable media.

Stacker is fast, provides good compression, and is a comfortable package to use. Stacker's utilities provided accurate information on hard disk space use, data-compression ratios, and error-correction functions. Also, the program's documentation is the best of the four DOS packages we tested.

SuperStor Pro 1.0

If Stacker is the DOS compression utility against which others are measured, SuperStor Pro from AddStor is the next best thing. Although SuperStor Pro shares Stacker's price (\$149) and is more Windows-capable, it's not quite as quick, flexible, or powerful.

Before you install SuperStor Pro, you must disable memory-resident programs (e.g., memory managers such as EMM386 or Compaq's CEMM). The installation program copies the device driver and utility programs to disk. The installer also modifies the CONFIG.SYS file to run the device driver at boot-up.

You continue the installation by running SuperStor Pro's main user program, sstor. With sstor, you can preview

compression results by viewing the uncompressed and compressed disk statistics. You then prepare the disk for compression. During this preparation, the program will recognize a Windows permanent swap file, and it will give you the option of keeping the swap file on a reserved partition or deleting it.

Next, the sstor program asks if you want to compress all or part of the disk. You can select the compression ratio—ranging from 2 to 1 to 8 to 1. We picked the default 2 to 1.

Because we chose to compress a non-booting partition, we had to create a separate mountable drive. The instructions for this custom installation weren't clear; we had to get information from three separate sections of the user's guide. To compress the 10-MB D drive partition, first we had to prepare the disk by making it mountable. Then we had to give the hidden file a unique name. To make the compressed partition automatically mountable, we had to manually change the AUTOEXEC.BAT file.

Like Stacker, SuperStor Pro can swap drive designations, so your compressed drive maintains its old drive letter. Even with the problems we had with the custom installation, we had no problems booting or running the system. Our original uncompressed D drive became a compressed D drive.

The device driver uses 52 KB of system RAM for a simple installation. You can load the driver into high or extended memory, which reduces the system RAM requirements to only 10 KB.

SuperStor Pro also works with floppy disks or other removable media. You just use the sstor menu options to mount and compress the selected disk. The sstor program lets you choose to make files on removable media read-only or read-write. Read-write compressed media include a driver each for DOS and Windows, as well as a Windows DLL. When you get your removable disk to another machine, you only need to run the appropriate driver, depending on whether you are running Windows.

SuperStor Pro has various utility programs, mostly under a single ssutil shell. The ssutil shell provides a variety of essential maintenance functions. The shell's analysis function is similar to that of chkdsk: It analyzes and repairs damage to compressed disks. A disk tune-up component performs fragmentation analysis and a full or partial defragmentation of compressed files. The ssutil shell can also recompress, raising the compression ratio by up to 25 percent by (more slowly) compressing files still further.

continued

Doublespace and DOS 6

We took an early look at DOS 6, Microsoft's heir to the single-user-PC throne. DOS 6 has data compression built into the operating system in the form of a utility called Doublespace. In fact, Doublespace is the subject of a lawsuit filed by Stac Electronics against Microsoft; Stac Electronics alleges that Doublespace infringes Stac Electronics' patents.

From a user perspective, DOS 6 works much like Stacker and SuperStor Pro. Once you install DOS 6, you type in `dblspac`. Doublespace creates what Microsoft calls a CVF (compressed volume file). It also installs a driver that tricks DOS into seeing a CVF as a logical drive. One key difference between Doublespace and the other PC compressors is that the compression driver is actually an operating-system kernel file—its routines become part of the MS-DOS operating system at boot time.

When you install Doublespace, you are faced with two options: You can compress all your existing files in place, or you can simply create an empty compressed logical drive. The former option causes Doublespace to scan your entire partition, compress uncompressed files, move them into the CVF, and delete the original copy



of the file from the regular partition.

Also included in DOS 6 is the MRCI (Microsoft Real-Time Compression Interface). The MRCI allows an application to query the operating system for the presence of a compression server. If a compression server is present, the application can call the server's compression and decompression routines. For example, if your telecommunications application is about to transmit a large amount of data across a network, it can first pass the data off to the compression server and then transmit the compressed information.

Within DOS 6 is an LZ (Lempel-Ziv)-based compression server, which is more or less the compression engine that Doublespace uses to do its work. Although we ran a beta release of DOS 6 (and therefore couldn't produce any conclusive test results), we got a good picture of what the new operating system intends to offer. Our preliminary tests show that the DOS 6 compression engine yields compression ratios that score around the middle of the pack of the DOS products in this review, and throughput performance that scores near the top. Look for tests of the final release of DOS 6 in an upcoming issue of *BYTE*.

Finally, you can adjust the size of SuperStor Pro's compressed partition. Besides the utilities in the `ssutil` shell, there is also the simple command-line `ssdir`, which lists the files on the mounted drive, their sizes, the compression ratio, and the time and date.

Some of SuperStor Pro's utilities are available through a well-designed Windows interface. SuperStor Pro's *SSWIN-PRO* Windows application is more informative than the Stacker equivalent. In addition, SuperStor Pro has a bundled program called the JPEG Workshop, which is a nice Windows application for image compression and light image processing. The JPEG Workshop is not integrated in SuperStor Pro and runs as a

separate program.

Unfortunately, SuperStor Pro is weakest where it matters most—in compression ratio and compression speed. SuperStor Pro turned in below-average scores on both of our measures of performance. Although its good utilities and Windows capability makes SuperStor Pro a strong contender, its performance keeps it from outgunning Stacker.

XtraDrive 1.0

XtraDrive from Integrated Information Technology takes a strange approach to increasing capacity. IIT's XtraDrive doubles the capacity of a hard disk by altering the boot track, replacing the DOS boot record at the BIOS level, and routing disk

function calls through its own device driver and interrupt handler. This has its pros and cons: It is easy to use, but data recovery can be considerably more difficult.

XtraDrive runs under DOS. There are no Windows programs in the package, although the software operates fine with Windows. Advanced installation options let you select expected compression ratio. We selected a ratio of 2 to 1, but you can go as high as 8 to 1. You can also select the EMS cache size, between one and four 16-KB blocks, and an optional system RAM cache of the same size. For the benchmarks, we selected a 16-KB block for the system RAM cache and no EMS cache. Depending on the options, the drivers and cache can use from 40 KB to 90 KB of system memory, although you can load them in high memory.

The program creates two compressed disks equal in size to the original uncompressed disk. In our test system, the 10-MB D drive became a 10-MB D and a 10-MB E drive. XtraDrive keeps all the original data on the new D drive, so paths are retained.

The original disk contains an invisible file called `IITV3.VOL`, which is about 160 KB in size. `IITV3.VOL` is the proprietary FAT (file allocation table) and drive information file for the XtraDrive virtual drive. It is one of two copies; the other copy is saved in a protected location outside of the compressed partition. If the `IITV3.VOL` file is damaged or destroyed, an XtraDrive utility program can rebuild the file.

XtraDrive is a slim package. It features three utilities: an `xdir` utility that is similar to `DIR`, which supplies information regarding compression and space availability, a `chkdisk` equivalent, and a defragmentation utility.

Because of the unique way in which XtraDrive modifies your hard disk, loss of or damage to the XtraDrive device driver will prevent access to the entire hard disk. With the other packages, such as SuperStor Pro or Stacker, loss or damage to the drivers prevents access to only the compressed disk space. Consequently, it is vitally important for you to follow the correct procedure for deinstalling XtraDrive.

XtraDrive provides fair compression and speed. Its technique of directly altering the boot track is unusual. Unlike Stacker and SuperStor Pro, the \$99 package has few utilities and no Windows interface. (Version 2.0, with a larger set of utilities, will soon be available.) XtraDrive also has a no-bells-and-whistles approach to data compression that's easy to work with but its boot-track modifications make us uneasy.

continued

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Data Compression on the Mac

All the products for the PC compress whole disk volumes, but with the products for the Mac, it's a different story. Three of the four Mac products we tested—AutoDoubler, SuperDisk, and StuffIt SpaceSaver—use what's best described as "file-at-a-time" compression. Whenever you open a compressed file or launch a compressed application, the compression utility jumps into action and decompresses a copy of the file. As long as the file remains open, any application accessing it works with a decompressed image of that file. When you close the file, the utility reactivates and recompresses the file.

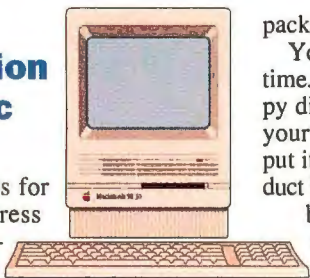
All three of the file-at-a-time compressors enhance the basic scheme with varying degrees of intelligence; for example, they all watch the uncompressed file for updates, and if none occurs, they simply discard the uncompressed image at close time. All three packages are also smart enough to recognize a .SIT file (i.e., a file compressed with the popular StuffIt utility) and don't bother trying to compress it.

This file-at-a-time technique has several advantages. Installation is painless, and you can freely mix compressed and uncompressed files on the same volume. In addition, it means that once a compressed file is open, you're working with an uncompressed data stream, and there's no time penalty for each read and write. However, the packages must play games with the Mac's file system so that, for instance, a Get Info selection returns the file's uncompressed size rather than its compressed size (i.e., its true size as seen by the File Manager).

Our fourth Mac product, TimesTwo, is a more traditional on-the-fly compression package. It operates beneath the Mac's File Manager, deluding your system into believing it has twice as much space as it really has.

AutoDoubler 2.0.1

Once installed on your Mac, Fifth Generation Systems' AutoDoubler waits silently for idle machine time. When such time is available, AutoDoubler begins scanning disks, looking for uncompressed files. It goes to work on any files it finds, turning the Mac's arrow cursor into a miniature AD (for AutoDoubler) so that a quick glance at your screen tells you that the



package is busy.

You can interrupt AutoDoubler at any time. If you move the cursor, insert a floppy disk, or do anything else that requires your Mac's attention, AutoDoubler will put its work aside and permit you to conduct business as usual. When your machine becomes idle again, AutoDoubler picks up where it left off. Your only clue that the package has been active at all (besides the increased disk space) is a small, reverse-video DD stamped in the lower left corner of the icons for those files that have been compressed. (AutoDoubler has a companion product, DiskDoubler, which is a less automated file compression utility. AutoDoubler uses the same compression technology as DiskDoubler; hence the DD stamp.)

Whenever you open a compressed file or launch a compressed application, AutoDoubler sneaks in and decompresses the file. Depending on how big the file is and how you call it up (e.g., whether you open it as a read-only file or as an update file), AutoDoubler attempts to expand the file in RAM and keep its compressed image on disk unchanged. Consequently, the package does its best to keep access as swift as possible.

AutoDoubler carries on its compression in the background, but you can make all sorts of adjustments to its operation through AutoDoubler's control panel. For starters, you can target which volumes you want the package to ignore, so if you have a disk that you keep your immediate work on and you don't want to wait around for decompression when you open a file, you can tell AutoDoubler to skip it. You can also tell AutoDoubler how much idle time it should let pass before it goes into action.

AutoDoubler will decide whether to go to work on a volume based on a free-space target that you set after installation. If after one compression pass it finds that the free-space target is not met, it makes another pass, attempting to compress the files even further. The target and the other settings that the control panel provides help you control AutoDoubler's enthusiasm about compressing files.

If you're running System 7.0, AutoDoubler installs a CopyDoubler utility on your disk. This program is integrated into the Finder and provides a number of useful enhancements. These enhancements include faster file copy (around two times faster) and file deletion (emptying the trash—about 10 times faster), as well as the ability to completely erase deleted files so they can't be illicitly recovered using a file recovery utility.

Fifth Generation Systems also includes the DD Expand utility with AutoDoubler.

DD Expand is an application that can expand any AutoDoubler-compressed file. Since you can freely distribute DD Expand on a noncommercial basis, you can simply copy it onto a floppy disk with your AutoDoubler-compressed files and pass the whole package to others who don't run AutoDoubler.

AutoDoubler provides compression that is as good as that of any of the other Mac packages not optimized for high compression. But AutoDoubler's compression speed was average. Although the \$89.95 AutoDoubler is complete and easy to use, you can find more capability in less expensive Mac packages reviewed here.

SuperDisk 2.1

SuperDisk from Alysis Software is a \$59, item-at-a-time compression program that is more obvious in operation than is AutoDoubler. SuperDisk doesn't operate during idle time; instead, it compresses a file when you close it and decompresses the file when you open it.

To make SuperDisk even more obvious when it kicks in, a pop-up window appears. The window plays a moviola whose main character is a soda can: If SuperDisk is compressing a file, you watch the soda can get crushed; if the package is expanding a file, the can reinflates. This display is charming the first few times, but its charm can rapidly transform into annoyance, particularly in the midst of compressing or decompressing a large file. Fortunately, you can disable this feature.

SuperDisk does not browse whole volumes, as AutoDoubler does. Rather, you tag those items that you want compressed by appending a .S to their names. This is not as arduous as it sounds: You can tag an entire folder, and anything moved into that folder will get compressed. You can also adjust SuperDisk's activity to your own workstyle: Files that you access frequently (and where you don't want to wait for decompression to take place) you simply leave untagged, and you move less active files into a tagged folder.

SuperDisk allows two levels of compression that are more or less a trade-off between speed and size. If you want maximum compression, then you'll pay a speed penalty. If you're happy with a less compact version of the compression algorithm, your system will open and close files more rapidly. Higher compression ratios consume more memory. (Just how much more is difficult to measure, since Mac memory is allocated and deallocated on the fly.) SuperDisk delivers great compression, but unfortunately, it's not very fast, even when set for maximum speed.

SuperDisk's control panel is as animated

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| Model Number | Formatted Capacity | Average Seek | Transfer Rate (MB/s) | 5-Year Warranty |
|--------------|--------------------|--------------|----------------------|-----------------|
| 2105 A | 560 MB | 10 ms | 5max* | Yes |
| 2112 A | 1,050 MB | 10 ms | 5max* | Yes |

*Asynchronous



FAST SCSI-2 INTERFACE

| Model Number | Formatted Capacity | Average Seek | Transfer Rate (MB/s) | 5-Year Warranty |
|--------------|--------------------|--------------|----------------------|-----------------|
| 2105 | 560 MB | 10 ms | 10 max | Yes |
| 2112 | 1,050 MB | 10 ms | 10 max | Yes |

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as its crushing-soda-can pop-up. To alter the package's compression options, you proceed to a dialog box that contains three subpanels: one showing the soda can, another showing a leaping rabbit, and the third showing an elephant. If, for example, you select the most compact compression, the bunny leaps more slowly (showing a speed penalty) and the elephant's girth swells (showing more memory consumption).

Another dialog box from the control panel lets you create *auto-expanding* files. These files are SuperDisk's answer to AutoDoubler's DD Expand utility. An auto-expanding file is compressed like any tagged SuperDisk file, but attached to it is a small piece of executable code that knows how to expand SuperDisk files. You can give an auto-expanding file to a Mac user who does not have SuperDisk, and he or she can decompress the file by simply double-clicking on it.

Finally, SuperDisk lets you password-protect files. When you attempt to open a protected file and the soda-can window pops up, you're prompted to enter the password before the open operation proceeds. This also occurs if you try to launch a protected application.

StuffIt SpaceSaver 1.0.3

StuffIt SpaceSaver (\$59.95) from Aladdin Systems is a direct descendant of StuffIt, the premier data-compression utility for the Mac. The StuffIt utility originally appeared around 1987 as a shareware utility, and since then it has set the standard for BBS compression and has become a commercial product. The commercial version is StuffIt Deluxe 3.0, which includes SpaceSaver.

Interestingly, SpaceSaver and StuffIt Deluxe do not use the same compression algorithm. SpaceSaver is geared for speed; thus, it uses an LZ variation, while StuffIt Deluxe uses a proprietary technique designed for maximum compression.

SpaceSaver operates like a hybrid of AutoDoubler and SuperDisk. Like AutoDoubler, SpaceSaver compresses files during your system's idle time. Decompression takes place when you open or launch a compressed file. As with SuperDisk, SpaceSaver lets you tag files and folders that you want compressed. However, SpaceSaver is not restricted to a predefined tag; you can modify the string that SpaceSaver looks for in file and volume names. Additionally, SpaceSaver will respond to

the tag at the beginning or end of the name.

As with AutoDoubler, you can adjust the amount of idle time SpaceSaver lets pass before it scans your disk. If you need to have files compressed immediately, you can completely disable idle-time compression, and SpaceSaver will work like SuperDisk—compressing when the file closes. If you frequently use more recent files and tend to keep older files around in archives, then you can configure SpaceSaver to only compress those files that have not been modified within a certain amount of time. In this way, SpaceSaver will pass over recently used files as it scans the disk.

SpaceSaver provides the same trade-off between space and speed that we saw in SuperDisk. You can choose "fastest" or "smallest" compression. SpaceSaver was the fastest among the Mac packages and came in second for high compression.

One of the package's unique features is its magic menu. This is a miniature menu icon that appears to the right of the Special selection on the Desktop's menu bar. Clicking on the magic-menu icon activates a pull-down menu that lets you directly expand or compress files. The magic menu

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also allows you to alter some of SpaceSaver's more important configuration parameters (e.g., fast or tight compression) without having to call up control panels.

It's simple to create a self-extracting file (or folder) within SpaceSaver. You can either move the files you want to compress into a folder and append a .SEA extension to the folder name—at which time SpaceSaver compresses that folder into a self-extracting archive—or use the Make Self-Extracting selection from the magic menu. Similarly, SpaceSaver can create .SIT files directly. If you're transferring files and the destination machine has a copy of StuffIt available, .SIT files offer the best compression since there's no executable code to carry for decompression.

TimesTwo 1.0.1

TimesTwo is an unusual, \$149 compression package from Golden Triangle Computers that provides sector-based data compression. When you install TimesTwo, it covers an entire disk volume. In fact, TimesTwo takes over entire disks; you cannot run TimesTwo on a multiply partitioned drive. The company says that it is working to remove this limitation.

TimesTwo's installation is lengthier than those of the other Mac compression products, because it compresses your whole disk at installation time. Although the documentation recommends that you back up your hard disk prior to installation (sound advice), the TimesTwo installations we performed resulted in no lost or corrupted files. Anything on the partition at installation was compressed where it stood.

TimesTwo installs itself beneath the

Mac's Finder, and once it's in place, you don't need to make any adjustments to it. Consequently, TimesTwo doesn't have a control panel for selecting compression ratio or speed. If you install TimesTwo on an empty drive, the package simply makes your disk seem twice as large as its physical capacity. As you move files onto the disk, the actual ratio varies depending on what sort of data you're storing.

The TimesTwo disk has no attendant utility programs. A TimesTwo volume looks to the outside world like an ordinary volume, so there are no self-extracting compressed files to be made.

Because TimesTwo affects the entire disk volume, the only way we could get a good idea of compression ratios was to run a file copy program that filled up the compressed disk—the same technique we used to gauge the compression ratios of the PC products. The test results were pretty good: TimesTwo was fastest among the packages not specifically set for speed, and it gave the best compression for a package not tuned for file size.

However, running our test meant that the TimesTwo driver had to contend with a disk-full condition. When the disk filled, TimesTwo's response was a series of alert dialog boxes that began with strident warnings and concluded with the package telling us that the volume was unusable. It then threw the icon of the compressed disk into the trash.

We got the icon back by rebooting the system. It took the Norton Utilities' Disk Doctor to recover the disk. Since the system chucked the disk into the trash without properly closing any open files, the vol-

ume's bit-map and information block were awry. Sometimes even the Disk Doctor couldn't resurrect the disk. It would tell us there was 75 MB of free space on the disk; however, TimesTwo kept complaining that we had less than 1 MB of space left and warning that we'd better not write any more files to the disk. Running the Verify option from TimesTwo's installer usually fixed the problem; in the most severe cases, we just had to reinstall TimesTwo.

Best to Compress

On the PC side, the overall winner was easily Stacker. It provided everything: the best performance, good data-compression ratios coupled with fast operation, a good user interface for Windows and DOS, an informative set of utility programs, and a well-written manual.

On the Mac side, all the packages were close on both the throughput index and the compression ratio. In the throughput index, SpaceSaver won out, although in compression ratios, there was no clear champion. SpaceSaver and SuperDisk ran a close race even down to the price; however, we chose SpaceSaver based on a mixture of price (\$59.95 is easy to swallow), performance (SpaceSaver always scored at or near the top), and the comfort that comes from a trusted name in compression. ■

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SYSTEM

Ultraportable PCs: Worth the Trade-Offs?

ROBERT E. CALEM

Relentlessly, personal computers continue to shrink. Early portable units, such as the first Compaqs, were actually more *luggable* than portable—they were about the size of a small suitcase and heavy enough to cause hernias. Luggables were soon followed by machines labeled *laptops* because they could be comfortably placed on your lap without blocking circulation. Soon after, the state of the art evolved to *notebook* computers, named for dimensions that were roughly equivalent to a sheet of notebook paper.

Two other categories—*subnotebooks* and *palmtops*—define a class of computers that can go anywhere you can go. Now you need never leave your computer behind. But has the ultraportability trend gone too far? As always, you must consider the trade-offs.

Smaller than a Breadbox

Subnotebooks are smaller than notebook computers but can still run standard DOS applications. These units have no internal floppy drive, helping them achieve lighter weights but hampering convenience. As the subnotebooks get even smaller, they are moving into the roles once reserved for palmtops. Some are now “instant-on” (i.e., you don’t have to wait for them to boot up) and include palmtop-style applications in ROM, such as schedulers and address books. But they still don’t fit into a jacket pocket.

Subnotebooks, in fact, come in a wide variety of shapes, sizes, and capabilities (see table 1). At the head of the class are models powered by processors able to run Windows 3.1 and with bright, backlit VGA displays. Lost in the crowd are models with slightly less powerful microprocessors and solid-state memory in place of hard drives, as well as less impressive

screens. Often, the same PC companies offering notebook computers sell subnotebook models: Dell Computer, Gateway 2000, and Zeos International, for example.

Palmtop computers easily fit into your jacket pocket and are mainly used as personal schedulers, memo-takers, and address books (see table 2). Unlike subnotebooks, a number of palmtops are made by the same consumer electronics companies that sell calculators, organizers, and video games. In fact, palmtop computers are about the same size as some calculators, and they usually weigh only a pound or less.

For this roundup, I used four subnotebooks (see photo 1) and three palmtops (see photo 2). The subnotebooks included the Dell 320SLi, the Gateway 2000 HandBook, the Olivetti Quaderno, and the Zeos Pocket PC. Among the palmtops were the Hewlett-Packard 95LX, the Psion Series 3 256K-s, and the Sharp Wizard OZ-9600.



Photo 1:
Subnotebooks come in ultraportable sizes but still run standard MS-DOS software. The price you pay for compactness is a cramped keyboard or a tiny screen.





SUBNOTEBOOKS

Dell 320SLi

I grew to like the \$2148 Dell 320SLi more and more as I used it. At first, like a child-safety cap on a bottle of aspirin, the two briefcase-type latches that sealed the unit shut were difficult to work. And at about 7½ inches deep and 11 inches wide, it's the largest machine tested. Compared to the other subnotebooks, the 320SLi seemed more cumbersome. In the end, however, its size was a major advantage.

Aesthetically, the 320SLi is the best of the lot. The matte-finished plastic case feels nearly like rubber and is pleasing to look at. The same could not be said about the 320SLi's reflective LCD, which, despite being bright, is difficult to look at

for a long time. Using a graphical word processor that I installed on the 60-MB hard drive, I often lost sight of the mouse cursor. It sometimes seemed to just disappear. Moreover, the dial for adjusting the display's contrast is located too near the machine's power switch. As a result, it's easy to dim the display accidentally before turning on the computer. The screen is big, though, thanks to the machine's large size.

The supplied external floppy drive is small enough to fit in a shirt pocket, but the 320SLi's best feature is a keyboard that is large enough to permit fast touch-typing. A clever keyboard mouse is designed in as well, although not clearly marked. I discovered it only after reading the plainly written and well-organized user's guide.

BYTE ACTION SUMMARY

■ WHAT SUBNOTEBOOKS AND PALMTOPS ARE

Subnotebooks are significantly smaller than traditional notebooks but still run standard DOS applications. Palmtops fit in a coat pocket and are more suited to personal scheduling and, in most cases, number crunching.

■ LIKES

Ultraportability; integrated applications.

■ DISLIKES

Touch-typing on subnotebooks is difficult; on palmtops it is impossible.

■ RECOMMENDATIONS

The HP 95LX combines impressive power in a palmtop package. Among the subnotebooks, the Gateway HandBook strikes the best mix of power, portability, features, and price. But go with a standard notebook unless portability is your top concern.

Serial, parallel, keyboard/mouse, and VGA display ports are all located together in a convenient rear bay. The 386-class microprocessor that powers the 320SLi provides brisk performance at all times. The machine's larger size sacrifices some convenience, but that trade-off is sufficiently balanced by the advantages of a larger screen and keyboard.

Gateway 2000 HandBook

The \$1295 HandBook was the subnotebook I tried first. I like it, despite some drawbacks. Its most outstanding feature is a backlit LCD with blue characters. It's the best screen in the group. Unfortunately, the HandBook's keyboard suffers from unusual placement of certain frequently used keys. The backslash key, for example, is positioned in the lower-right corner in a difficult-to-reach spot rather than in its familiar locale above the Enter key. Moreover, the keyboard, while better than all but the 320SLi's, would benefit from wider key-spacing.

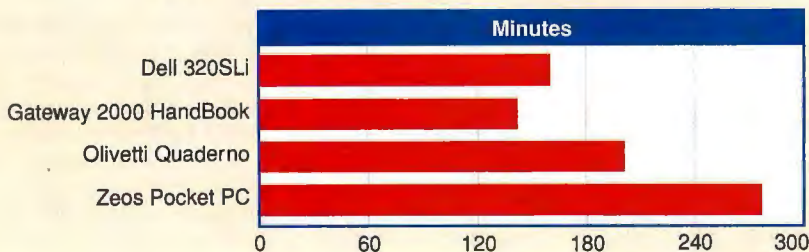
The slightly cramped keyboard contributes to the compact dimensions of the HandBook. It's small enough to fit in your lap with room to spare. But that extra room would be taken up by the HandBook's

SUBNOTEBOOK FEATURES

Table 1: Subnotebooks come in a range of sizes and capabilities. Of these four, the Gateway HandBook is the only one with a backlit display. The Dell 320SLi sacrifices some portability for a larger screen and keyboard. (● = yes; ○ = no.)

| | Dell Computer | Gateway 2000 | Olivetti | Zeos International |
|---|---|---|--|---|
| Subnotebook model | 320SLi | HandBook | Quaderno | Pocket PC |
| Price | \$2148 (with 4 MB of RAM) | \$1295 | \$1195 | \$595 |
| Processor | 20-MHz 386SL | C&T 10-MHz 8680 | 16-MHz NEC V30HL (8088-compatible) | 7.15-MHz NEC V30 (286-compatible) |
| RAM (standard/maximum) | 2 MB/10 MB | 1 MB/3 MB | 1 MB/1 MB | 1 MB/1 MB |
| Dimensions (D×W×H; inches) | 7.8×11×1.3 | 5.9×9.8×1.4 | 6.0×8.3×1.2 | 4.5×9.6×0.88 |
| Weight | 3.6 lbs | 2.75 lbs (with battery) | 2.0 lbs | 1.2 lbs |
| Display type | Reflective triple-supertwist LCD | Backlit supertwist LCD | Reflective LCD FSTN | Supertwist LCD |
| Keyboard layout | 85 keys | 78 keys | 94 keys | 81 keys |
| Integrated mouse | ● | ○ | ○ | ○ |
| Battery type | Rechargeable nickel-metal hydride | Rechargeable nickel-metal hydride or six AA | Nickel-cadmium or six AA | Two AA |
| Battery life (vendor spec.) (without power conservation) | 3.5 hours | 2.5 hours | 2 to 4 hours | 10 hours |
| Recharge time | 1.5 to 2 hours | 2 hours | 3 hours | Not applicable |
| External floppy drive | Standard | Optional | Optional | Optional (through parallel port) |
| Hard drive size | 60 MB | 40 MB | 20 MB | IC cards (512 KB, 1 MB, 2 MB) |
| Ports | PCMCIA, serial, parallel, VGA, keyboard | Parallel, serial | Serial, parallel, PCMCIA | Serial, parallel, two PCMCIA Type 1 |
| Accessories | Tape drive, battery charger, external keypad | 2400-/9600-bps fax modem | Cigarette-lighter adapter | Serial and parallel adapters |
| Included software | | | | |
| Editor | ● | ● | ● | ● |
| Spreadsheet | ○ | ● | ○ | ● |
| Database | ○ | ● | ○ | ● |
| Address book | ○ | ○ | ● | ● |
| Scheduler | ○ | ● | ● | ● |
| File transfer | ● | ● | ● | ● |
| Other | MS-DOS, Windows | MS-DOS, Windows | MS-DOS, audio software | MS-DOS |

SUBNOTEBOOK BATTERY LIFE



Tests performed by the BYTE Lab indicate the type of battery life you can expect without power-conservation features. The Zeos Pocket PC used alkaline batteries; the other units were tested with rechargeable batteries.

Combo Unit. This \$265 option houses an external floppy drive, as well as serial and parallel ports to supplement the ones found

on the HandBook itself.

Microsoft Works for DOS, which comes loaded on the HandBook's 40-MB hard

drive, was easy to use from the start. I was up and running with the unit right after unpacking it, and there was little need to read the simple user's guide.

On one occasion, the HandBook slipped into a coma while in suspend mode, and no amount of fidgeting would awaken it. My call to Gateway's support line was answered quickly, though, and I was back up and running in less than 3 minutes. The solution: pressing a reset switch on the bottom of the machine. Another alternative—pressing Fn-Alt-Del to reshow the BIOS, clear memory, and issue reset commands to some hardware functions—was ineffective, as was attempting to warm-boot the machine.

I was disappointed by the slow performance of the Chips & Technologies 8680 PC/Chip microprocessor that powered the HandBook. Often, something as simple as



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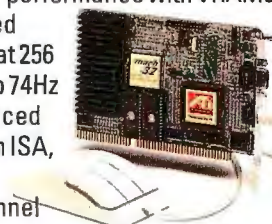
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saving a text file within Works took so long it left me wondering if I had stalled the system. Still, I liked this machine and loved the bright, backlit display.

Olivetti Quaderno

Like a fine Italian sports car, the \$1195 Olivetti Quaderno is fine to behold. It has some nifty features. But like a sports car, this machine has limited appeal. The unit is highly compact, but the keyboard is too cramped for touch-typing. It also suffers from a dim reflective display.

The XT-compatible Quaderno includes audio features that set it apart from the other systems. Built-in audio-recording software lets you store voice messages in MS-DOS file format on the internal 20-MB hard drive. You can record voice files with a microphone hooked to a port on the computer's side and use them within any of the Quaderno's built-in applications or most word processors. The usual cassette-player controls—fast-forward, rewind, pause, play, and stop—are located on top of the machine, and you monitor functions on a small LCD screen that is always visible. You can use the controls even when the system is closed.

Built-in software includes a word processor, calculator, calendar, business card database, and phonebook. All are easily accessed from a main menu and are simple to learn. The unit is powered by a rechargeable nickel-cadmium battery or six AA batteries. Options include a car cigarette-lighter adapter and an external floppy drive. While the Quaderno is probably the most unique system in this lineup, it falls a bit short when confronted with serious business tasks.

Zeos Pocket PC

The Zeos Pocket PC strikes a middle ground between subnotebooks and palmtops. It's extremely portable, runs on AA batteries, and has built-in palmtop-style software, such as a scheduler and an address book. But the DOS interface and programs will still be familiar to PC notebook users.

As soon as you turn on the juice to the Pocket PC, an attractive main menu greets you, with graphical buttons depicting the eight built-in software applications. The choices include file management, calendar, to-do list, card file, and calculator software, Microsoft Works for DOS, a file transfer utility, and an information base listing international telephone area codes, weight and measure conversion tables, and user-customizable currency exchange rates. The combination of a function-key interface and an underlying DOS interface makes the Pocket PC easy to learn and

use. The user's guide, however, is intimidating, with small, dark type and very little white space.

The Pocket PC is an XT-compatible system, making it a relatively slow machine. The keyboard, just wide enough for touch-typing, lacks a solid feel, but it employs an efficient layout with no keys mysteriously placed in awkward locations. The unit houses two PCMCIA card slots as

well as a serial and parallel port.

At \$595, and without a real hard drive, the Pocket PC comes very close to being categorized as an electronic organizer. In the end, however, it is distinguished from those devices by its 10-inch-wide keyboard size. If you're looking for one machine that doubles as a scheduler and a low-end subnotebook, Zeos offers a clever combination.



Photo 2: *Palmtop computers can usually fit in a coat pocket. They can handle scheduling, note-taking, and some pretty serious spreadsheet work—but forget touch-typing.*

PALMTOPS

Sharp Wizard OZ-9600

The OZ-9600 was the newest and in some ways the best palmtop computer I tested. Still, some improvements are required. The unit sells for \$649 and comes standard with 256 KB of RAM.

Although too large and heavy to fit comfortably in any pocket, the OZ-9600 won't occupy too much space in a briefcase or handbag. And despite having the largest reflective LCD in the group, its application screens are often cramped with narrow rows and columns. The interface is sometimes difficult to navigate. At one point, I found myself stuck trying to delete an entry in the to-do list. A search through the user's guide revealed an overly complex menu system. And while the user's guide clearly explains how to use all the OZ-9600's many features, its heft and complexity can be intimidating.

I appreciated some of the unique features. The display, for example, is touch-sensitive. The special pen that ships with the device, when combined with integrated "digital ink" software, turns the OZ-9600 into an electronic notebook where you can write notes on the screen and store them away for later retrieval. This scrapbook might even temporarily substitute for the other integrated applications, such as the appointment scheduler or card file, until you have learned how to use them effectively.

Other interesting features include a built-in infrared system for transmitting data from one OZ-9600 to another (or to a personal computer hooked up to an optional interface device) and a built-in word processing program that is powerful enough to be used on a PC. Unfortunately, its power was difficult to use for very long because the machine's small keyboard is not well suited to touch-typing. Overall, the OZ-9600 is intriguing and powerful, but I found its interface somewhat complex.

Psion Series 3 256K-s

The \$545 Psion Series 3 is the smallest, lightest, and best-looking of the three palmtops. It is also the easiest to learn because of its simple interface. I was able to effectively use the Series 3 right away. Icon buttons located just above the keyboard open the built-in applications. These applications include Lotus 1-2-3-compatible software, a personal scheduler, a calculator, a world clock, and a word processor. The keyboard itself is uncluttered, and the light keys are easily distinguished against the darker background. Like the other palmtops, though, it's too small for touch-typing.

A main menu on the reflective LCD lists the data contents of the various multitasking applications. The display itself is small but adequate.

Like Sharp's OZ-9600, the Series 3 is accompanied by a hefty user's guide, but this guide is not as well written. It did not,

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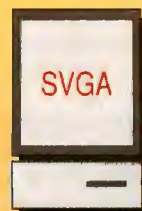
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| Spatial definition | 768 x 576 (PAL and SECAM) 640x480 (NTSC) | 720x512 (PAL) 640x480 (NTSC) |
| Aspect ratio | square pixel | rectangular pixel |
| Size of the board | short: compatible with desktop PCs | long |
| Technology | miniaturized: SMT | classic |
| Installation | no switches at all | many switches |
| IRQ, DMA | none: high compatibility | several IRQ and DMA |
| SVGA modes | all | limited |
| Video feature connector | not needed | absolutely necessary |
| RAM limitation in your PC | unlimited | conflict above 8 MB |
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PALMTOP FEATURES

Table 2: *Palmtops are about the size of electronic calculators and run on alkaline batteries. The HP 95LX includes Lotus 1-2-3 in ROM. The Sharp Wizard OZ-9600 features a touchscreen and infrared communications. (● = yes; ○ = no.)*

| | Hewlett-Packard | Psion | Sharp Electronics |
|-----------------------------------|---|---|--|
| Palmtop model | HP 95LX | Series 3 256K-s | Wizard OZ-9600 |
| Price | \$550 for 512-KB model, \$799 for 1-MB model | \$545 | \$649 |
| Processor | NEC V20H (8088-compatible) | NEC V30H (80C86-compatible) | Proprietary |
| Standard RAM | 512 KB or 1 MB | 256 KB | 256 KB |
| Dimensions (D×W×H; inches) | 3.4×6.3×1.0 | 3.3×6.5×0.9 | 4.1×7.1×1.0 |
| Weight | 11 ounces | 12 ounces | 15 ounces |
| Display type | Supertwist LCD | Retardation film LCD | Touchscreen LCD |
| Display size (inches) | 1.9×4.5 | 1.5×3.9 | 3.0×4.0 |
| Ports | Serial | Serial | Serial, infrared |
| Card slots | One PCMCIA | Two (solid-state disks for RAM, EEPROM, or ROM) | One proprietary Wizard slot |
| Batteries | Two AA | Two AA | Four AAA |
| Options | Connectivity pack, serial interface, RAM cards, dictionary card | Serial and parallel interfaces, C development environment, language translator, software cards | Wireless printer and computer interfaces, PC and Mac link software, 30 software cards |
| Integrated software | | | |
| Editor | ● | ● | ● |
| Spreadsheet | ● | ● | Optional |
| Calculator | ● | ● | ● |
| Address book | ● | ● | ● |
| Scheduler | ● | ● | ● |
| To-do list | ● | ● | ● |
| File transfer | ● | ● | ● |
| Other | File utility | Database, programming language, world information, Spanish version | World clock, electronic ink pad, filer |

for example, explain how to clear the calculator's "list of previous calculations," a pot into which all solved problems are thrown when a new problem is begun. Neither could I figure out how to do this on my own. To the day I sent the unit back, the list remained.

The Series 3 works very well as a simple organizer and scheduler. It does not offer some of the high-end features of the OZ-9600 or the HP 95LX, but it is very easy to learn and use. If you want an electronic replacement for your Day-Timer, the Series 3 is a solid choice.

Hewlett-Packard 95LX

The HP 95LX is quite plain, with a small keyboard featuring black keys on a black background, but don't let the aesthetics fool you. HP has packed a lot of power into a small package, as evidenced by the intimidating user's guide. The guide is nearly as thick as the Concise Oxford Dictionary that sits on the shelf above my PC. But there is a lot to cover here. The HP 95LX contains real Lotus 1-2-3, not a com-

patible, in ROM; and much of the manual is devoted to explaining the spreadsheet program alone. The HP 95LX also features a high-end HP scientific calculator and the usual array of applications: a to-do list, an appointment diary, a memo editor, a card file, and a telephone directory. It also has MS-DOS loaded into ROM.

For data communications, the HP 95LX is a powerhouse—especially considering the number of after-market wireless devices that will work with it to send and receive information over long distances. It also boasts the most on-board memory for data storage: The \$799 model includes 1 MB; the \$550 model holds 512 KB. Its reflective LCD is adequate.

If you have serious spreadsheet work in mind for your palmtop computer, the HP 95LX is an excellent choice. You'll also appreciate the connectivity pack for transferring files to your PC.

Carry-Along Alternatives

Subnotebook and palmtop computers serve very different needs. The larger machines,

while they can be loaded with the same types of applications found in the palmtop models, are not nearly as portable and are usually more expensive. Moreover, battery life for the subnotebooks is measured in hours, not weeks or months as with the palmtops, and that often means you'll have to take along a cumbersome AC adapter. Add to that an external floppy drive and perhaps a spare battery, and you might be looking at a major nuisance.

You should consider these systems only if portability is your chief criterion. When testing the battery life of the subnotebooks (see the figure on page 166), the BYTE Lab discovered some problems with voltage levels on the serial port. The Gateway HandBook, in particular, provided unacceptable voltage levels to the serial port as battery power began to degrade. And, in general, the subnotebooks did not seem as sturdy as standard notebooks. These types of problems emphasize the nature of these units: They are not in the same class, in terms of power and functionality, as standard notebook computers.

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At only 9 1/2" x 4 1/2" and only 1.3 lbs., what's great about the ZEOS Pocket PC is that it has a keyboard you can really use. If you're accustomed to typing with both hands, switching to a palmtop can be awkward because the keyboard only lets you type with one hand or even one finger. Yet the ZEOS Pocket PC's keyboard lets you use both hands easily, so you won't sacrifice comfort and speed for portability.

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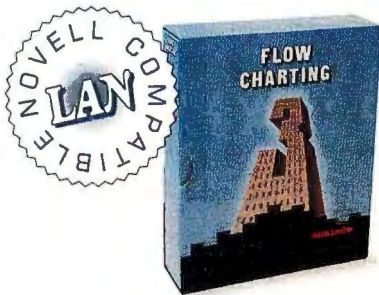
Of the units tested, I really appreciated the Dell 320SLi's larger keyboard and the form factor of the Zeos Pocket PC, but the Gateway HandBook offers a strong combination of features and, even with the optional floppy drive included, lists for almost \$600 less than the 320SLi.

The palmtop units can be useless if your major work entails typing or using powerful PC software while mobile. They're intended as supplements, not substitutes, for a desktop or even a notebook PC. They

can be very efficient organizational tools if used to their full advantage as replacements for the myriad scraps of paper that might be floating around in your pockets and on your desk right now. Because of its impressive mix of power and features, I recommend the HP 95LX. ■

Robert E. Calem is a freelance computer journalist based in New York. He can be reached on both BIX and MCI Mail as "rcalem."

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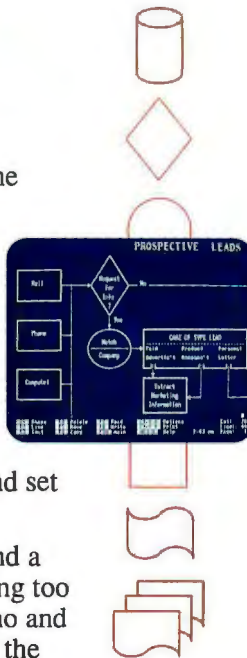
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HARDWARE

PowerBook Peripherals

TOM THOMPSON

In October 1991, Apple introduced the PowerBooks, the company's new line of notebook computers. A year later, Apple delivered more powerful PowerBooks and introduced new, lightweight PowerBook Duos designed for docking stations. As small and light as the original PowerBook and the PowerBook Duo are, their designs actually offer significant room for expansion. Both models have two slots: a memory slot for adding extra RAM and a modem slot for installing an optional modem.

Unfortunately, Apple offers only a few options for these systems: a pricey 4-MB RAM expansion board for each machine; a 14,400-bps data and 9600-bps fax modem, called the Express Modem, for each machine; and a 2400-bps fax/data modem for the PowerBook. Naturally, third-party vendors leapt at the opportunity to get a piece of the PowerBook action, and they quickly offered their own expansion hardware at competitive prices.

To see how this third-party expansion market is developing, I gathered together a variety of peripherals, ranging from network connectors to modems to a Duo docking unit, for evaluation. For hardware, I used a PowerBook 180 and a PowerBook Duo 230. This review is by no means intended to be a comprehensive guide to every PowerBook peripheral on the market, but it does offer an overview of some of the more significant products that are now available.

While I found plenty of products for the standard PowerBooks, there were virtually none for the Duo. Two factors account for this paucity of Duo peripherals. First, the Duo is a new design, on the market for scarcely six months. Second, the dimensions and power requirements for Duo expansion boards are radically different from those of the PowerBook, which means that even seasoned third-party vendors practically had to start over on the peripheral designs.

At the time of this review, most Duo products were still preliminary or in very short supply. Even Apple was experiencing difficulties: The Duo 230 that it sent me came without an Express Modem or MiniDock. By the time you read this, however, more Duo peripherals will be available.



Photo 1:
Two ways for PowerBooks to tap into Ethernet: Asanté's EN/SC PB (left) and Dayna Communications' DaynaPort SCSI/Link-3 PB (right).

Outside In

Gaining access to the PowerBooks' innards is a simple matter of loosening some screws. You'll need a Torx #10 and a Torx #8 driver for the PowerBook 140, 145, and 170, while just a Torx #8 suffices for the PowerBook 160 and 180 and the Duo 210 and 230.

First, shut down the PowerBook and take out the battery. Remove the four screws from the bottom and then the one at the back. Next, gently pry open the PowerBook at the front seam, starting at the battery compartment. Then unplug the SCSI cable from the internal hard drive and separate the top and bottom sections of the notebook to get at the slots.

To open up the PowerBook Duo, you loosen the three rearmost screws on the bottom of the computer. (Do not loosen the deeply recessed screw near the front!) Then turn the Duo over, and gently pry up the keyboard with your fingernail. Don't yank it, because the keyboard is attached to the main unit by two slender ribbon cables. Beneath the keyboard, on the main logic board's right side, are the two slots for memory and a modem board.

For a good description of how to open a PowerBook safely, get a copy of *The PowerBook Companion* by Richard Wolfson (Addison-Wesley, 1992). This book is chock full of tips and hints on the care and feeding of PowerBooks, and it's well worth the money.

Exercise care when opening these com-

puters, as you can easily damage them. Neither I nor BYTE is responsible if you damage your PowerBook while following these instructions. If you're not handy with tools or if the PowerBook is still under warranty, take the computer and peripheral to a dealer for installation.

Network Connections

The high-end PowerBooks (the 160, 170, and 180) have enough processing power and hard disk capacity (80 to 120 MB) to make them suitable as substitute desktop systems. But how do you connect them to the office network? Of course, there's the LocalTalk port, but if the notebook is going to play desktop computer, you will also want it to manipulate large chunks of data. That job requires being hooked into Ethernet.

Some hardware solutions are available. Two are Dayna Communications' DaynaPort SCSI/Link-3 PB and Asanté's EN/SC PB (see photo 1). These are Ethernet interface units that attach to the PowerBook's SCSI port. Clever Ethernet driver software routes network traffic through the SCSI port, to the interface unit, and out over the network. Both units have two DB-25 SCSI ports and a SCSI ID selector switch so that they can be daisy chained with other SCSI devices; they provide thick, thin, and 10Base-T Ethernet connectors. Be sure that you specify the PB version to obtain the special HDI-30 SCSI-to-DB-25 SCSI adapter cable required to connect these

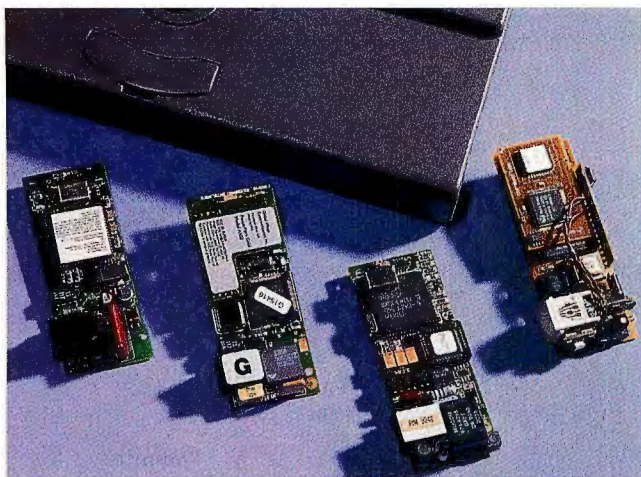


Photo 2: Internal modems for the PowerBook (from left to right): PSI Integration's PowerModem IV, Global Village's PowerPort/Gold, Supra's SupraFaxModem 144PB, and Applied Engineering's DataLink PB.

peripherals to the PowerBook.

Both the SCSI/Link-3 PB and the EN/SC PB provide an Installer disk, along with the appropriate driver software. Be careful when you do the installation: The Dayna installation script wants to install a serial version of the driver (it has no way of knowing there's a SCSI device present if the SCSI/Link-3 isn't powered on, so it guesses), and the Asanté installation script wants to add AppleTalk 57. Version 57 supplies some important features that the driver requires, but it is superseded by AppleTalk 58, which is found in the PowerBook 160 and 180. For both peripherals, you should click on the Custom Installation

button when you run the Installer and make the choices yourself. If you sidestep these pitfalls, the SCSI/Link-3 PB and the EN/SC PB both work well, providing high-speed Ethernet communications—including printing and file sharing—with a minimum of trouble.

If you are unable to get an Ethernet connection because you have a PowerBook Duo (which doesn't have a built-in SCSI port), check out Farallon's PowerPath solution. PowerPath consists of two PhoneNet nodes and a cable, plus a disk of software. You plug one node into the Duo's LocalTalk port and the other into the printer port of a desktop Mac connected to Ethernet. Then you copy the PowerPath Control Panel to the desktop Mac and reboot.

The PowerPath software acts as a forwarding agent, routing network traffic appearing at the printer port onto the Ethernet network. From a Duo 230 connected to my office Mac IIci running PowerPath, I was able to access BYTE's file servers and printers located on the Ethernet. Furthermore, when the Duo ran File Sharing, other Macs on the network could see the Duo and access its hard drive. Network traffic operates at LocalTalk speeds, and the host Mac's performance plummets when the Duo accesses the network; still, at \$149, the PowerPath offers a quick but elegant network connection for Duo owners.

Going Serial

For keeping in touch with the office, either by E-mail or by ARA (AppleTalk Remote Access), you have a wide choice of PowerBook-compatible modems (see photo 2). I looked at four V.42bis/V.32bis modems: Global Village Communication's PowerPort/Gold, PSI Integration's PowerModem IV, Applied Engineering's DataLink PB, and Supra's SupraFaxModem 144PB. These modems have 14,400-bps data and

send/receive fax capabilities, except for the PowerPort/Gold (14,400-bps data, 9600-bps send/receive fax). Each is compliant with MNP levels 2-5; the DataLink PB also complies with MNP level 10.

The DataLink PB also comes with built-in digitizer hardware and memory that allow it to act as a telephone, a speakerphone, and an answering machine. I didn't check out this feature because it required soldering wires to the PowerBook 180's main logic board.

Each modem has disks containing fax software, a CCL (Connection Control Language) file for ARA, and perhaps a modem control panel. All come bundled with terminal-emulation software—typically MicroPhone 1.7, except for the DataLink PB, for which a freeware terminal application is provided. I had no problem installing any of the boards.

For modem tests, I called the National Bureau of Standards atomic clock to reset the PowerBook's date and time (which get lost when you remove the battery during modem installation), faxed a three-page document with a mix of typefaces to our fax machine, and dialed into BYTE's AppleTalk network as an ARA client. I used Shiva's LanRover/L and an external SupraFaxModem to manage the ARA server connection.

Global Village's Control Panel 2.04 did not recognize the PowerBook 180. However, the PowerPort/Gold still functioned, so I called AppleLink and downloaded the company's 2.06 software revision. Once I updated the software, the PowerPort/Gold was the only modem to run through the tests without problems. The PowerPort/Gold's data dial-up test ran cleanly; the faxed output was crisp at the high-quality settings; and I got good 14,400-bps ARA connections to the network every time.

With the other three modems I experienced some problems, all having to do with software. The difficulties involved either the CCL file, which ARA relies on to configure the modem properly and to establish a connection, or the fax software. PSI Integration, Applied Engineering, and Supra all rely on STF Technologies for their fax software. For the DataLink PB and the SupraFaxModem, the STF Installer didn't have the name of the modem in its selection list. I had to guess, using a related modem name, or install the software by driver type. Once the software was installed properly, I got fine faxes out of these modems.

The PowerModem IV faxed without incident, but I had all sorts of problems trying to establish an ARA session with it. With the PowerModem IV CCL, ARA did not recognize the modem at all. A

BYTE ACTION SUMMARY

■ WHAT POWERBOOK PERIPHERALS ARE

Third-party hardware that delivers expanded functionality—communications, network connections, or other services—to Apple PowerBooks.

■ LIKES

These peripherals connect your PowerBook to the world.

■ DISLIKES

There's a dearth of peripherals for the Duo Dock; some of the modems have software problems.

■ RECOMMENDATIONS

Wait for the PowerBook Duo peripherals market to mature somewhat before making any large-scale purchases.

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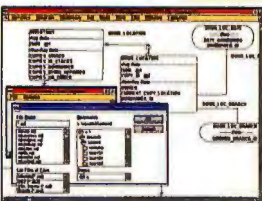
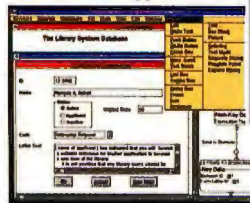
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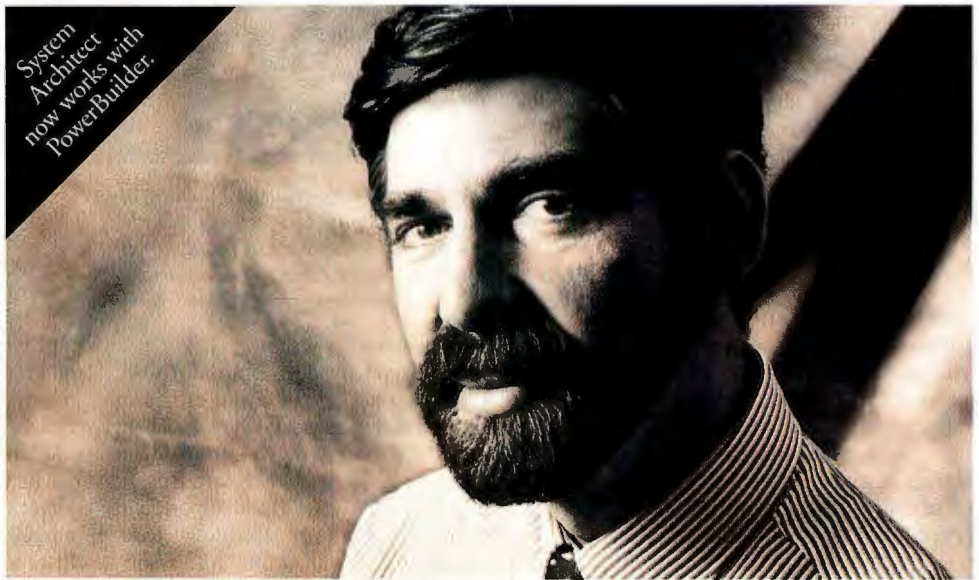
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call to PSI's technical support confirmed that this CCL file was bad. The company sent me a new version of the file via AppleLink, and, at last, I was able to get ARA sessions at 14,400 bps.

The SupraFaxModem had the same problem, but I found a CCL (the Practical Peripherals 14400-SXFA) that allowed me to establish 14,400-bps ARA sessions reliably. The DataLink PB was the only modem besides the PowerPort/Gold whose CCL file worked perfectly the first time, providing me with 14,400-bps sessions.

These are all good modems, but their effectiveness can be seriously hampered by the software. Global Village writes its own fax software to avoid problems. PSI has just bought STF's fax source code so it can manage its own updates and add new features, such as a one-stop fax menu and OCR (optical character recognition) software.

Currently, only a few fax machines can accept faxes at 14,400 bps, but that will change over time. Those funky CCL files are a more serious problem. Most people shell out extra for these modems so that they can connect to the office network through ARA at high speeds. An ineffective CCL file can turn that high-performance, high-priced modem into useless junk.

Getting Docked

Earlier, I mentioned a shortage of PowerBook Duo peripherals. In fact, there was exactly one ready at review time: E-Ma-



Photo 3: E-Machines' PowerLink Presenter plugs into the Duo's back expansion connector and provides a floppy drive connector, a port for the ADB, a sound jack, and external video ports.

chines' PowerLink Presenter.

This docking module plugs into the Duo's back expansion connector and brings out a variety of useful signals. There is an HDI-20 floppy drive connector, a port for the ADB (Apple Desktop Bus), a sound jack, a DB-15 RGB video port, and a composite video port. The PowerLink Presenter's driver and frame buffer support monitors in sizes ranging from 13 inches (displaying 256 colors) to 21 inches (displaying 16 colors). The PowerLink Presenter also supports a "virtual desktop" 1656 by 1296 pixels when it's in black-and-white mode.

I plugged the PowerLink Presenter into the back of the Duo 230 (see photo 3) and checked it out. It worked fine driving both 13- and 16-inch Apple monitors. Better still, I didn't have to plug in the power charger to use them—unlike with the

PowerBook 180, which insists on running off its power charger when an external monitor is connected.

The video mirroring mode worked fine (video mirroring allows you to see an identical image on both the PowerBook screen and the external monitor), as did a mouse plugged into the ADB port. I plugged a stereo amplifier input cable into the sound jack and got bowled over when a beep sound came blasting out of the speakers.

I routed the composite video to a small color monitor and got a good image: E-Machines has some sophisticated deconvolution hardware inside the PowerLink Presenter that minimizes the shimmering that occurs

when 1-pixel-wide lines are shown on an interlaced display. A Duo, monitor, PowerLink Presenter, and mouse would make a dandy on-the-road demonstration machine.

The diversity in the current crop of peripherals indicates that the PowerBook market is growing rapidly. The presence of different vendors, especially for modems, will only produce better products while driving prices down. I expect to see even more interesting things happen when the PowerBook Duos arrive in force. Stay tuned. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is also an Associate Apple Developer. You can contact him on BIX as "tom_thompson," or on the Internet at tomt@bytepb.byte.com.

ITEMS DISCUSSED

DataLink PB\$525
Applied Engineering, Inc.
3210 Beltline Rd.
Dallas, TX 75234
(800) 554-6227
(214) 241-6060
fax: (214) 484-1365
Circle 1075 on Inquiry Card.

DaynaPort SCSI/Link-3 PB.....\$499
Dayna Communications, Inc.
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Salt Lake City, UT 84144
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EN/SC PB (for thick, thin, and 10Base-T cable).....\$499
EN/SC 10-T PB (for 10Base-T only).....\$419
Asanté Technologies, Inc.
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PowerLink Presenter\$499
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9305 Southwest Gemini Dr.
Beaverton, OR 97005
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PowerModem IV\$495
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PowerPath.....\$149
Farallon Computing
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PowerPort/Gold.....\$499
Global Village
Communication
685 East Middle Field Rd.,
Building B
Mountain View, CA 94043
(800) 736-4821
(415) 390-8200
fax: (415) 390-8361
Circle 1081 on Inquiry Card.

SupraFaxModem 144PB.....\$349.95
Supra Corp.
7101 Supra Dr. SW
Albany, OR 97321
(503) 967-2400
fax: (503) 967-2401
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SOFTWARE

OS/2's Multimedia Extensions

TOM YAGER

With the release of Multimedia Presentation Manager/2, IBM bridges the gap between OS/2 and the world of multimedia. MMPM/2 builds a systems-level foundation for multimedia applications into OS/2, inviting developers and multimedia producers to create their programs and materials on IBM's powerful PC operating environment.

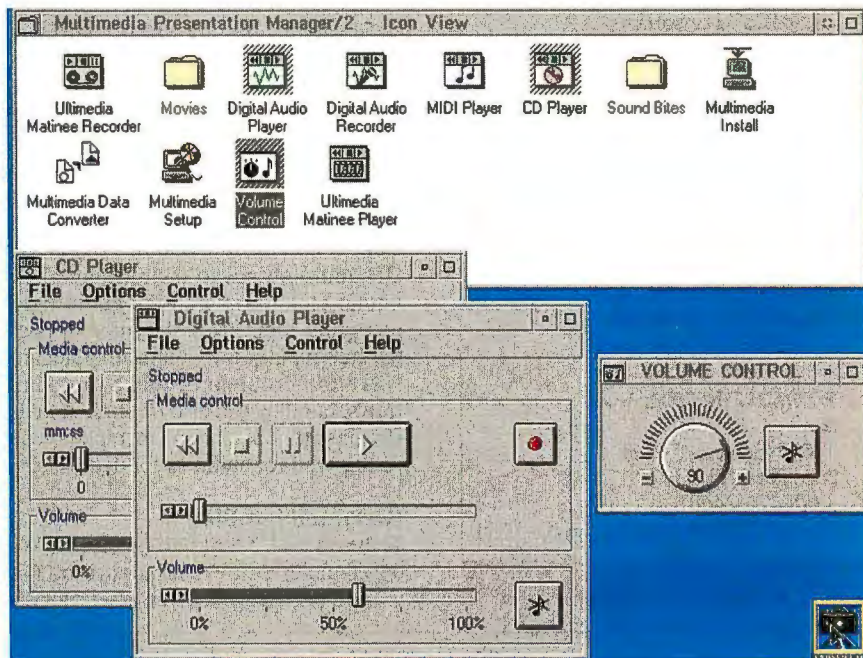
The Flyby

IBM didn't spend a lot of time making MMPM/2 glamorous. The packaging and documentation are minimal. That treatment fits, though, because MMPM/2 isn't an application; it's an OS/2 extension. You can get the basic version of MMPM/2 on floppy disks or preinstalled on a PS/2 system, or grab the development kit on CD-ROM (MMPM Toolkit/2).

The basic version of MMPM/2 came to me loaded onto a PS/2 Ultimedia Model 77. This system, and its less-expensive brother, the M57 SLC (see "IBM's New System Speaks for Itself," September 1992 BYTE), are the target hardware environment for MMPM/2. I had both the shipping version and a prerelease of the next version of MMPM/2 for this review, and while I can't go into detail about those things that aren't real yet, I can say that IBM is planning some support for non-PS/2 systems.

I installed the CD-ROM developer's toolkit version onto my system. The installer lets you choose from among the available drivers and modules, which include complete on-line manuals, sample source code, and the header files and libraries you need to write C or assembly language programs. Standard multimedia device support in MMPM/2 1.0 includes digital audio and MIDI (through the M/Audio board), CD audio, and videodisc control. The prerelease included CD-ROM XA (Extended Architecture) support, and that will be standard in MMPM/2 in the future as well.

You don't get a lot of cute sample programs in MMPM/2. You get only a media player, volume control, and data converter. The media player records digital audio as well (see the screen), but it provides no control over sampling rate, record level, and other settings. The volume control is as close as MMPM/2 gets to the



MMPM/2's standard applications are functional, but the real power of OS/2 multimedia is best seen from a programmer's point of view.

central mixer applet bundled with most Windows sound boards. Just one knob controls the volume for the entire system's audio output. The data converter is most useful for converting audio and graphics originally created in AVC (Audio Visual Connection—IBM's most popular multimedia development system) to MMPM/2 formats.

The media player itself is merely functional. When you play CD audio, for example, you see only the total playing time of the disc on the seek slider; there are no track markers or next/previous track buttons. It works, but as your primary introduction and interface to MMPM/2, the media player belies the power of the structure beneath it. The media player launches automatically when you double-click on a multimedia file from within the Workplace Shell. Unlike Windows, which is hobbled by the DOS file system, OS/2 can identify multimedia files either by extension or by data in the file's extended attributes.

Digging In

To appreciate MMPM/2 today, you must look at it from a developer's point of view. IBM wisely chose to create a structure and an API for its multimedia extensions that

are very similar to Microsoft's. The benefit is obvious: It's easier for IBM to coax developers into an environment that's familiar to them.

There are a number of low-level calls, but you'll likely use MMPM/2's high-level API. IBM's MCI (media control interface) is a superset of Microsoft's, so if you're Windows MCI-savvy, you'll feel right at home. The MCI string interface reduces most multimedia programming to simple commands like `play iquit.wav` that you can easily build into your applications regardless of the language.

MMPM/2 is no clone: It has several intriguing and useful traits that distance it from Windows' multimedia extensions. Among the notable enhancements offered by IBM are playlists, cuepoints, closed captioning, and connectors. A playlist is a microprogram that lets you exert precise control over the data stream associated with an open MCI device. The machine language—like playlist instructions include branches, loops, and subroutines, and playlist programs offer many benefits of driver-level operations without forcing you to dabble in low-level or device-dependent code.

MMPM/2's cuepoint interface allows

BYTE ACTION SUMMARY

- **WHAT MULTIMEDIA PRESENTATION MANAGER/2 IS**
An OS/2 extension providing extensible support for multimedia devices and programs.
- **LIKES**
Powerful API; closed captioning.
- **DISLIKES**
Poor set of standard applications.
- **RECOMMENDATIONS**
The most powerful PC multimedia environment available. A good choice for multimedia applications developers.
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you to drop markers at precise, arbitrary positions in a media stream, from within your application. Each time a marker is hit during recording or playback, a message is dispatched to your application. Cue-points can be embedded in MMPM/2 data files in addition to being set at run time.

Closed captioning offers multimedia producers an easy system for providing running caption text with audio. This is an extremely thoughtful aid for persons with hearing impairment.

Finally, MMPM/2's connector interface puts your program in charge of those hardware signal paths under the system's control. You can, for example, connect the CD audio output to the system's headphone jack, or switch the audio card's recording input from the microphone to the line input jack. Connectors elegantly solve the problem of managing signal flows, but they can also be applied to data streams; this patchcord metaphor works just as well for audio as for data.

Borrowed but Blue

That MMPM/2 looks so much like Windows' multimedia extensions doesn't bother me a bit; I consider it an asset. But once

you peel away the look-alike layers, you learn that IBM's multimedia foundation is much more powerful than Windows'.

As a developer, I became instantly enamored with the greater control offered by IBM's MCI. OS/2 is not constrained by the limitations of a DOS environment (e.g., dealing with DOS device drivers, working within a segmented memory model, or making things run on a 286 system), so it's no surprise that MMPM/2 attains a higher standard than the multimedia extensions built into Windows 3.1. Developers who take the time to dig deeper than the Windows-compatible layers will find a well-designed support structure for demanding multimedia applications. Certainly, anyone who thinks Windows is the only game in town for multimedia development needs to take a look at OS/2 and MMPM/2. ■

Tom Yager is a multimedia consultant, analyst, and developer, and author of The Multimedia Production Handbook for the PC, Macintosh and Amiga (Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.

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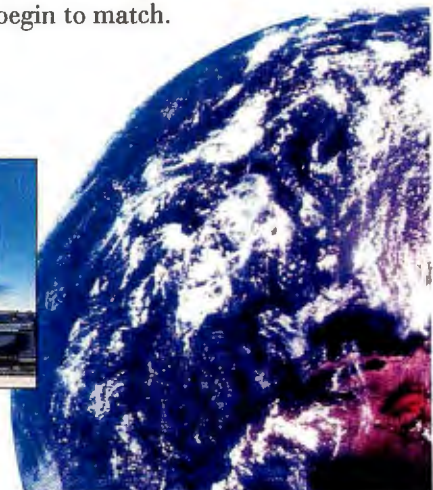
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HARDWARE

Two Ways to Say VL-Bus

RAYMOND GA CÔTÉ

Systems that use VL-Bus (VESA Local Bus, from Video Electronics Standards Association) technology promise faster throughput for peripherals from video cards to network adapters. These PCs can now be purchased from a host of system manufacturers. Further proof that VL-Bus has hit the big time lies in the ready availability of VL-Bus motherboards from high-end board manufacturers. These boards will not only form the basis of many VL-Bus clones but will be popular items in the end-user replacement market. I tested the performance of two 486 VL-Bus motherboards: American Megatrends' Enterprise III and Micronics' EISA/VL-Bus System Board (see the photo).

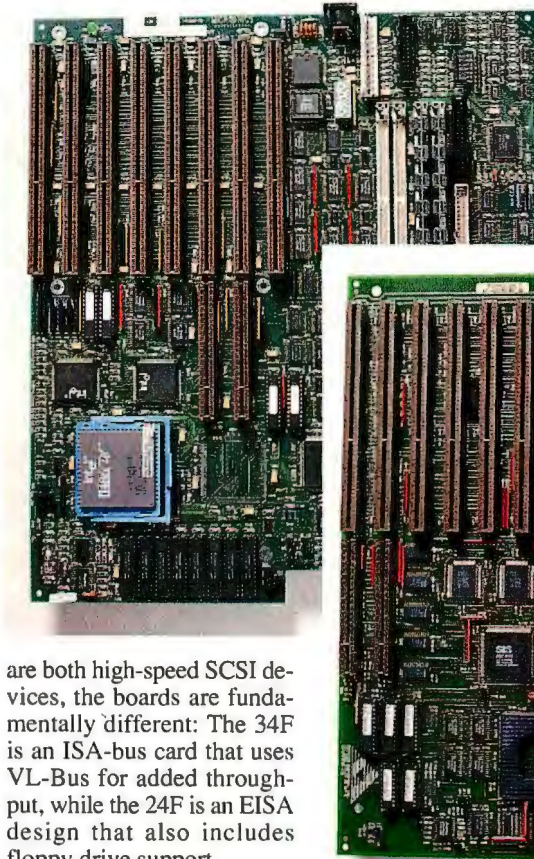
The boards were similarly configured, with 8 MB of base memory, 256 KB of processor cache, and a 33-MHz 486DX processor. Micronics places its 486DX processor in a ZIF (zero insertion force) socket for easy removal. Both boards are in standard AT format with eight EISA slots, two of which have accompanying VL-Bus sockets. Micronics' EISA/VL-Bus System Board provides on-board IDE and floppy drive controllers, while the Enterprise III sports a PS/2-style mouse port. Both motherboards provide an industry-standard BIOS: Micronics opts for the Phoenix BIOS, and American Megatrends, not surprisingly, includes its own AMI BIOS.

In my test configuration, the Enterprise III lists at \$1150, and the EISA/VL-Bus System Board lists at \$1275. In OEM quantities, both should be comparable at about \$1000. But as is frequently true with new technology, it's performance, not price, that drives the decision.

Test Flight

To get a feel for performance, I ran a series of low-level benchmark tests on both motherboards, both through the VL-Bus and through the EISA channel. Naturally, the tests required fast peripherals that were available for both buses.

First, I ran BYTE's File I/O benchmarks on a 540-MB Maxtor SCSI drive (see figure 1). I hooked the SCSI drive to the motherboards through both the VL-Bus (using an Ultra 34F host adapter, \$325) and the EISA bus (with an Ultra 24F, \$595). Although the two UltraStor adapters



The Micronics EISA/VL-Bus System Board (left) and the American Megatrends Enterprise III are combined EISA/VL-Bus motherboard designs.

are both high-speed SCSI devices, the boards are fundamentally different: The 34F is an ISA-bus card that uses VL-Bus for added throughput, while the 24F is an EISA design that also includes floppy drive support.

The disk performance results were surprising. On both motherboards, the EISA host adapter ran significantly faster than the VL-Bus version. On the Micronics board, the Ultra

24F showed a 10 percent advantage in read rates. According to UltraStor, VL-Bus interface boards that need to move large

BYTE ACTION SUMMARY

- **WHAT VL-BUS MOTHERBOARDS ARE**
High-end 33-MHz 486 motherboards with EISA and VESA Local Bus support.
- **LIKES**
High performance for both systems. A variety of platforms (EISA, VL-Bus, and ISA) from which to choose the fastest peripherals.
- **DISLIKES**
Disk performance shows an advantage for EISA over VL-Bus.
- **RECOMMENDATIONS**
Price/performance is about equal between the two boards. The Micronics EISA/VL-Bus System Board has superior EISA-bus performance, but it is also somewhat more expensive.
- **PRICE**
Enterprise III (486DX/33, 8 MB of RAM), \$1150
EISA/VL-Bus System Board (486DX/33, 8 MB of RAM), \$1275

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TWO WAYS TO SAY VL-BUS

BYTE FILE I/O BENCHMARKS

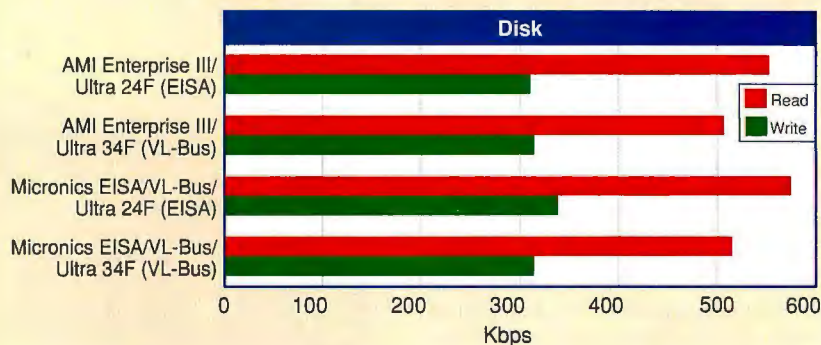


Figure 1: Disk tests show similar performance for both system boards using VL-Bus peripherals. However, the Micronics EISA/VL-Bus System Board is somewhat faster as the basis for an EISA design.

BYTE WINDOWS BENCHMARK INDEXES

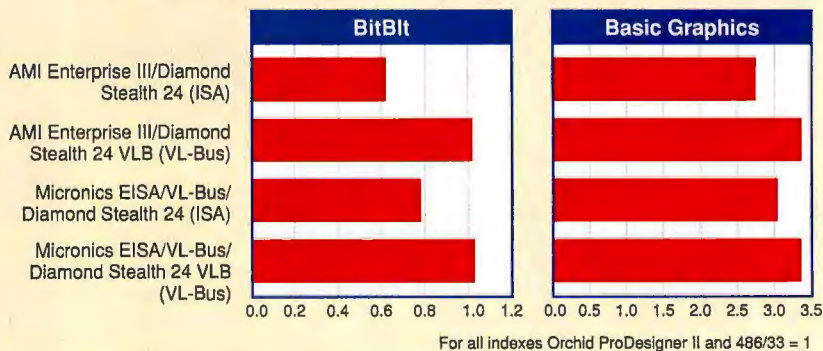


Figure 2: Video benchmarks for both motherboards, running over ISA and over VL-Bus. The BitBlt test, especially, shows a substantial performance increase when run through a VL-Bus video card.

blocks of data are very sensitive to system architecture (e.g., factors like memory interleave).

When purchasing a motherboard to use with a VL-Bus peripheral such as a SCSI interface, you should test the particular board to ensure that it meets your needs. Keep in mind that although the EISA interface looks faster on both motherboards in this configuration, EISA peripherals are often more expensive than VL-Bus devices.

My video tests (see figure 2) ran on two Diamond Stealth video boards: the Stealth 24 (an ISA-bus board) and Stealth 24 VLB. Except for the additional VL-Bus support, these two boards are identical. Both contain 1 MB of display memory, support up to 1280 by 1024 pixels at 16 colors, have a 24-bit Super VGA Windows accelerator, and sell for \$249. Both

motherboards showed substantially better video performance through VL-Bus than through EISA.

VESA Vis

Comparing the performance of these motherboards yields some interesting conclusions. On the video tests, Micronics' board was faster with the ISA-based Diamond Stealth, but the two motherboards showed equivalent performance using VL-Bus accelerated video. Disk test results show that VL-Bus performance was nearly equal, while the Micronics board outperformed the Enterprise III over the EISA bus.

So, which motherboard is best for you? When considering them strictly as EISA-bus systems, the Micronics board is clearly the quicker of the two motherboards. It showed a significant increase in video throughput and maintained a slight edge

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TWO WAYS TO SAY VL-BUS

on SCSI performance. For either system, I would recommend an EISA SCSI card over a VL-Bus host adapter if maximum performance is required.

Price/performance is about equal between the two boards; the Micronics board compensates for its somewhat higher price with slightly better performance. You'll have to consider your need for VL-Bus throughput against the availability of EISA peripherals, which may offer a performance advantage. ■

Raymond GA Côté is a BYTE consulting editor, freelance writer, and publisher of the Robot Explorer newsletter. You can reach him on BIX as "rgacote" and on the Internet at rgacote@bytepb.byte.com.

COMPANY INFORMATION

American Megatrends, Inc.
 (Enterprise III)
 6145-F Northbelt Pkwy.
 Norcross, GA 30071
 (800) 828-9264
 (404) 263-8181
 fax: (404) 263-9381
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Diamond Computer Systems, Inc.
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SOFTWARE

Teaching Macs to Fetch

STANFORD DIEHL

Graphics professionals working in a production environment must maintain thousands of images. These images, created in-house or purchased, come in a variety of formats and spill across network servers, removable-cartridge drives, CD-ROM discs, and shared volumes. Aldus Fetch 1.0—a \$295 multiuser, mixed-media database for cataloging images, QuickTime movies, animations, and sound files—is designed to meet the challenges of a workgroup production environment.

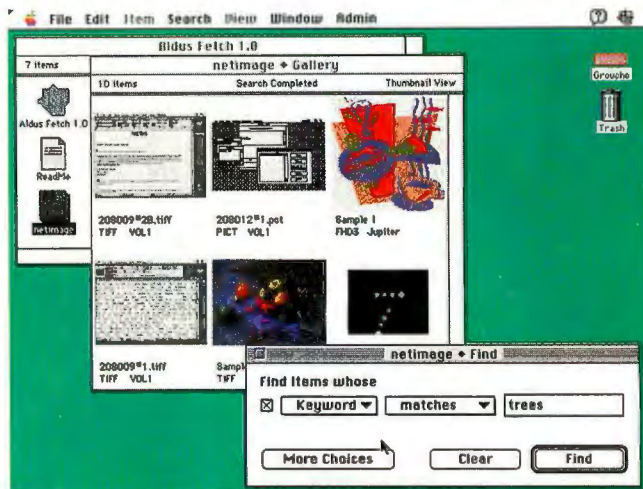
Fetch is a snap to use. To catalog a CD-ROM full of images, I simply dragged the CD-ROM icon onto the Fetch application icon. Indexing 500-plus images on a CD-ROM took a little over 45 minutes. Once created, a catalog contains a visual thumbnail (a tiny replica) of all the items within it. You can browse through the thumbnails or search for a specific item by filename, description, or user-supplied keywords (see the screen). Double-clicking on an item loads it into the proper viewer. There is no need to open the application that created the file.

Fetch supports a wide variety of formats (e.g., EPS, JPEG, PICT, TIFF, SND, Illustrator, Photoshop, Kodak Photo CD, and SoundEdit), but noticeably missing is a GIF viewer. Aldus does plan to ship one with the next version.

Fetch keeps track of where an image resides. When you call up a cataloged image on CD-ROM, Fetch prompts you for the correct disc. If you're working off a network server, the volume is automatically mounted and the file retrieved. Even if an image is moved from one place to another, Fetch will find it and update the catalog. Fetch is not quite as smooth when dealing with shared drives. When a catalog is created on a local drive and then accessed remotely, Fetch thinks the files in that catalog have moved and asks if you want to update every file you access. Only if you use file sharing to access local CD-ROM drives or removable-cartridge drives should this limitation be of concern.

By designating a subset of a catalog as a "project," you can streamline the flow of files. For example, an art director could create a project of images to be used in a specific layout and send the images over the network (or through E-mail) to the production department.

Fetch creates a catalog of thumbnail images. You can browse through the images or search for a specific item by filename, description, or keyword.



The advantages are numerous. For instance, the art department can maintain a central catalog of images; designers can quickly browse through images (or search for items of interest) and visually select graphical elements for the layout; the production department can work with small images and view the full image without source applications; and one set of images can be stored on a network drive while only the thumbnails are shipped around. And if a file changes along the way, you needn't worry about obsolete files floating around, since everyone is working with pointers to a single file. Fetch doesn't have the high-end version-control features of some document management packages, but it's a very useful utility that doesn't require a large commitment of resources to learn and implement.

Fetch lets you search for files by description or keywords rather than just filenames, but generating this information can be quite a chore. Descriptions and keywords can be attached to any file using the pnot resource, and pnot information isn't destroyed by a desktop rebuild, making it more persistent than simple Finder comments. Major applications (including the new versions of Adobe Premiere and Aldus FreeHand) are starting to include menu options for adding descriptions to a file. With some procedural discipline, all your files could have keywords and descriptions built into them, allowing Fetch to use all of its ample searching capabilities.

I hope to see some enhancements to Fetch soon—a GIF viewer and better version tracking would be nice—but anyone who deals with lots of images, QuickTime

movies, sounds, or animations will surely appreciate Fetch. ■

Stanford Diehl is a BYTE Lab technical editor covering graphics software, peripherals, and add-ins. You can reach him on BIX as "sdiehl."

BYTE ACTION SUMMARY

- **WHAT ALDUS FETCH 1.0 IS**
A multiuser, mixed-media database for cataloging images, animations, QuickTime movies, and sound files on the Mac.
- **LIKES**
Easy to learn and use; broad support of file formats.
- **DISLIKES**
No GIF viewer; lacks version-control features.
- **RECOMMENDATIONS**
An excellent utility for workgroups working with images.
- **PRICE**
\$295
- **FOR MORE INFORMATION**
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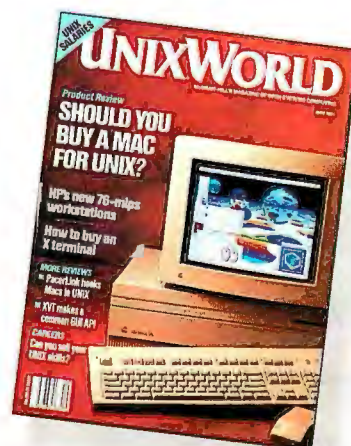
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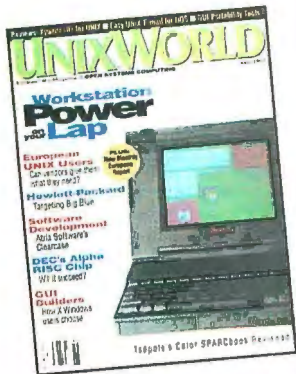


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SOFTWARE

Macs and Windows PCs Share Control

TOM YAGER

With the success of Windows and the Macintosh, most offices include systems of both types. There are plenty of ways to share files between PCs and Macs, but the most useful link would permit you to share applications as well.

Farallon Computing's Timbuktu is a popular Macintosh program that allows you to reach across a network link to operate someone else's Mac by remote control. Now the vendor has introduced Timbuktu for Windows, making it possible to create remote-control links not only from Windows PC to Windows PC but between Macs and Windows systems as well.

The Road to Timbuktu

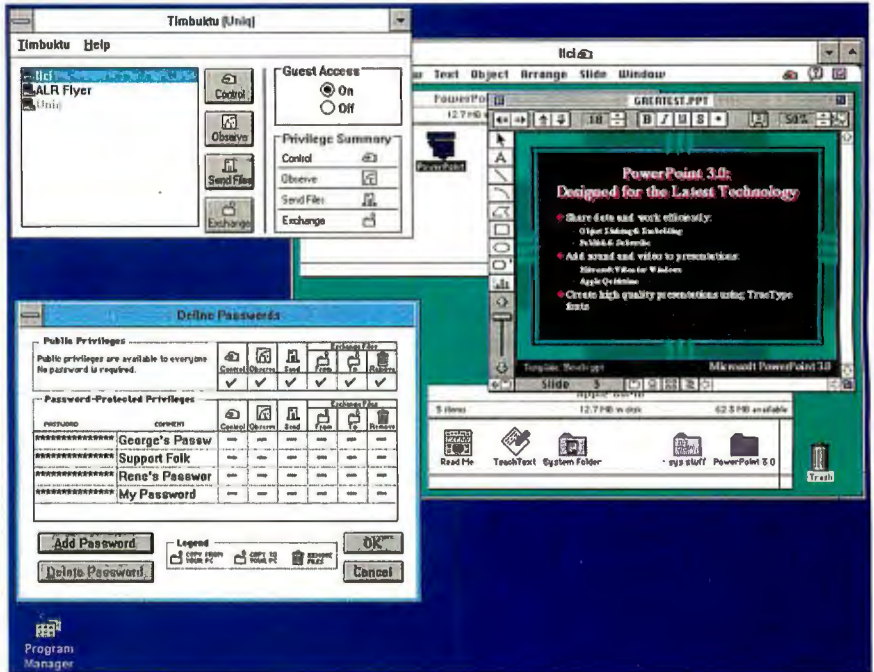
I tested Timbuktu for Windows using a trio of machines: an Advanced Logic Research Flyer 32LCT (66-MHz 486DX2), a UniQ 50-MHz 486 EISA file server, and a Mac Ili. Both PC systems were running DOS 5.0 and Windows 3.1, and all three systems had 8 MB of memory. I hooked the systems together on a dedicated thin-wire Ethernet network.

I installed Timbuktu on all three systems. On the PC, it sits atop Farallon's AppleTalk software, called PhoneNet PC. This foundation network is installed under DOS and runs as an army of TSR programs—160 KB of them, in my case. That's the last thing my already-overburdened PCs needed. Farallon's documentation lays out some useful tips for moving the PhoneNet drivers into high memory, and you can selectively leave out some services—like printer sharing—to conserve memory.

The PhoneNet TSRs bring partial AppleTalk network participation to your PC. You can mount a remote Mac's hard drive as a DOS drive or redirect your printer output to an AppleTalk printer, but PhoneNet PC provides no reciprocal incoming services.

Starting a Timbuktu session is easy. The New Session dialog box (see the top-left window in the screen) maintains a list of systems listening for incoming connections. All you have to do is select the system you want and then click on the icon for the level of service you're requesting: You can control, observe, send files, or exchange files.

You can request any of these services,



Timbuktu for Windows' connection dialog box (upper left) and access-control dialog box (lower left), and a remote Mac screen. This PowerPoint image was relatively unchanged, but others had severely distorted colors.

but what you're actually granted is determined by the remote system. Timbuktu's access-control scheme is inventive: Instead of assigning a password to each service, the interface (the bottom-left window in the screen) gives you up to four passwords, each of which unlocks a group of services. I found Timbuktu's access controls excellent as far as they go, but I'd have liked a little more control, perhaps in limiting access from certain machines or certain named users.

Services Rendered

The services offered by Timbuktu fall into the four classes shown in the connection dialog box's icons. The least capable is a Send Files connection. With this, all you can do is copy files from your system to a designated drop folder or subdirectory on the destination machine. You can't see the other system's directories or access its files. Timbuktu doesn't make any conversions between Mac- and DOS-format files, except to mangle Mac filenames to fit the DOS 8.3 convention.

The next level up is bidirectional file transfer. When you send, receive, and delete files through this interface, you can

specify independent permissions through the access-control dialog box. The file transfer interface looks just like the familiar Apple File Exchange: You see your system's files listed side by side with the other system's files. All you have to do is select the files you want moved or deleted and click on the appropriate button.

The heart of this program is its remote-session capability. Timbuktu allows both observing and controlling connections. As an observer, you can monitor a remote system's display. With a controlling connection, your keyboard and mouse input is relayed to the remote machine, and that system's display is duplicated on your screen.

By default, Timbuktu presents the remote system's display in a window (the middle window in the screen). With a controlling connection, Timbuktu sends your input over the wire whenever that window is selected and the mouse pointer is inside it. If the window is smaller than the remote system's screen, Timbuktu will scroll in all directions; as you move the mouse close to the edges of the window, the screen scrolls underneath it. It's a little disconcerting, because the scrolling makes

the mouse pointer sit still even though you're busily rolling away. It's like moving your mouse pad around to position your cursor. It works, though, and since all my systems have accelerated graphics controllers, scrolling was very snappy.

When the screens are precisely the same size (as they were when I connected the two Windows systems), maximizing the Timbuktu session window makes the borders and scroll bars disappear. The remote system's display fills yours, and only a floating title bar remains to remind you that you're running someone else's machine. Clicking on an icon on the title bar will put the screen back into a resizable window.

You can have only one screen-sharing session going at once, but you can pop up the send or exchange interfaces during a screen-sharing session. I'd have liked the ability to run more than one observation session, a feature that would be particu-

larly useful for network administrators, instructors, and others who benefit from keeping a watchful eye over a small flock of users.

If you're worried about Big Brother, you'll be relieved that Timbuktu doesn't allow silent connections. Whenever someone is hooked into your system, a tiny icon appears in the corner of the screen that reflects the type of connection.

Protocol Matters

According to Farallon, Timbuktu for Windows expands on a scheme the company devised for its Macintosh Timbuktu product. When two Macs converse, Timbuktu passes data using a packaged version of the Mac's QuickDraw graphics system. When mixing Macs and Windows PCs, Timbuktu uses the guest's native graphics system: That is, a Windows system controlling a Mac uses GDI (Graphical Device Interface) for its protocol, and a Mac controlling a Windows system uses QuickDraw.

With Timbuktu for Windows, Farallon has also introduced a set of optimizations that are specific to graphics type. The result is that elements drawn by Windows (e.g., text, icons, windows, and other specific object types) are specially packaged for efficient transport and display on the guest system.

Farallon admits that there are weaknesses in its current scheme, especially when controlling a Mac from a Windows system. Text-display scrolling is particularly painful. Also, complex graphics can bog Timbuktu down, particularly if the application's interface is sloppy. The Mac version of PowerPoint, for example, repaints its entire window *a lot*. That's not something you notice sitting in front of the system, but when those changes are packed up, sent through a little wire, and unpacked on the other end, you notice.

The good side of Timbuktu's performance can be seen in the rapid drawing of filled rectangles (like windows) and icons. Menus and dialog boxes generally popped up in good time on both sides of my test connection.

The two Windows machines, with their 66-MHz and 50-MHz 486 processors, got along famously. I ran FrameMaker over a remote connection, even on a file loaded with bit-mapped graphics. I would liken the performance to that of an unaccelerated display card. It felt smooth and fast enough that I sometimes lost track of whether I was running remotely or not. Similarly, I was able to connect to Windows from a fast Mac with lesser but still acceptable performance. Although the display lagged noticeably behind my typing,

Timbuktu never dropped a character.

Timbuktu proceeds only as quickly as the remote connection will allow; the local system always stays in sync with the remote. This can be troublesome, as Timbuktu's response often lags well behind input. Scroll buttons and other interface elements that require a click-and-hold are handled badly. If you hold down a scroll button until the image in the window looks like it's in the right position, you'll generate a long queue of scroll requests that will continue to march along well after you release the button.

As I mentioned earlier, running a Mac remotely from a Windows system brought out the worst in Timbuktu. Windows and icons came up quickly enough, but text and complex graphics drew and scrolled so slowly as to be really frustrating. Moreover, while both Windows systems happily displayed each other's 256-color screens with no loss of quality, 256-color Mac screens under Windows lost their color palette. I chose one of the less-affected images for the screen shot; PowerPoint slides that used graduated shading got hopelessly stepped on by Timbuktu for Windows.

Timbuktu supports up to 24-bit color between systems, but Farallon wisely recommends that you put the Mac in monochrome-display mode for acceptable performance when you're controlling it from Timbuktu for Windows.

How Slow Can You Go?

Among fast machines, Timbuktu is good enough to use anytime it's not convenient to walk over to a free Mac or Windows system, or when you need to guide someone through a tough problem without looking over his or her shoulder. However, when you control a Mac from a Windows system, performance is poor enough that you need to seriously consider what Timbuktu offers before running it.

If you use it to gain access from off-site through a WAN (wide-area network), then the convenience of access to your files and applications may well be worth the sluggish response. And for remote administration and support, as well as occasional short bursts of cross-platform applications use, I'd say Timbuktu is good enough in every case to give you most of the benefits of sitting in front of a remote machine. ■

Tom Yager is a multimedia consultant, analyst, and developer, and author of The Multimedia Production Handbook for the PC, Macintosh and Amiga (Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.

BYTE ACTION SUMMARY

■ WHAT TIMBUKTU FOR WINDOWS IS

A remote-control package that allows file transfer and remote-session connections to PCs and Macs.

■ LIKES

Well-designed interface, particularly access controls and full-screen remote sessions; notification and control over incoming remote connections.

■ DISLIKES

Size (160 KB) of TSRs; poor color-palette mapping from Mac to Windows; serious performance problems on slower systems.

■ RECOMMENDATIONS

An elegant solution for network administrators, support people, and others who value accessibility over performance.

■ PRICE

\$199

■ FOR MORE INFORMATION

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* DESQview makes multitasking and windowing available to users of 286-class machines with similar memory efficiencies through QEMM-50/60 for IBM™ PS/® 50 and 60 users and QRAM for other 286 users.
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CodeBase 5.0

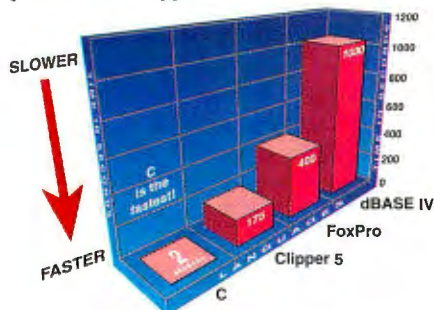
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Circle 129 on Inquiry Card.

APPLICATION

Sun's C Solution for Solaris

BENJAMIN FRIED AND OTHAR HANSSON

Sun Microsystems startled many of its customers when it announced that, starting with SunOS 5.0 (a.k.a. Solaris 2.0), SunOS will no longer include a C compiler. Sun has explained that a C compiler is no longer necessary to reconfigure the operating system and has pointed to the bulk of Solaris customers who never use one.

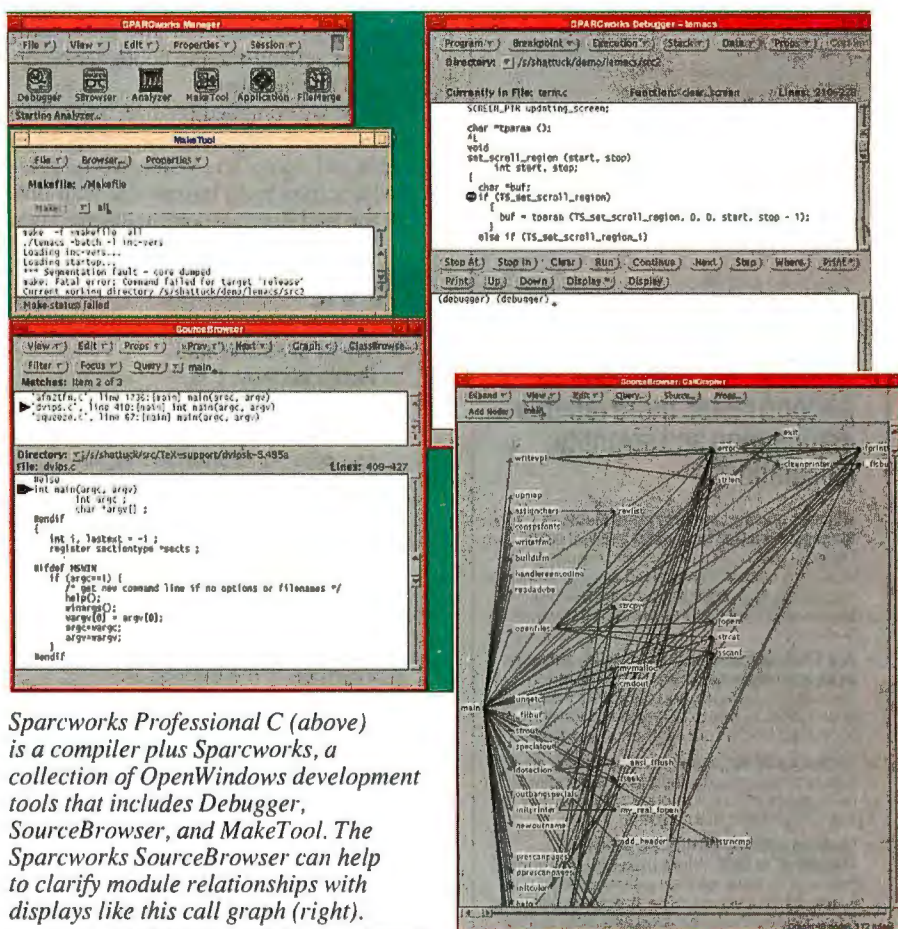
For those of us who do use one, including Solaris 2.0 developers and SunOS 4.1 users who want a professional compiler and development environment, SunPro offers Sparcworks Professional C. Sparcworks Professional C is the bundling of two development products: Sparc compiler C, which is Sun's C compiler, and Sparcworks, a collection of language-independent tools, including a browser and a debugger (see the screens).

What's New

Sun hasn't just uncoupled its old compiler and remarketed it at a premium; Sparc compiler C is a significant improvement, providing ANSI C compatibility, better optimization, and many new command-line options. The compiler also offers substantial support for developers moving their programs from Kernighan and Ritchie C to ANSI C, plus a wealth of useful documentation.

Sparcworks is a set of language-independent development tools with OpenWindows user interfaces, controlled by a graphical utility called Sparcworks Manager. The Sparcworks applications are

- *FileMerge*, which aids in comparing and merging differing versions of source files.
- *SourceBrowser*, for examining and searching source code, viewing call graphs, and performing simple editing tasks. SourceBrowser can also graphically display C++ classes and class hierarchies with the Sun C++ compiler.
- *Analyzer*, a profiler and performance tuner (for Solaris 2.0 only).
- *MakeTool*, which browses make files, displays expansions for make-file rules and macros, and runs make on selected targets.
- *dbx* and *Debugger*, a multilanguage command-line debugger and its OpenWindows front end.



Sparcworks Professional C (above) is a compiler plus Sparcworks, a collection of OpenWindows development tools that includes Debugger, SourceBrowser, and MakeTool. The Sparcworks SourceBrowser can help to clarify module relationships with displays like this call graph (right).

SunPro also bundles AnswerBook—Sun's handy hypertext browser and navigator—with on-line copies of all the paper manuals.

SunPro distributes all this on a single CD-ROM. Installation is simple. Sun's CDmanager program shows icons for each package on the CD-ROM; all you have to do is select the products for which you hold licenses.

Sparcworks Does Windows

The window-oriented tools that make up Sparcworks were not equally useful. FileMerge has an impressive GUI, but it was not as good as a combination of *diff* and *patch*, a free command-line utility. Similarly, MakeTool has a pretty interface and some nice features, including a menu with entries for each target and being able to

run user-specified commands when make operations start, complete, or fail. Overall, though, MakeTool was more cumbersome than just running make directly from a shell window.

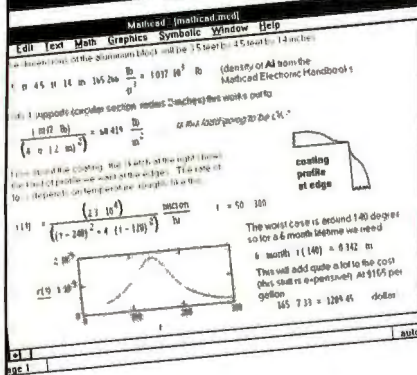
In contrast, the other two tools are clearly better for the addition of the GUI. The debugger shows the most improvement. Being able to use the mouse to set breakpoints, display the value of variables, and step through code represents a big step up from the traditional *dbx*.

SourceBrowser's graphical display of function-calling relationships (see the screen) can clarify the structure of a program. SourceBrowser includes an editor, good for making simple changes to source code, and it hooks into the debugger to keep the debugger and browser displays in sync.

continued

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SUN'S C SOLUTION FOR SOLARIS

Lots of Options

Of course, the backbone of the development environment is the compiler, and Sparc compiler C supports its environment well. Sparc compiler C has four levels of ANSI conformance, ranging from loose—essentially K&R C—to strict. Sparc compiler C also has five levels of optimization, which lets you choose the trade-off between size and speed. You can compile with both optimization and debugging switches set and run the debugger on optimized executables.

When we compiled for size, object files were about as large as those produced by Sun's old compiler. When we targeted speed, results were impressive with both integer- and floating-point-intensive code.

BYTE ACTION SUMMARY

■ WHAT SPARCWORKS PROFESSIONAL C IS

It comprises Sparc compiler C, a highly optimizing ANSI C compiler, and Sparcworks, an integrated set of OpenWindows development tools.

■ LIKES

Sophisticated optimization, good support for moving from K&R C to ANSI C, and a nice user interface to the debugger.

■ DISLIKES

Some Sparcworks tools are of limited utility; the price will seem high for users used to getting a compiler and debugger free with the operating system.

■ RECOMMENDATIONS

Superior optimization and excellent ANSI C compatibility make the compiler well worth considering.

■ PRICE

(single-user, with printed manuals) Sparcworks Professional C, \$1795
Sparc compiler C, \$795

■ FOR MORE INFORMATION

SunPro
2550 Garcia Ave.
Mountain View, CA 94043
(800) 926-6620
(415) 336-6848
fax: (415) 964-0946

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Although Sparc compiler C generated reasonably sized object files, SunOS 4.1 executables of very small programs (e.g., "hello, world") were about 100 KB larger than those compiled with Sun's bundled compiler or with the GNU C compiler. A call to Sun technical support revealed the reason: The SunOS 4.1 shared C library has a bug in the base conversion routines. Rather than distribute an updated shared library, Sun elected to include the fixes with Sparc compiler C. The compiler statically links in the fixed routines if they're needed, and it was these routines that inflated the files.

Compiler Comparisons

Sun's is a fine compiler, but it's not the only horse in the race. GNU's GCC supports SunOS 4.1 and Solaris 2.0, is ANSI-compatible (with several strictness levels), has a long list of optimizations that can be switched individually, and comes with extensive documentation. Its price is hard to beat, too: It's free. Since GCC comes with source code, fixes are widely available, and several companies provide commercial support at rates that compare favorably to Sun's right-to-use licenses and support contracts.

Sparc compiler C, for its part, optimizes better than GCC, provides good support for moving between K&R C and ANSI C, and with Sparcworks is part of a promising development environment. AnswerBook provides most of the help you'll need, and SunPro's sizable support infrastructure offers added assistance. If you want a well-supported compiler that produces good code, and if buying the compiler from the hardware vendor is important to you, you'll feel comfortable with Sparc compiler C.

Of the Sparcworks tools, we found that Debugger stood well above the rest as a genuine improvement over the command-line utility it replaces. SourceBrowser has some useful features, providing elements of many different utilities under a single window. The other tools were not very useful, and we abandoned them for their (free) command-line equivalents. You'll want to carefully consider whether two good tools justify the cost (\$1795) of the entire package. If you're working with more than one Sun language, Sparcworks becomes considerably more attractive than in a single-language environment. ■

Benjamin Fried and Othar Hansson are both members of the technical staff at Heuristic Research, Inc., a software R&D firm in Berkeley, California. You can contact them on the Internet at ben@heuristicrat.com and othar@heuristicrat.com, respectively.

SOFTWARE

A Beefier MKS Toolkit

BEN SMITH

Ask a developer what's best about Unix, and you'll hear about its rich set of command-line utilities and the great flexibility with which these can be strung together. Ask a developer what's best about MS-DOS, and you'll hear first about a massive potential market.

But why sacrifice a great working environment just because DOS and Windows are where all the action is? The MKS Toolkit has been bringing DOS and Unix together for eight years by providing DOS (and more recently, OS/2) developers with a full set of Unix utilities and a Korn shell command interpreter. Version 4.1 of the MKS Toolkit represents a significant improvement, introducing background UUCP file transfer and Unix mail and bundling two utilities (make and awkc) that were previously sold separately.

The Toolkit bucks a trend with its primarily command-driven, nongraphical user interface. Version 4.1 does include some character-based GUI utilities and some PIFs for Windows (see the screen). However, its extensive set of Unix utilities easily offers far more power and flexibility than a flashy palette of icons.

Significant Enhancements

The two most significant enhancements in version 4.1 are UUCP support and the addition of Unix E-mail. There are standalone UUCP systems that run under DOS, but Mortice Kern Systems puts most of its UUCP system in a TSR program that takes up less than 3 KB. As a result, the entire process of calling (or answering) another UUCP system, setting up the connection, and handling spooled UUCP requests takes place in the background. MKS's UUCP utilities include file transfer (uucico) and remote command execution (uux and uuxqt) as well as utilities for configuring and administering UUCP.

Version 4.1 includes the Berkeley E-mail interface (mailx) and a mail router (rmail) so you can carry on Unix E-mail communications just as if you were on a Unix system. The mail and UUCP support are solid enough that you can even create a UUCP network of DOS or OS/2 sites running MKS utilities. You'll need one real Unix site designated as a "smart site" to resolve unknown addresses; MKS UUCP does not include sendmail, re-

MKS Toolkit 4.1 makes a few concessions to graphical orientation, including Windows PIFs for some (appropriate) command-line utilities.

quired to resolve addresses for sites not directly connected to your system.

MKS's UUCP configuration program uses a character-based GUI. Configuration files are binary rather than plain text (the Unix way) for security, since text files have no protection on a DOS system.

Variable Immersion

You can install the Toolkit in several different configurations, depending on how deeply you want to immerse yourself in a Unix-like working environment. You can choose anything from installing a simple collection of utility programs (more than 170) to replacing COMMAND.COM and AUTOEXEC.BAT with a Unix-style shell complete with log-in security. MKS Toolkit includes on-line documentation in the form of the man command and quick syntax reference with help.

MKS's utilities are very well written; the quality and level of Posix compliance of these tools exceed that of many commercial Unix versions. In fact, the Toolkit is often used by vendors of non-Unix operating systems, such as in DEC's VMS, to claim Posix compliance.

I run the MKS Toolkit on every DOS machine that I use, from laptops to high-end desktops. With version 4.1, I also enjoy background access to Unix mail and UUCP while running a DOS application. ■

Ben Smith is a testing editor for the BYTE Lab and the author of Unix Step-by-Step (H. W. Sams, 1990). You can reach him on BIX as "bensmith" or on the Internet at ben@bytepb.byte.com.



BYTE ACTION SUMMARY

- **WHAT MKS TOOLKIT 4.1 IS**
Unix utilities and a Korn shell command interpreter for DOS and OS/2.
- **LIKES**
Inclusion of UUCP and background mail access; quality and completeness of utilities.
- **DISLIKES**
If you prefer working with a GUI, you won't get much out of it.
- **RECOMMENDATIONS**
Well worth the price for developers and users familiar with Unix. Current MKS Toolkit users who make frequent use of Unix mail should make the upgrade.
- **PRICE**
\$299
- **FOR MORE INFORMATION**
Mortice Kern Systems, Inc.
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HCL-eXtend — UNIX host-based X clients for accessing DOS services.



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HARDWARE

Pioneer's Super CD-ROM Drive

HOWARD EGLOWSTEIN

If you think your CD-ROM drive is fast enough and you like loading those ornery CD caddies, then don't try out Pioneer's DRM-604X high-speed minichanger. This drive features Pioneer's Quadraspin technology to achieve a continuous 600-KBps transfer rate, and it automatically switches between six CD-ROM discs at one time.

The DRM-604X is an external unit with two 50-pin SCSI connectors, switchable internal termination, and push-button SCSI ID selection. You load your CD-ROMs into a six-disc magazine that slips easily into a slot on the front panel. Loading the discs is simple enough, but the magazine itself feels breakable. The leaves that separate the discs are thin, and it wouldn't take much to snap one off. A front-panel button ejects the magazine; a rear-panel DIP-



The Pioneer DRM-604X racks six CD-ROM discs at one time.

BYTE ACTION SUMMARY

- **WHAT THE PIONEER DRM-604X IS**
A CD-ROM drive that accepts six discs at a time and runs at four times the speed of standard CD-ROM drives.
- **LIKES**
Fast and convenient.
- **DISLIKES**
The magazine is somewhat flimsy.
- **RECOMMENDATIONS**
If you need to access large databases on CD-ROM or regularly use multiple discs, the DRM-604X is an excellent choice.
- **PRICE**
\$1795
- **FOR MORE INFORMATION**
Pioneer Communications of America, Inc.
3255-1 Scott Blvd., Suite 103
Santa Clara, CA 95054
(408) 988-1702
fax: (408) 988-1848
Circle 1231 on Inquiry Card.

switch setting allows you to disable the eject button if you wish.

I tested the Pioneer drive on a Mac IIx and a 33-MHz 486 EISA machine with an Adaptec 1742 EISA SCSI controller and an internal Sony CDU-541 CD-ROM drive. Pioneer's drivers loaded perfectly on the Mac. In spite of the IIx's goofy SCSI port, I had no trouble using the Pioneer's internal terminators. If a SCSI drive works on the IIx, it'll work just about anywhere. I loaded up the magazine with a selection of Mac HFS, ISO 9660, and Kodak Photo CD ROMs. The IIx had file sharing enabled, and I had no trouble accessing a number of different CD-ROMs simultaneously from different machines on the network. The Pioneer drive handles the disc requests on a first-come, first-served basis, transparent to the Mac OS. The discs get swapped in and out of the magazine as needed; as far as the Mac can tell, the drive is simply six different CD-ROM drives.

Using the drive on the 486 machine should have been as easy, but the Pioneer DOS drivers simply wouldn't talk to the Adaptec board. The drivers will handle standard ASPI (advanced SCSI programming interface) drivers or selected Future Domain boards. I had been using Adaptec's ASPI to run the internal Sony drive, so connecting the Pioneer should have been a simple cabling problem. I ended up using CorelSCSI to drive both the Sony and Pioneer drives at the same time.

A test program confirmed Pioneer's speed claims: The DRM-604X transferred 60 MB in about 10 seconds (actually 598.6 KBps). The Sony CDU-541 single-speed

drive ran the same test at 149.8 KBps. Some of the machines in the BYTE Lab have hard drives slower than the Pioneer CD-ROM drive. Scary.

I also installed Microsoft's Video for Windows and ran a number of video clips (.AVI files) from a Microsoft sampler CD-ROM. AVI files get choppy if your CD-ROM drive can't read fast enough; the DRM-604X's busy light barely flickered.

At \$1795, the DRM-604X isn't for everyone. To date, I haven't seen six CD-ROMs that I'd ever use on a regular basis; for me, switching CD-ROMs isn't a big problem. If all you need is a drive for occasional software installation, you don't really need quadruple-speed performance.

However, in some applications, Pioneer's drive would be a bargain at twice the price. Research libraries often have a number of large CD-ROM databases, and the minichanger would save wear and tear on both the users' patience and the CD-ROMs. Educational applications are notorious for accessing a lot of animations and graphics, and the DRM-604X's speed really makes these applications fly. You may also find yourself switching between several software programming reference CD-ROMs on a regular basis. If you regularly use more than one CD-ROM and spend a lot of time watching your drive's busy light, check out the DRM-604X; you'll wonder how you ever worked without one. ■

Howard Eglowstein is a BYTE Lab testing editor who holds an S.B. from MIT. You can reach him on BIX as "heglowstein."

BOOK

AND CD-ROM REVIEWS

HUGH KENNER

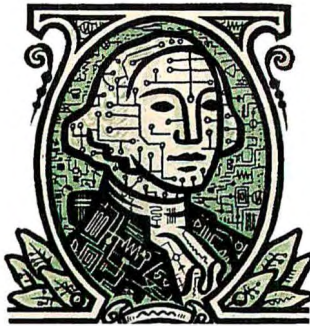
Such was the barbarity of its opening prose, I nearly tossed *The Death of Money* aside. "The network is juxtaposed by computers that chart investment risk"—that kind of thing. And (my favorite), "Supply and demand—the two bedrock tenants of economics." What Joel Kurtzman must mean is *tenets*, but I cannot guess what he intends by *bedrock*.

Don't expect computer expertise, either. Of TFLOPS CPU speeds he exclaims, "A machine this big could read, digest, and process the entire contents of the Library of Congress" in just seconds. But the reading bottleneck isn't the CPU, it's the medium read from. And "digest, and process"? What can be going on? *Burp* suggests itself. Or *barf*.

But Kurtzman's book does come to cohere, sort of. He has arresting news. Time was, you bought a bond and held it to maturity. Now, the average ownership period is 20 days. That comes of eyes kept on tiny fluctuations—quick, it's up, sell it—that need cashing in on at speeds once unimaginable. Computers enable that. So does Money-as-Information: not gold nor paper, just strings of bytes moving via New York-Tokyo-Zurich, zap.

The book's title says the money you carry in your pocket is no longer what matters. That's the money you imagine as "real" because it's imprinted on real paper and used to buy real commodities: autos, houses, software, kittens. There, it's a measure of comparative values. But the economy in which I hand you \$20 and you hand me the kitten of my choice is no longer, Kurtzman says, where the action is. That economy—of kittens, scissors, cars, screwdrivers—is where most of us live most of the time. But it's now exceeded by the non-kitten economy of just, oh, futures contracts, to which nothing tangible, nothing save spreadsheet numbers, can be attached.

Exceeded, moreover, by—hang on—a multiplier of 30 to



MARKETS AS VIRTUAL REALITY

The Death of Money

Joel Kurtzman

Simon & Schuster, \$21,
ISBN 671-68799-9

Windows 3.1 Insider

Keith Weiskamp

and Ron Pronk

John Wiley & Sons, \$26.95,
ISBN 0471-57984-X

50. That's the extent to which phantom trading exceeds trades in anything as real as a meowing kitten. So forget kittens. Consider how we all exist amid "a network of financial networks." Unless we're speculators, they don't touch you and me in our daily transactions at all. But they touch us, year by year, as they devalue our dollar. Each January it buys less than in former Januaries. That's because (Kurtzman says) the "dollar" has lost all contact with tangible commodities. It's bounced about by speculative fervor, which can be obsessed with mere seconds. (Humans haven't so short an attention span, let alone reaction time. But trading programs, yes, have.)

The new electronic economy, juggling those phantom dollars, is "not only exceptionally complex and responsive, but it is also prone to volatility... temperamentally high-strung." Though I closed the book persuaded of that much, some things never did get clear. How was it that our pre-1971 money supply, tied to gold, grew at just about the right rate to deal with "the orderly expansion of growth and

trade"? What magic in gold? And when the crash of '87 wiped out "trillions of dollars," just how were zapped megabucks re-created within two years?

Still, an arresting book while we wait for a better one.

Short Subject

Wiley's *Insider* series aspires to "put an expert by your side." The introductory volume, on Windows 3.1, may be the best Windows book yet. It avoids rewriting the manual when the manual is adequate. It's knowingly explicit where the manual is confusing or silent. It abounds in hot tips. And it's organized to help you find what you need. ■

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times to Art & Antiques. You can contact him on BIX as "hkenner."

RAY TRACING AS ART

Practical Ray Tracing in C, Craig Lindley, John Wiley & Sons, \$49.95, ISBN 0-471-57301-9

P*actical Ray Tracing in C* is the perfect introduction to ray tracing as art and science. Ray tracing is a technique for generating photo-realistic 3-D images using the principles of geometric optics. It models the interaction of light and objects within a scene so you can display shadows, reflections, perspective, and surface texturing.

This is a dense book that's not for casual browsing. I had to work hard to gain a firm understanding of the mathematical basis for using this powerful technique.

Lindley emphasizes the practical. He tells you exactly

what you need to know and moves on. No fluff. No unnecessary details. You'll learn to view ray tracing from two perspectives—the technology required to make a picture and the techniques required to make it pretty.

An accompanying set of source code and executable files lets you start experimenting with designing and drawing images without writing thousands of lines of code. The package includes full source code for DKBTrace, a high-quality public domain ray-tracing program. Although it's written for PC compatibles, you can port the source code to the Amiga, Mac, VAX, and Unix environments.

Practical Ray Tracing in C will have you whiling away many hours of your free time. Rather than sitting idle overnight or during weekends, your computer will be generating your new masterpieces for the world to see.

—Raymond GA Côté

HEALTH ON DISC

The Mayo Clinic Family Health Book on CD-ROM

(Windows or Mac), \$99.95, Sony Electronic Publishing, 9 West 57th St., New York, NY 10019, (212) 410-9409

The CD-ROM version of *The Mayo Clinic Family Health Book* augments the full text of the 1378-page book with 500 narrated illustrations and 45 animations and video clips. You locate a subject by way of the table of contents, an illustration list, or a full-text search. But the main attraction is a morph-like animation of the human anatomy that gradually exposes the muscles, organs, and skeleton as you move a slider bar. From there, you can click on an anatomical label to bring up more detailed illustrations.

Like most family health books, the Mayo Clinic CD-ROM presents an overview of many subjects but lacks depth. Many illustrations don't add much detail, and they often include single-sentence narrations that state the obvious (e.g., "Arterial pressure points are shown in this sequence"). The product also would benefit from more hypertext links between subjects.

I searched for "chronic lymphocytic leukemia" and turned up a one-screen synopsis of the disease and a link to a sidebar on "understanding your blood." But there were no links to cancer, chemotherapy, prednisone treatments, or other mentioned subjects. Prescription-drug information is limited to a simple listing. And a section on childhood immunizations includes just a few sentences about each inoculation and when your child should receive it. I'd like to see hypertext links to all the diseases mentioned, as well as information on each immunization's potential side effects.

The Mayo Clinic Family Health Book on CD-ROM is an entertaining introduction to family health, but I don't see a clear advantage over the book version. Anatomical illustrations aside, the multimedia contents aren't compelling, and the textual content lacks the depth to make hypertext links truly beneficial. For more serious health questions, you'll find a copy of the *Physicians' Desk Reference* or the *Merck Manual* more informative.

—Rob Mitchell



FUZZY-LOGIC FOUNDATIONS

Fuzzy Logic, Daniel McNeill and Paul Freiburger, Simon & Schuster, \$22, ISBN 0-671-73843-7

A washing machine evaluates a load of clothes and automatically chooses the correct cycle. A hand-held camcorder compensates for wobble and records rock-steady scenes. Two common threads weave through these examples: The products represent applications of fuzzy logic, and they are made in Japan.

Fuzzy logic deals with vague knowledge and shades of meaning. Unlike classical set theory, which requires binary inclusion or exclusion, fuzzy logic defines continuously varying degrees of set membership: The load of laundry is mostly white, moderately heavy, and extremely dirty. Because fuzzy logic uses the numerical equivalent of such language (e.g., 0.8 heavy, 0.9 dirty), it greatly simplifies the development of control systems that mimic human judgment. Although such systems have proved effective, there's been a strong Western bias against a technique whose name connotes imprecision.

The authors of *Fuzzy Logic* plausibly suggest that fuzzy logic may require a Kuhnian paradigm shift to break free of the 2000-year tradition of crisp Aristotelian logic. Attributing Japan's rapid embrace of fuzzy logic to an inherently "vague" religious and cultural disposition, however, they skate on dangerously thin ice. It's true that fuzzy logicians Lotfi Zadeh and Bart Kosko are far better known in Japan than in their own U.S., but so is the management scientist W. Edwards Deming. In fairness, McNeill and Freiburger do eventually admit that pragmatism, more than Buddhism, may account for these preferences.

While *Fuzzy Logic* whetted my appetite, I went away hungry. The authors assert the superiority of fuzzy logic as a basis for control systems and say it will work synergistically

with expert systems and neural networks, but they don't describe their gee-whiz examples in enough detail to help you evaluate these claims. I would prefer less pop sociology and more substance.

—Jon Udell

PHOTO JOURNEY



From Alice to Ocean, Rick Smolan and Robyn Davidson, Addison-Wesley, \$49.95, ISBN 0-201-63216-0

From Alice to Ocean is a coffee-table picture book with a twist. The subject is Robyn Davidson's solo journey by camel across the Australian outback, and the book contains photojournalist Rick Smolan's dazzling pictures, with text from Davidson's book *Tracks*. The bonus are the two CD-ROMs: a Kodak Photo CD of high-quality images from the book and an interactive CD developed by Apple. The interactive CD presents a map of the trip that lets you point and click to jump to different portions of the route, and to see and hear Davidson's travel experiences in an arbitrary hypertext fashion.

The audio tracks—snatches of native music, *Tracks* narratives read by Beverly Dunn, and Smolan's commentary on the making of the book—pepper the work with intriguing facts and draw you into Davidson's travails as she makes the trip.

The discs are well done. The images are carefully dithered to 8-bit color and reproduce gorgeously on a 14-inch Mac monitor. This is the best example of interactive CD technology that I've seen. It's too bad Davidson herself didn't read the excerpts: That would have made the account more compelling.

—Tom Thompson

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As a bonus, you will get all the software you need to communicate. Like Lotus Sound™, an OLE server for Windows 3.1. WinReader for Windows 3.1, a handy text-to-speech utility. Digispeech's DOSTalk and DOSReader text-to-speech applications. Show & Tell For Kids™ for

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FDDI SPEAKS



After a long standardization period and a slow start, FDDI (Fiber Distributed Data Interface) has gained acceptance. Now a new FDDI standard is set to take the technology to the next level.

The original FDDI, known as FDDI I, calls for a 100-Mbps optical-fiber network that can function as both a LAN and a MAN (metropolitan-area network). With the increasing use of high-speed workstations, the growing reliance on graphics and image processing, and the need to interconnect departmental LANs with a high-speed backbone, FDDI has found plenty of niches.

However, FDDI is poorly suited to voice and other applications that have traditionally been handled by circuit-switching networks. To remedy this weakness, the ISO has defined FDDI II. As of this writing, the FDDI I documents are approved ANSI standards; the FDDI II documents are still in committee, but they appear to be technically stable.

The Optical Advantage

One of the biggest strengths of FDDI I and II is that both use optical fiber. Fiber-optic cable already enjoys considerable use in long-distance telecommunications and in the military. But optical fiber is used less than twisted-pair and coaxial cable for office LANs because of its relatively high cost and the complexity of its installation and maintenance.

Nonetheless, optical fiber enjoys several advantages over copper media that make it attractive for a number of

LAN applications. The most obvious advantage is capacity. Optical fiber's potential bandwidth is immense: Data rates in the gigabit-per-second range have been achieved. In addition, optical-fiber cable is considerably thinner and lighter than coaxial cable or bundled twisted-pair cable, and it's at least an order of magnitude thinner in terms of comparable information-transmission capacity. For cramped conduits in buildings or underground along public rights-of-way, the advantage of small size is considerable. The corresponding reduction in weight reduces structural support requirements.

Another advantage of optical fiber is its electromagnetic isolation properties. Fiber-optic LANs are not affected by external electromagnetic fields that create interference, impulse noise, and cross talk. And optical fibers do not radiate energy that might cause interference with other equipment and provide an easily detectable signal for eavesdropping.

Because of these advantages, fiber-optic LAN technology has enjoyed substantial R&D, and related products have proliferated in recent years.

FDDI Foundations

The original FDDI I standard is a high-speed, fiber-based alternative to existing LAN standards. Like the twisted-

A new optical-fiber LAN standard adds circuit-switched voice and video traffic to the mix

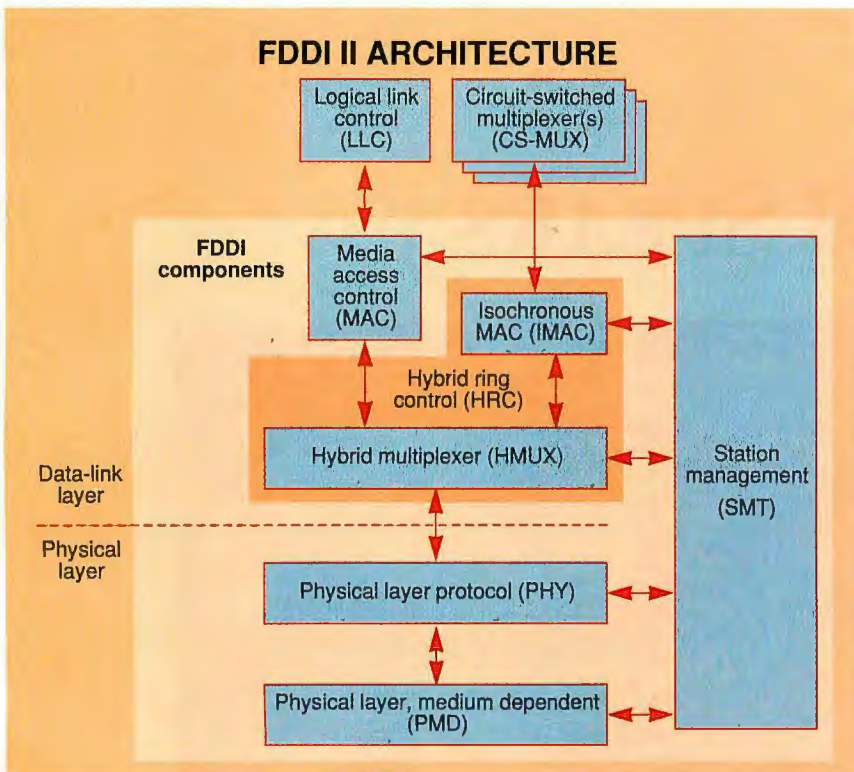


Figure 1: The internal structure of the FDDI II data-link layer enables support for the usual packet-based applications provided by other LANs, as well as circuit-switching applications.

pair token-ring standard, FDDI uses token passing to control access to the ring.

The FDDI MAC (media access control) algorithm is based on the use of a small token packet that circulates around the ring when all stations are idle. A station with data packets to transmit must wait until it detects a passing token. The station then captures the token by aborting the token transmission (i.e., by not repeating bits of the token) as soon as it recognizes the token. After it has completely received the captured token, the station begins transmitting one or more packets.

At this point, other stations with data to transmit must wait until the transmitting workstation releases the token. The transmitting station does this by inserting a new token on the ring when it has completed transmitting.

FDDI enhances this basic scheme with a capacity-allocation capability that regulates the amount of access time available to each station. Each station must release the token after its allocated time is up; stations with a higher priority are allowed to hold the token longer than other stations.

FDDI Extended

FDDI LANs transmit all data in frames of variable length. Each frame includes de-

limiters to mark its beginning and end, and address information indicating source and destination stations. But FDDI I is not suitable for maintaining a continuous constant-data-rate connection between two stations. Even the so-called *synchronous*

**With FDDI II,
you can maintain a
constant-data-rate
connection.**

traffic class of FDDI guarantees only a minimum sustained data rate; it does not provide a uniform data stream. Such a continuous, constant data stream is required for circuit-switched applications such as digitized voice or video.

FDDI II is an upward-compatible extension to FDDI that provides a circuit-

switched service while still maintaining FDDI's token-controlled packet-switched service. With FDDI II, you can set up and maintain a constant-data-rate connection between two stations. Instead of using embedded addresses in frames, a connection is established on the basis of a prior agreement, which may have been negotiated using packet messages or established by some other suitable convention known to the stations involved.

The technique FDDI II uses to provide circuit-switched services imposes a 125-microsecond frame structure on the ring. A circuit-switched connection consists of regularly repeating time slots in the frame. This mode of transmission is sometimes called *isochronous* transmission.

The FDDI II Architecture

Figure 1 shows a block diagram of an FDDI II station. The PMD (physical-layer, medium-dependent) portion of the specification defines the physical medium and specifies reliability features. The FDDI standard specifies an optical-fiber ring with a data rate of 100 Mbps. Based on the detailed characteristics of the medium and the electrical signaling specification, the maximum distance between adjacent repeaters is 2 kilometers. The total ring can have a maximum of 1000 repeaters and a total fiber path length around the ring of up to 200 km. Thus, FDDI can easily cover large office buildings and building complexes and can support a large number of computers and slow-speed LANs.

The medium-independent portion of the physical layer specification, the PHY (physical layer protocol), addresses the electrical specification of the signal that transmits bits on the ring. The encoding scheme developed provides for efficient signaling at FDDI's high data rate. This scheme, known as 4B5B, includes the definition of several nondata symbols that are used to communicate control information.

At the MAC level, two new components are added to the token-passing MAC module: the HMUX (hybrid multiplexer) and IMAC (isochronous MAC). The IMAC module provides the interface between FDDI and the isochronous service, represented by the CS-MUX (circuit-switched multiplexer). The HMUX multiplexes the packet data from the MAC and the isochronous data from the IMAC.

SMT (station management) monitors activity and exercises overall control of physical- and data-link-layer activity at each workstation. These functions include control and management within a workstation for such purposes as initialization, activation, maintenance, performance monitoring, and error control. SMT also com-

municates with other SMT entities on the LAN for the purpose of controlling network operation. Examples of SMT functions include the administration of addressing, allocation of network capacity, and network control and configuration.

A Hybrid LAN

An FDDI II network can operate in either basic or hybrid mode. In basic mode, only the packet-switched service is available, and the network operates in the same fashion as an FDDI I network. In hybrid mode, both packet and circuit services are available. An FDDI II network typically starts out in basic mode to set up the timers and parameters necessary for the token protocol (e.g., each station's token-holding time) and then switches to hybrid mode.

When operating in hybrid mode, FDDI II uses a continuously repeating 16-bit pattern referred to as a *cycle*. A cycle is a framing structure similar in principle to that used in synchronous transmission systems such as T1. The contents of the cycle are visible to all stations as it circulates around the ring. A station called the *cycle master* generates a new cycle 8000 times per second, or once every 125 μ s. At 100 Mbps, this works out to a cycle size of 12,500 bits (see the table). The cycle master strips each cycle as it completes its circuit around the ring.

Figure 2 shows the cycle format, which has four components. The *preamble* is a five-symbol (20-bit) nondata stream. Its actual size varies from four to six symbols to maintain synchronization in the face of jitter. The 12-octet (8-bit) *cycle header* defines how the rest of the cycle is used. A *DPG* (dedicated packet group) consists of 12 octets that are always available for token-controlled packet transfer. Finally, the *WBCs* (wideband channels) each consist of 96 octets per cycle.

Each WBC provides a capacity of 6.144 Mbps (96 octets per cycle \times 8 bits/octet \times 8000 cycles/second). Each channel can be set aside for circuit switching or packet switching. If a channel is used for packet switching, then it is merged with the DPG octets and any WBCs set aside for packet switching to form one large, dedicated packet-switching channel. This channel, referred to as the *packet-data channel*, is controlled by a circulating token. The minimum capacity of the packet-data channel is 768 Kbps, and it can grow in increments of 6.144 Mbps to a maximum of 99.072 Mbps. The table shows the capacity allocation of FDDI II.

The IMAC sublayer located within the hybrid ring control (see figure 1) determines which WBCs are used for circuit-switched traffic. Each 6.144-Mbps wide-

band channel can support a single isochronous channel. Alternatively, the IMAC can subdivide one WBC into several subchannels that permit simultaneous, independent, isochronous dialogues between different pairs of FDDI II stations.

The Cycle Header

The FDDI II cycle header consists of the fields shown in figure 3. The start delimiter (SD) indicates the beginning of a cycle and contains a unique pair of nondata symbols. The synchronization-control field (C1) establishes the ring's synchronization state. The nondata symbol R indicates that synchronization has not yet been established and that the cycle can be legally

interrupted by another cycle. The C1 field is set to R during hybrid-mode initialization or by any station that detects a loss of cycle synchronization by not receiving a cycle within 125 μ s of the previous cycle. The nondata symbol S indicates that synchronization has been established; only the cycle master can set this value.

The sequence-control field (C2) indicates the status of cycle sequencing. A value of R indicates that either the cycle sequence (CS) has not yet been established or that a CS error has been detected; a value of S indicates that a valid CS has been established and stations can latch each CS value to compare it to the CS value in the next cycle.

continued

| FDDI CAPACITY ALLOCATION | | |
|--|---------------------------------|--------------------------------------|
| <i>The minimum capacity of a data channel in an FDDI II system is 768 Kbps; the maximum capacity is 99.072 Mbps.</i> | | |
| | Bits per cycle | Data rate (Mbps) |
| Overhead (cycle header + preamble) | 116 | 0.928 |
| <i>n</i> channels of circuit-switched data | <i>n</i> \times 768 | <i>n</i> \times 6.144 |
| Packet-data channel | 96+(16- <i>n</i>) \times 768 | 0.768+(16- <i>n</i>) \times 6.144 |
| Total | 12,500 | 100 |

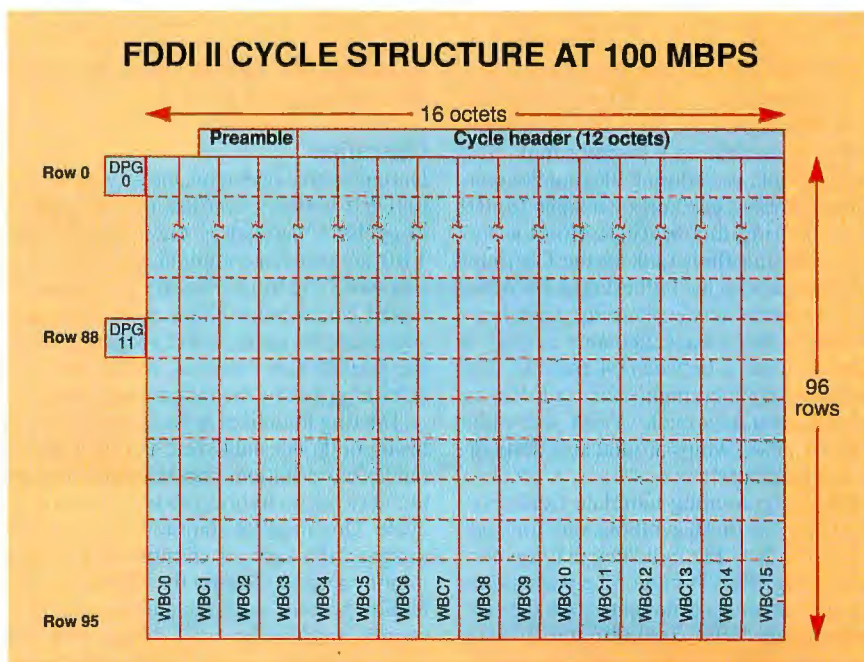


Figure 2: FDDI II imposes a framing structure on 100-Mbps traffic. The specification divides this structure into several channels to provide both packet-switching and circuit-switching facilities.

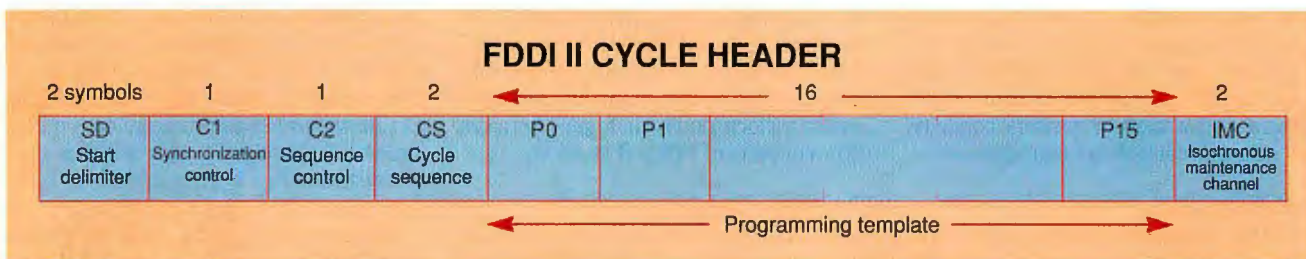


Figure 3: The cycle header appears at the start of each cycle. It provides synchronization and housekeeping information and defines the channel allocation used.

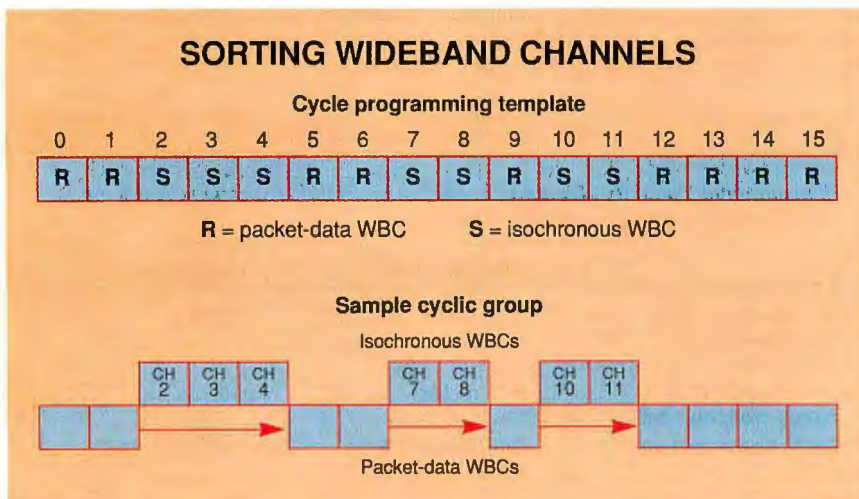


Figure 4: This sample programming template indicates which channels to merge to provide one token-passing channel for packet-based traffic and which channels to reserve for circuit-mode traffic.

The CS field takes the form *nn*, where *n* is a data symbol. If the C1 and C2 fields both contain R, then the CS field is interpreted as containing a monitor rank. The monitor rank, used during the monitor contention process, can take on a value from 0 to 63. During this process, monitor stations transmit their rank in the CS field. The station with the highest rank becomes the new cycle master. During normal operation, both C1 and C2 contain S, and CS contains a value between 64 and 255. The cycle master increments this number by one for each new cycle. When the value reaches 255, it wraps around and starts incrementing at 64.

The programming template field (P0-P15) consists of 16 symbols, one for each WBC. An R value indicates that the corresponding WBC is part of the packet-data channel, while an S indicates that the corresponding WBC is dedicated to isochronous traffic (see figure 4). All stations read the programming template, but only the cycle master can modify it.

The IMC (isochronous maintenance channel) field carries isochronous traffic

for maintenance purposes. Its use is outside the scope of FDDI II.

Operation

During normal operation, the activity on an FDDI II network consists of a sequence of cycles generated by the cycle master. Two stations can communicate using circuit switching by sharing the use of a dedicated isochronous channel, or they can communicate using packet switching over the packet-data channel, observing the rules imposed by the token-ring protocol.

The ring initializes in basic mode. Once basic mode is established and operating, one or more stations can attempt to move the network to hybrid mode by issuing a cycle. One monitor station might be pre-assigned this task, or all monitor stations might compete. During the monitor-contention process, each contending monitor station continually issues cycles with an R value in the C1 and C2 fields and issues its monitor value in the CS field. If it sees an incoming frame with a higher monitor value, it ceases to transmit its own cycles and simply repeats incoming cycles. Even-

tually, the monitor with the highest rank sees its own rank. It then issues cycles with an S value in the C1 and C2 fields and a cycle-sequence number in the CS field.

The cycle master maintains the programming template. The allocation of capacity between packet and circuit transmission can be modified dynamically by means of SMT requests to the cycle master. When a request for modification comes in, the cycle master waits until it receives the token on the packet-data channel to ensure that no other station's packet data is circulating on the ring. It then generates a new cycle with the new programming template and issues a new token on the packet-data channel. Other FDDI II stations adjust to the new allocation as soon as they receive the new programming template.

The End of the Line

FDDI II expands the power of FDDI I by supporting circuit switching for users who need LAN support for voice, video, or other constant-data-rate applications. With its standardized data rates, FDDI II lends itself to ready integration with ISDN, T1, and other long-haul data-transmission services.

FDDI II most likely represents the end of the line for refinements of this sort of shared-access technology. Vendors are already beginning to explore the use of ATM (asynchronous transfer mode), or cell relay, technology. With the use of ATM switches, it is possible to build a LAN or MAN in which each attached station has a dedicated high-speed link to the network, rather than a shared link, as is the case with FDDI II. For the near term, however, FDDI II should rejuvenate the FDDI market. ■

William Stallings is president of CompComm Consulting (Brewster, MA) and is a lecturer and author. This article is based on his two most recent books: Local and Metropolitan Area Networks, 4th Edition (Macmillan, 1993), and Networking Standards: A Guide to OSI, ISDN, LAN, and MAN Standards (Addison-Wesley, 1993). You can reach him on BIX c/o "editors" or on CompuServe at 72500,3562.

PROCESSING MAGIC ON THE MAC



Imagine working in an environment of total isolation. You have no neighbors, no one to call, and nobody to help you with your work. Until Apple's System 7 operating system arrived, most Macintosh programs worked this way. Programs executed in the midst of a bustling, industrious work environment without any means of communicating outside their own boundaries. While programmers could find an occasional peephole through which a trickle of information might pass between applications, doing so required arcane knowledge and questionable tricks.

Today, System 7 enhancements such as the Process Manager and Apple Events permit programs to communicate freely with other applications, request help, and exchange data. While System 7 has been around since 1991, many programmers are still unaware of how their applications can take advantage of these enhancements. I'll focus here on the capabilities of the Mac Process Manager.

History Lesson

The original Mac OS could run just one application at a time. You could also run DAs (desk accessories)—small utility programs roughly equivalent to TSR utilities under DOS—but these specialized utilities had several severe constraints, including very limited size.

Apple's Switcher was the first attempt to allow users to keep multiple applications active on the Mac. Switcher moved applications in and out of memory while fool-

ing the operating system into seeing only one application. This solution let users quickly change from one application to another, but tricking the operating system was not an optimal solution.

Then came MultiFinder, which let users have multiple applications active simultaneously and allowed operations to continue in applications that were not currently on-screen. MultiFinder still required a bit of magic to work. The Finder still saw only one program; MultiFinder tricked the Finder into running more than one. To add to the complexity, MultiFinder was an option, and you couldn't easily tell when it was installed. Nevertheless, MultiFinder appeared to be a complete solution for users, who could now have multiple programs running at the same time and could switch smoothly and quickly between them.

Programmers saw things differently. They wanted to use the inherent features of MultiFinder in their products, but doing so wasn't easy. Apple proclaimed that MultiFinder should be transparent: A program shouldn't have to know whether it was running under MultiFinder or the Finder. But some subtle—and not so subtle—differences between the two environments made complying difficult.

The most important difference was how one application could start another application and then regain

Here's a look at how the System 7 Process Manager works—and how you can use it

PROCESS MANAGER CALLS

Use these Macintosh Process Manager calls to read process information.

```
OSErr GetCurrentProcess ( ProcessSerialNumber *psn );
OSErr GetFrontProcess ( ProcessSerialNumber *psn );
OSErr GetNextProcess ( ProcessSerialNumber *psn );
OSErr GetProcessInformation ( ProcessSerialNumber *psn, ProcessInfoRec *pInfo );
OSErr SameProcess ( ProcessSerialNumber *psn, ProcessSerialNumber *ps2 );
OSErr SetFrontProcess ( ProcessSerialNumber *psn );
OSErr WakeUpProcess ( ProcessSerialNumber *psn );
```

control. An application running under the Finder could perform this task, but it would not regain control until the other application had finished. Launching from within MultiFinder allowed both of the applications to be active simultaneously. Furthermore, developers found that the process of launching one application from within another was fraught with loopholes and dangers: This operation was not officially supported by Apple, required a relatively arcane invocation of the code, and usually broke between operating-system releases.

It was also impractical, if not downright impossible, to detect other currently active applications. This, again, required delving into the hidden system resources and was fraught with peril, since Apple never guaranteed that such officially unsanctioned features would exist in the next system release.

Salvation

System 7's arrival changed the rules. MultiFinder and the Finder are fully integrated and documented, and one of the results of this integration is the Process Manager.

It schedules all processes, including both applications and DAs. The number of available processes is limited only by available memory.

Apple also provides an official interface to the Process Manager's internal data structures and functions. Although much of this information is interesting only to programmers who design operating-system utilities, other pieces are vital if you want to use interprocess communications in your applications.

When a user launches an application or a DA, the Process Manager assigns it a PSN (process serial number) that's unique to the system but not necessarily unique to the application. The Process Manager stores the PSN, a 64-bit value, as two 32-bit unsigned long integers in a structure of type `ProcessSerialNumber`. This ID is the key to all the system-maintained information stored about that process.

The sample program I built for this article prints out the PSN for informational purposes, but Apple instructs programmers not to try to interpret it. Apple doesn't want you to even try to compare two PSNs, except by way of the built-in `SameProcess` function. The company reserves the

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right to maintain status data or other dynamic information in the PSN, so don't make any assumptions about the format of the PSNs, their order, or their magnitude.

The table lists the system calls used to acquire process-dependent information. The three functions that return PSNs are `GetCurrentProcess`, `GetFrontProcess`, and `GetNextProcess`. Each of these calls accepts a pointer to a `ProcessSerialNumber` structure. The `GetCurrentProcess` call returns the PSN for the currently active process, which is your own identity. `GetFrontProcess` returns the PSN of the process that owns the active window, which the user sees. Since applications can operate in the background, these two numbers are frequently different. One way your application can determine whether it is the foreground process is to compare the PSNs returned from calls to `GetFrontProcess` and `GetCurrentProcess`.

You use `GetNextProcess` to walk through the system's internal process list and find all active processes. Listing 1 shows the simple process. Before the first call to `GetNextProcess`, the Process Manager sets the PSN to the special system constant `kNoProcess`. The first call to `GetNextProcess` returns the first active process—typically, the Finder. On subsequent calls, the program passes the record that was returned from the previous call.

`GetNextProcess` currently returns only three defined values: `noErr`, `paramErr`, and `procNotFound`. The `paramErr` value indicates that the PSN passed in the record structure is invalid. If you receive `procNotFound`, then there are no other processes on the process list following the specified one. This is not an error—it simply means that you've iterated through all available processes.

Current versions of System 7 assign PSN 8192 to the Finder and then increment the PSN by 1 for each additional launched application. Be aware that this is not a behavior on which your code should depend. Apple doesn't even guarantee that the values will appear in sequential order.

Having a PSN is not very interesting unless you can do something useful with it. One use is to bring an application to the foreground. For example, an application can call `GetCurrentProcess` to determine its own ID and then call `SetFrontProcess` to activate itself. Or you can use it when an application needs to launch several other applications simultaneously. Instead of having each of the new applications flash on the screen, your application can launch them with instructions to stay

in the background. The launching application can then determine which application to move to the foreground.

Since the Mac is still a cooperative multitasking environment, calling `SetFrontProcess` doesn't automatically make the specified application move to the foreground. The specified process becomes the foreground process only after the current foreground process makes a call to `WaitNextEvent` or `EventAvail`. The one exception to this is when the current

foreground process is displaying a modal dialog box. In this case, the specified process remains in the background until the user dismisses the dialog box.

Process Details

The Process Manager maintains a data set on each process. The information it contains ranges from the application name to its memory location. Programs access this data by calling `GetProcessInformation` with a pointer to a PSN structure

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Listing 1: Listing all processes on a Macintosh.

```
psn.highLongOfPSN = kNoProcess;
psn.lowLongOfPSN = kNoProcess;

while( noErr == (result = GetNextProcess( &psn )) )
{
    /* process the information */
}
if( procNotFound != result )
{
    /* generate an error message */
}
```

Listing 2: GetProcessInformation returns this process information record.

```
struct ProcessInfoRec {
    unsigned long    processInfoLength;
    StringPtr        processName;
    ProcessSerialNumber processNumber;
    unsigned long    processType;
    OSType           processSignature;
    unsigned long    processMode;
    Ptr              processLocation;
    unsigned long    processSize;
    unsigned long    processFreeMem;
    ProcessSerialNumber processLauncher;
    unsigned long    processLaunchDate;
    unsigned long    processActiveTime;
    FSSpecPtr        processAppSpec;
};
```

Listing 3: Grabbing the process information.

```
/*
 * Initialize the size of the passed structure
 * and a pointer to the buffer into which the
 * name is returned.
 */
pInfo.processInfoLength =
    sizeof( ProcessInfoRec );
pInfo.processName =
    (StringPtr) (&theNameString);
pInfo.processAppSpec = &pFSpec;

result = GetProcessInformation( &psn, &pInfo );

if( noErr != result )
{
    /* Generate an error message */
}
```

Listing 4: Typical output.

```
Process.π
Process ID:      8252
Application file type: PROJ
Application signature: KAHL
Process mode
    Need suspend and resume events
    Can background
    Activate on foreground switch
    32-bit compatible
    Aware of high-level events
    Aware of local and remote high-level events
    Stationery aware
Partition starts at: 00CADC38
Partition size:      64000
Free heap memory:    49634
Launched by process ID: 8251
Running since time tick: 4300cf
Accumulated CPU time ticks: 9a
```

Listing 5: Launching another application.

```
void doLaunch( void )
{
    StandardFileReply    mySFR;
    SFTYPEList            myTypeList;
    OSERR                result;
    int                   fsRefNum;
    LaunchParamBlockRec   lParms;
    ProcessSerialNumber    launchedProcessSN;

    myTypeList[0] = 'APPL';
    StandardGetFile( NULL, 1, myTypeList, &mySFR );
    if( true == mySFR.sfGood )
    {
        lParms.launchBlockID      = extendedBlock;
        lParms.launchEPBLength    = extendedBlockLen;
        lParms.launchFileFlags    = 0;
        lParms.launchControlFlags =
            launchContinue +
            launchNoFileFlags +
            launchInhibitDaemon;
        lParms.launchAppSpec      = &mySFR.sfFile;
        lParms.launchAppParameters = NULL;

        result = LaunchApplication( &lParms );
    }

    /*
     * Process error codes
     * MemFullErr, MemFragErr,
     * appModeErr, appMemFullErr, and appIsDaemon
     */
}

// doLaunch
```

obtained from one of the Getnnn calls and a pointer to a ProcessInfoRec structure (see listing 2).

Your application must initialize several fields in ProcessInfoRec before it can call GetProcessInformation. Since the size of this structure may increase in future versions of the operating system, the first 32-bit structure member is set to the

size of the current record definition. (Note that all the structure members are 32-bit values. This helps speed up structure access in Macs using 32-bit processors.)

The structure also contains pointers to a name string and to a System 7 file specification record. If your application doesn't require this information, you can set the pointers to NULL. Listing 3 shows the set-

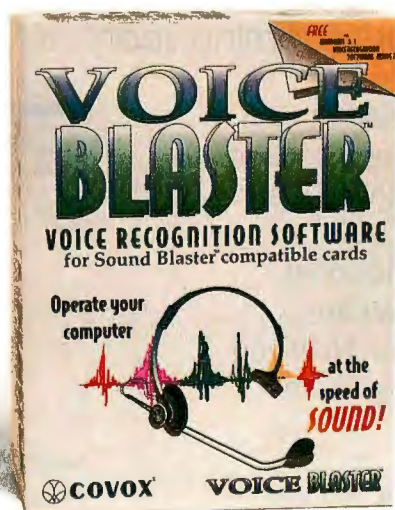
up code and call to GetProcessInformation. The only possible return values are noErr and paramErr.

Look at the information returned in the ProcessInfoRec. The processName returns the name of the application as a Pascal string—with one complication: DA names contain a \0 in the first character location, and this makes them difficult to

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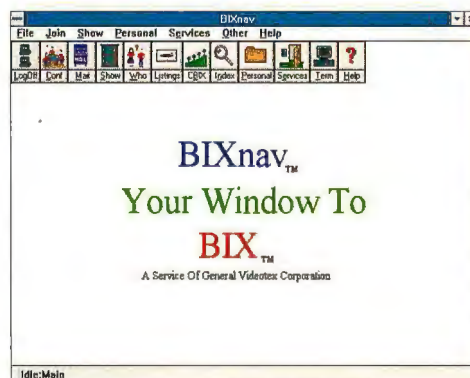
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SOME ASSEMBLY REQUIRED

print from within C routines. I ignored the problem and obtained the program name from the file specification record, which contains the name of the file that launched the application. There is a subtle difference between the process name and the file specification record: One is the name of the application in memory, and the other holds the name of the application on disk. These two names are currently identical, but in future operating-system releases, in-memory applications might be allowed to have different names.

Although I defined the `processType` and `processSignature` values as unsigned long integers, they're actually 4-byte character arrays. The `processType` for applications is always `APPL`, unless the application launches at setup and runs only in the background. In that case, the type is `appe`. Apple's documentation says that all DAs are of type `drvrr`, but all the DAs I tested had the file type `dfil`.

The 4-byte `processSignature` is unique for commercial applications, since Apple requires that developers register the signatures. This is the value applications store as the creator type in the files they create. The creator type determines which application System 7 launches when you double-click on a data file on the desktop.

The `processSignature` has other uses as well. If you're writing an application that communicates with other applications by way of Apple Events, then you must ensure that the application with which your application is communicating is active. You can do this by simply searching through all active processes until you find the one with the correct signature. You then know the PSN of the program with which you must communicate. For example, if you need to send Apple Events to Microsoft Word, you can search until you find a process with the signature `MSWD`.

The next structure member, `processMode`, contains a set of single-bit flags that indicate if the process is an application or a DA. It also contains information from the application's size resource. Among other things, these bits indicate whether the application is 32-bit compatible, if it can use high-level Apple Events, and whether it operates in the background.

The `ProcessInfoRec` also contains information detailing the application's memory use. The `processLocation` field contains the application's starting address. The amount of memory used is in `processSize`, and `processFreeMem` indicates the current number of bytes available in the application's heap. Use this information to build system memory maps and to monitor how closely applications are reaching their memory limits.

You could use the information the Process Manager returns to build a tree showing which applications launched other applications. The `processLauncher` value is a `ProcessSerialNumber` containing the process ID of the initializing application. Be aware, though, that the launching application may no longer be running.

You might also want to know when a process started an application (`processLaunchDate`) and how much of its activity has been devoted to computation (`processActiveTime`). My applications typically use 30 percent of their available time; the rest of the time they wait for user input. When developing new programs, I find it useful to check how much time an application is using while it is in the background. When the values become too large,

The Process Manager can determine when a process started an application and its activity level.

I rethink my process architecture.

Finally, `ProcessInfoRec` contains the name of the file from which an application launched, and its location on the disk. You'll find this information by way of `launchAppSpec`, which points to the appropriate `FSSpec` record. This record type (available only in System 7) contains a volume reference number that identifies the file, the reference number of the directory in which it is located, and the actual name. This information is particularly useful if you have multiple copies of the same application on your system. Displaying the information available in the `FSSpec` record shows me that I am running the wrong application, and it shows precisely where it is so that I can remove it easily. Listing 4 shows the type of information that you can extract from the system for a single application.

Prepare to Launch

Having one application launch another just is a 5-minute exercise with System 7 (see

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SOME ASSEMBLY REQUIRED

listing 5). Before you launch an application, first you have to fill out an FSSpec record with the appropriate information. The simplest method is to ask the user and the operating system to do it. StandardGetFile presents the user with the typical Open File dialog box and returns the required FSRec (professional programs will want to use a custom dialog box that says "Launch" rather than "Open").

The program fragment in Listing 5 sets up StandardGetFile to display only launchable applications. The user then selects the application to launch from the standard dialog box. When StandardGetFile returns, the StandardFileReply record is set to the description of the selected file. The sFile member contains an FSSpec record that you must pass on to the LaunchApplication function.

Several other parameters must be initialized before launching the application. The values stored in launchBlockID and launchEPBLength are predefined constants provided for historical reasons. Always set these fields as shown.

The launchFileFlags variable allows you to set the Finder flags (typically found in the size resources) for the application. The easiest approach is to place a 0 in this location and set the launchNoFileFlags bit in the launchControlFlags. This instructs the Process Manager to extract the flags from the application file.

Launch options in launchControlFlags indicate how the application is loaded and whether or not the launching application will continue operating. The launchContinue option indicates that you want your application to continue running after the launch occurs. If you do not set this flag, your application will terminate, even if the launch attempt fails. When you set this flag, the launched application does not actually start executing until your application's next call to WaitNextEvent or EventAvailable.

Use SetLaunchUseMinimum when you want the application to load using the minimum amount of recommended memory. Without this flag, the application is launched using the preferred memory size. If you set the launchDontSwitch flag, the launched application will not automatically move to the foreground, but will remain in the background until the user selects it (or your program issues a SetFrontProcess call).

Setting the last option, launchInhibitDaemon, ensures that you do not launch a background-only application. Background-only applications have the only-Background flag set in the Finder flags; however, since my example shows the pre-

ferred method of letting the launch function set the flags for you, I never actually see them. This flag ensures that the user does not accidentally launch an application that has no user interface.

The last parameter to be set, launchAppParameters, is a pointer to the first high-level event to be sent to the newly launched application. If this field is set to NULL, the Open Application event is sent.

After you've set up the preliminaries, all that's left is to call LaunchApplication and check the result value. If the returned value is memFullErr or memFragErr, you can try relaunching the application in the minimum recommended space. You will receive an appModeErr if you attempt to launch an application that is not 32-bit clean while you are in 32-bit address mode. A result of appMemFullErr indicates that the application requires more memory to load than is indicated in the size resource; this is a programmer's problem that you cannot solve. If you have set the launchInhibitDaemon flag, you may receive the appIsDaemon result, indicating that the application was a background-only task and was not launched.

The LaunchParams record holds several other useful bits of information. The Process Manager returns the launched application's PSN in launchProcessSN. If you have difficulty launching because of limited memory, you can check the launchPreferredSize and launchMinimumSize parameters to see how much space the application would like to consume. The variable launchAvailableSize contains the size of the maximum contiguous chunk of memory currently available.

System 7 has elevated process management from the depths of murky obscurity to mainstream functionality. Programs are no longer officially isolated entities, but can be more fully aware of the environment in which they're operating. This capability will gain greater importance as more and more applications seek to communicate with each other through Apple Events. ■

Editor's note: The complete listings for this article are available in electronic format. See page 5 for details.

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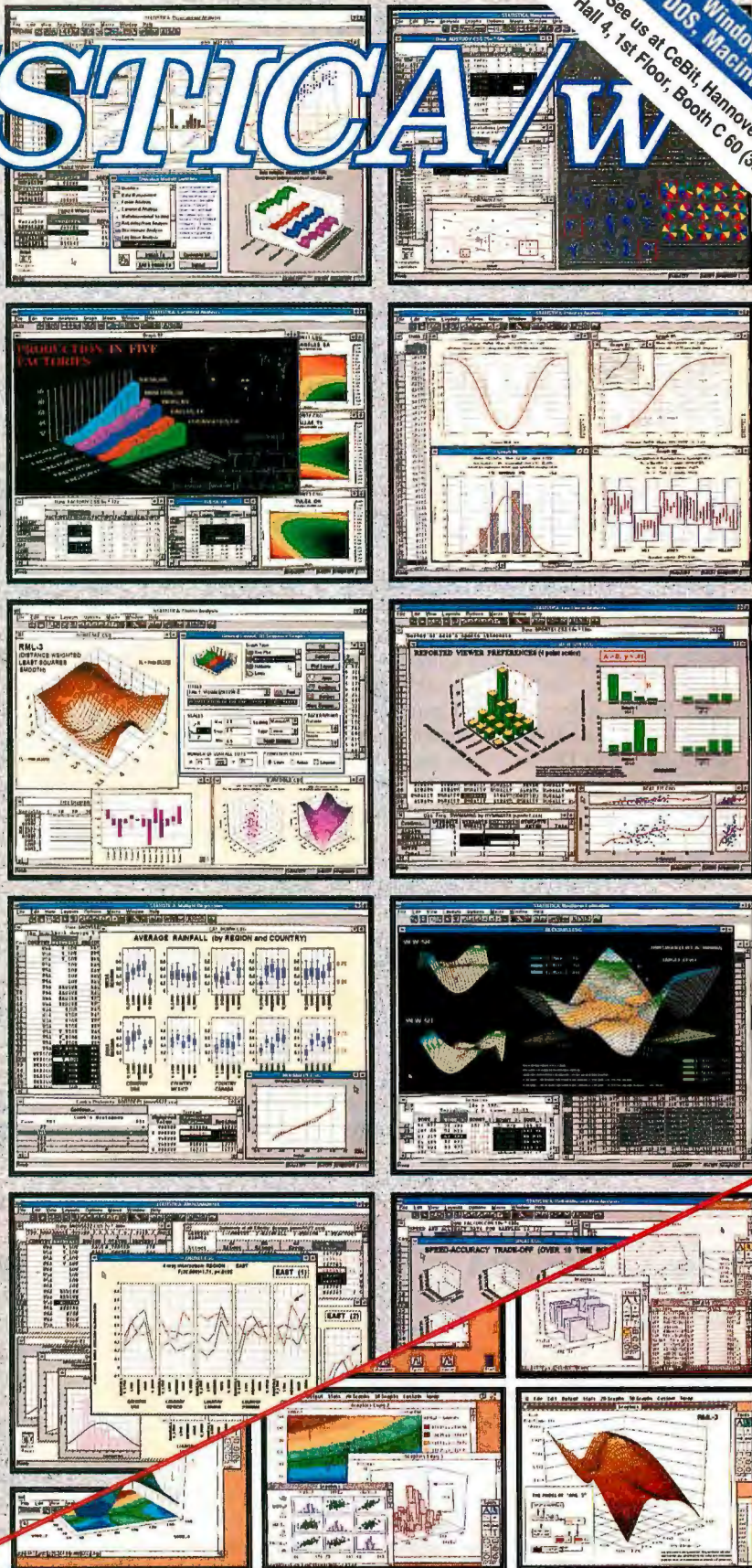


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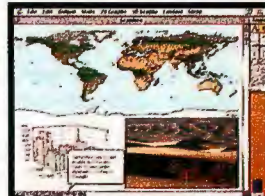
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LAN REMOTE CONTROL

Operating another PC across the LAN saves time walking around the office to troubleshoot problems. It's also useful for a variety of tasks. You might use remote control as a training tool, to demonstrate the proper use of an application. Or you can use remote control to manage an unattended PC, such as a backup server, without leaving your desk. This month's Software Corner offers a pair of programs, Control and SlaveIPX, that implement remote control of DOS sessions over IPX. These programs, which include assembly language source code, should run over any Novell NetWare 2.x or 3.x LAN.

Programming a LAN-based remote-control utility means choosing a transport protocol such as NetBIOS or IPX to shuttle screen and keyboard messages back and forth. Because Control and SlaveIPX use IPX, you don't have to load the Novell NetBIOS emulator to do over-the-wire remote control. However, using IPX also means that the remote-control software won't run on LANtastic, LAN Server, or other NetBIOS-based networks. I plan to add NetBIOS support to future versions.

A pair of PC remote-control programs for NetWare LANs

You run SlaveIPX at the host workstation, the one that you want to operate through the wire. SlaveIPX is a TSR program that takes only 7 KB of RAM. It listens for message packets containing keystroke information from Control. SlaveIPX also watches the video buffer for changes and sends the screen updates to Control at your PC. On the other end, Control sends keystroke information to the SlaveIPX workstation and accepts video-buffer updates from the host.

You run Control at the remote, or controlling, workstation. Control takes a single command-line parameter, the log-on user ID for the workstation you'd like to control. If Fred is logged in and his PC is running SlaveIPX, you'd enter `Control FRED` to start up the remote session. When you want to stop Control, press Control and the 5 key on the numeric keypad. Your keyboard reverts to controlling your PC instead of the remote PC. SlaveIPX stays

ready, waiting for the next call.

The slave program intercepts the timer tick interrupt, INT 8h. On every tick (i.e., 18.2 times a second), the SlaveIPX program checks the text video buffer (i.e., monochrome at B000:0000, or color at B800:0000) to see if it should send a screen update to Control. SlaveIPX also sends cursor-size and cursor-location updates. Control hooks the keyboard interrupt INT 9h. When you press a key on the controlling machine, Control sends the event to the SlaveIPX TSR at the remote PC. INT 9h is the low-level keyboard interrupt, so Control gets raw scan codes. It sends keys and shift-key states across the LAN to the host machine.

These programs don't attempt to shuttle screens in graphics mode, handle mouse movements, or print to a remote printer. These might make SlaveIPX and Control more useful, although it wouldn't get you to Windows remote control. If you need these enhancements, add them to the barebones versions of SlaveIPX and Control available through the usual sources. You need only MASM (Microsoft Macro Assembler) or TASM (Turbo Assembler) and a linker to create new executable files. ■

MAC/Tom Thompson

Cleaned-Up ARA

AppleTalk Remote Access lets your PowerBook call up a Mac at work and appear as a node on the office AppleTalk network. You can view files, copy them to the office network, and print them, just as if you were there. The only problem with ARA is that it has a clunky interface that uses a Control Panel to enter configuration settings and then an application to dial and establish the connection.

ARAClient, shareware written by Ron Duritsch, consolidates both the setup and access procedures into one convenient Control Panel. You enter the modem settings, phone number, user ID, and password into ARAClient and click on a button to make the connection. You can also save these values into a file for later use. ARAClient saves filed connection information into a stand-alone application that automatically makes the connection when launched.

UNIX/Ben Smith

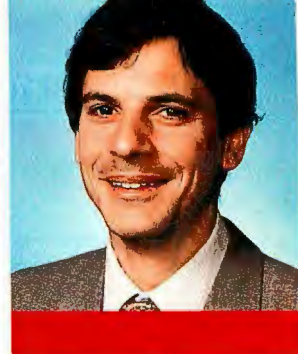
An Old Friend Extended

Yes, I have heard the joke: "Friends don't let friends use vi." But vi is an old friend to many a Unix user. Compared to emacs, it's small and simple—yet it does everything you need.

Chris and John Downey have developed a freely available version of vi with extensions (hence the name xvi). Although xvi is not an X Window System application, it does have multiple windows and buffers, 8-bit character support, multiple command buffers (i.e., it can repeat more than one command), and on-line help.

Even though xvi was originally developed for the Amiga, it's been ported to almost every popular operating system except the Mac OS. If your fingers (and mind) are already conditioned to vi, you will enjoy this old friend in this more sophisticated and more portable incarnation.

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JON UDELL

SIMPLE MAPI DELIVERS

You've probably heard that Windows for Workgroups comes with built-in mail and mail-enabled scheduling. You may not realize, though, that it is also a platform for building mail-enabled applications. The key to this kingdom is the first incarnation of MAPI, Microsoft's Messaging API. A major piece of WOSA (Windows Open Services Architecture), MAPI aspires to make mail a standard Windows system service, just as ODBC (Open Database Connectivity) does for SQL (see "Connecting Windows to Data with ODBC," January BYTE).

The simplest MAPI-aware applications will present Send menu items (or toolbar buttons) so you can mail a file or a range of files from your word processor or spreadsheet. In Windows for Workgroups, for example, File Manager's toolbar sports a Send File button. More fully MAPI-enabled programs will route forms, distribute software, and manage work flow.

Unfortunately, MAPI isn't yet as mature as ODBC. Developers are rapidly making the WOSA vision of multiple service providers a reality for ODBC. I just learned that both Watcom's and Raima's newest SQL products support ODBC. I fully expect that the WordBasic macro and the supporting DLL I built to access dBase and SQL Server data through ODBC will converse successfully with these new databases and many others.

The situation with MAPI is different. The shipping version, called *simple MAPI*, is inseparably bound to Microsoft Mail. The first beta version of an *extended MAPI* open to alternate mail transports, address books, and message stores won't be available until you read this. So don't plan on running MAPI-enabled software over MHS, Vines, SMTP, or other popular mail transports anytime soon.

Using Simple MAPI

Despite this limitation, you can do quite a lot with simple MAPI today. Comprising just a dozen function calls and a few

basic data structures, it's a surprisingly powerful tool. I began exploring simple MAPI using the MAPI custom controls included in the professional edition of Visual Basic 2.0. In just a few minutes, I created a Visual Basic mail notifier that periodically polled my mailbox and popped up a message box when it spotted a piece of unread mail. Although trivial, it served a useful purpose. Windows for Workgroups doesn't provide a lightweight notifier, so you have to keep Mail—a hefty program—loaded all the time to check for incoming messages.

The Visual Basic custom control does a great job of encapsulating the MAPI data structures—a message, along with its lists

of recipients and attachments—but the result wasn't the lightweight notifier I'd envisioned. The next step was to re-create the program in C. That was straightforward, too. LoadLibrary and GetProcAddress gave me the addresses of the entry points in MAPI.DLL that I needed: MAPILogon (to establish a session), MAPIFindNext (to enumerate unread messages in the inbox), MAPIReadMail (to peek at the contents of new incoming mail), and MAPIFreeBuffer (to free memory allocated by MAPI for message storage). You can do this in any language that can call a DLL and can represent a message and its associated lists.

When a mail-enabled program logs on to the mail system, it can display the same log-on dialog box that Mail itself uses, or, if it knows a valid name and password, it can bypass that dialog box and silently establish a session. Both approaches have their uses. When interaction is necessary, a standard look (as with the Windows 3.1 common file, print, and font dialog boxes) tells you to expect standard behavior. Developers who've worked with both MAPI and the VIM (Vendor-Independent Messaging) API cite VIM's lack of an embedded common user interface as a drawback.

MAPI Functions

Simple MAPI provides two functions for sending mail. MAPISendDocuments, which always prompts with standard dialog boxes for recipients and sending options, works even with minimally capable languages like WordBasic that can't pass message structures as parameters. If you're using a more robust language, you can use MAPISendMail and skip the addressing and attachment dialog boxes. An unattended program using this function can send a message (with a list of file or OLE attachments) to a list of recipients. Other MAPI functions enable programs to save and delete messages, build recipient lists using the address-book dialog box, resolve a name to an address-book entry, and view

**Microsoft's new E-mail
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or edit an address-book entry.

Every MAPI message has an associated type. These types conform to a three-part syntax. If I send you a standard Microsoft Mail message, its type will be IPM.Microsoft Mail.Note. The first field denotes interpersonal mail, the second identifies the sending application, and the third further categorizes the message. Other IPM message flavors common in Windows for Workgroups define message receipts and requests for meetings.

Simple MAPI also recognizes message types beginning with IPC, which stands for interprocess communications. IPM messages show up in your inbox when you run Mail, but IPC messages don't. Suppose I'm a network administrator receiving frequent automatic status reports—via E-mail—from nodes on a network. Instead of cluttering up my inbox, the reporting nodes and monitoring application might use the invisible IPC channel.

Hitting the Wall

Why not just stash IPM messages in a designated folder accessible to the standard Mail client? Here's where simple MAPI starts to run out of gas. Its concept of a

message store is extremely limited. It knows only about a single folder: Mail's inbox. You can't use simple MAPI to create a new folder or set the current folder to be other than the inbox. Extended MAPI, by contrast, defines a rich message store comprising a hierarchy of folders and provides functions to create, move, copy, delete, and search those folders. There may, in fact, be several message stores, so extended MAPI also provides a function to enumerate them.

Like message stores, transports and address books can multiply in extended MAPI. Novell's MHS, for example, comprises both a store-and-forward mail transport and a directory of users. A MAPI implementation would make MHS one of several transports that are available to MAPI clients and merge the MHS directory into the system address book. At this point, MAPI starts to look a great deal like ODBC. As more service providers appear on the scene, diverse message systems—MHS, SMTP, and even fax—will become accessible to Windows applications that use MAPI.

Such integration today requires specific collaboration between clients and gate-

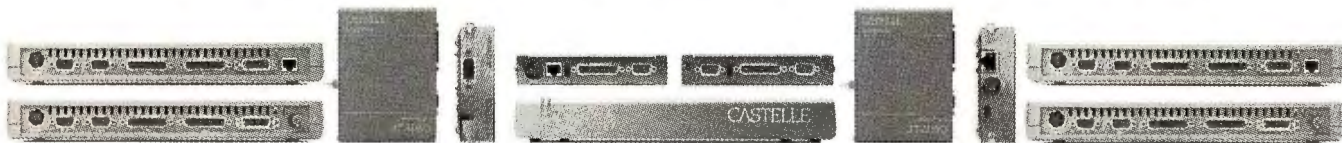
ways. Extended MAPI aims to generalize that relationship, granting any Windows application common access to all the message systems enabled on a given machine. Moreover, you will enjoy a unified view of those diverse systems. When you address a note to a mixture of E-mail and fax recipients, you'll always work with the same address-book dialog box, whether you initiate the action from a minimally mail-aware application or from a full-blown mail client.

Extended MAPI Objects

All the objects that an extended MAPI client can manipulate—including message databases, messages, attachments, folders, address books, users, and distribution lists—support a common interface for querying and setting properties. Additional common interfaces support streaming text to and from messages and attachments, and arranging lists or hierarchies in tabular form for search or display.

The function `GetContentsTable`, for example, works polymorphically to enumerate flat objects like distribution lists and attachment lists, while `GetHierarchyTable` examines tree-structured

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objects like address-book containers and folders. Tables acquired by means of either of these functions support common search, sort, and navigation protocols.

To support the multiprovider scenario, extended MAPI defines a trio of interfaces to which message store, address book, and transport providers must conform. For the most part, MAPI.DLL, like ODBC, will play the role of a driver manager that loads DLLs. Then it will get out of the way so those DLLs can do the real work. However, MAPI.DLL will directly implement certain key services such as memory management and event notification.

In general, service providers will ask MAPI to allocate memory, and clients will ask MAPI to free it. Because a central authority brokers requests from both sides, ownership conflicts won't arise. There's also a chaining function that a provider can use to grow complex, nested structures that a client can nevertheless free by calling MAPI with a single base pointer.

The event-notification service is particularly elegant. A client that wants to be notified when the contents of a particular folder change issues a call to the folder's provider. It in turn sends a client-supplied

folder ID and callback function along to the *notification engine* in MAPI.DLL. When the provider changes the folder's contents, it alerts MAPI, which takes care of notifying all clients that have registered interest in the folder.

MAPI in Your Future

Microsoft plans to roll out extended MAPI with a future version of Windows, probably in 1994, and promises that applications written to simple MAPI today will run unmodified on extended MAPI when it's available. Message-enabled applications previously confined to a Microsoft Mail straitjacket will suddenly be able to connect to a rich assortment of message systems. And at the same time, extended MAPI's superior facilities for organizing, searching, and storing message data will encourage the development of new mail-enabled applications more ambitious than those feasible today with simple MAPI.

Do developers buy into this plan? Yes and no. The author of a leading mail-enabled forms program told me his principal concern is to get that program onto as many mail platforms as possible. A multiprovider version of MAPI would do the

trick, but so would a multiprovider version of VIM. Currently, he's forced to support the early, uniprovider versions of both APIs to get coverage of just two mail systems—Microsoft Mail and cc:Mail. Both MAPI and VIM promise to decouple from proprietary transports and push beyond their current Windows (and, for VIM, OS/2) implementations to DOS, Unix, and the Macintosh. But E-mail developers aren't sitting on their hands waiting for all this to happen.

In the meantime, it's hard to go wrong with simple MAPI. Windows for Workgroups is going to put Microsoft Mail and MAPI onto a lot of desktops. Users of Windows for Workgroups will come to expect that applications notice the mail system and react by offering Send options. It's so easy to satisfy that expectation that there's no reason not to. A developer who supports DDE or OLE must make a major commitment. Simple MAPI, by contrast, lives up to its name—it really is a cinch. ■

Jon Udell is a BYTE senior technical editor at large. You can contact him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.



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ASK BYTE

Running CD-ROMs in Parallel

I have an NEC Intersect CDR-73 external CD-ROM drive connected to my Amiga 2000. I recently purchased a Librex T386SX/Notebook and would like to use the CD-ROM drive with it. Because my notebook cannot use SCSI peripherals directly, I am looking for ways to connect external SCSI devices to either the parallel printer port or the PCMCIA slot. How do I do so?



Bryan Brown
Silver Spring, MD

I'm not aware of any PCMCIA SCSI adapters. Parallel-port adapters seem to be all the rage these days, and two companies attract most of the attention. Always Technology (Westlake Village, CA, (818) 597-1400) and Trantor Systems (Fremont, CA, (510) 770-1400) both make parallel-port SCSI adapters that should do the trick.

Always' AL-1000 supports a full host of SCSI devices and comes with ASPI (advanced SCSI programming interface) drivers. It should handle your CD-ROM drive. If you have a bidirectional port, the AL-1000 will give you data at rates of up to 250 KBps. Trantor's T338 MiniSCSI and T348 MiniSCSI Plus both come with CD-ROM support. If your Librex machine has a bidirectional parallel port, you'll want to investigate the T348 MiniSCSI Plus. Freeport Data (Fremont, CA, (510) 505-0567) makes two similar products: the Freeport/25 and Freeport/50 (25- and 50-pin SCSI, respectively) adapters.

MSCDEX comes with most drives, or you can get a copy as part of Corel SCSI, a universal SCSI driver that handles many different SCSI drives, from Corel Systems (Ottawa, Ontario, Canada, (613) 728-8200). Because these products are always being upgraded, you should check with the manufacturer to make sure that the Intersect CDR-73 is one of the supported drives.

—Howard Eglowstein

Dynamic Arrays

Regarding Daryl F. Watson's C programming problems (Ask BYTE, December 1992), I had the same problems when I started programming. For a program to execute another program or an operating-system command and return to the mother program, ANSI C provides the `system()` function with prototype in `stdlib.h` (e.g., `system("rog1.exe")` will execute `rog1` in DOS).

Dynamically allocating multidimensional arrays is not as tricky as your reply says, although it requires a programmer's logic. For example, to allocate a 2-D array with six columns and nine rows, you define a pointer that indicates an array of six pointers, each pointing to its own array of nine floats. Listing 1 shows how to do it in C++.

The solution in ANSI C follows similar lines. As a physicist, I use multidimensional arrays so often that I have defined functions with templates to handle this business. This lets me dynamically allocate memory for multidimensional arrays of any object in a single line.

Michael Chen
Riverdale, MD

There are two items of importance in your listing: The first is the `system()` function; the second is the concept of dynamic-array allocation.

On the first point, note that the I/O of any program or process started with `system()` is completely independent of the parent program, your C code. It doesn't even return the exit status of the program, only the exit status of the command interpreter (e.g., `command.com` or `/bin/sh`). This is acceptable if you only

want to initiate another program from within yours.

The second point is also valid, but only in a limited context. It is in the definition of the word dynamic that our views differ, and it's from this difference that the problem becomes either trivial or complex. I'll define dynamic-array allocation in this way: the ability to expand or contract the size of an array based on the dynamic conditions within a running program.

To allocate memory once during the program is no problem, but when you want to add to the size of the array, many things can go wrong. The C++ operator `new` and the C function `malloc()` return a pointer to a block of memory. Even sequential calls to these operations will not give you the next sequential address so that you could have merely concatenated the new with the old, to create a contiguous array.

Assuming that you plan to allocate an entirely new block of memory when it comes time to change the size of the array, you face some inconveniences: You must copy valid contents of the old array to the new array before you free the space on the old one; you can't use more than half of the free heap space, because you must maintain two copies of the array during the copy; and your heap space will become fragmented and limit the size of your arrays even more.

The solution is to manage the heap with your own routines for dynamically changing the size of arrays. Some of our longtime readers may recall that Rick Grehan offered such routines in "If Memory Serves..." (August 1989 BYTE).—Ben Smith ■

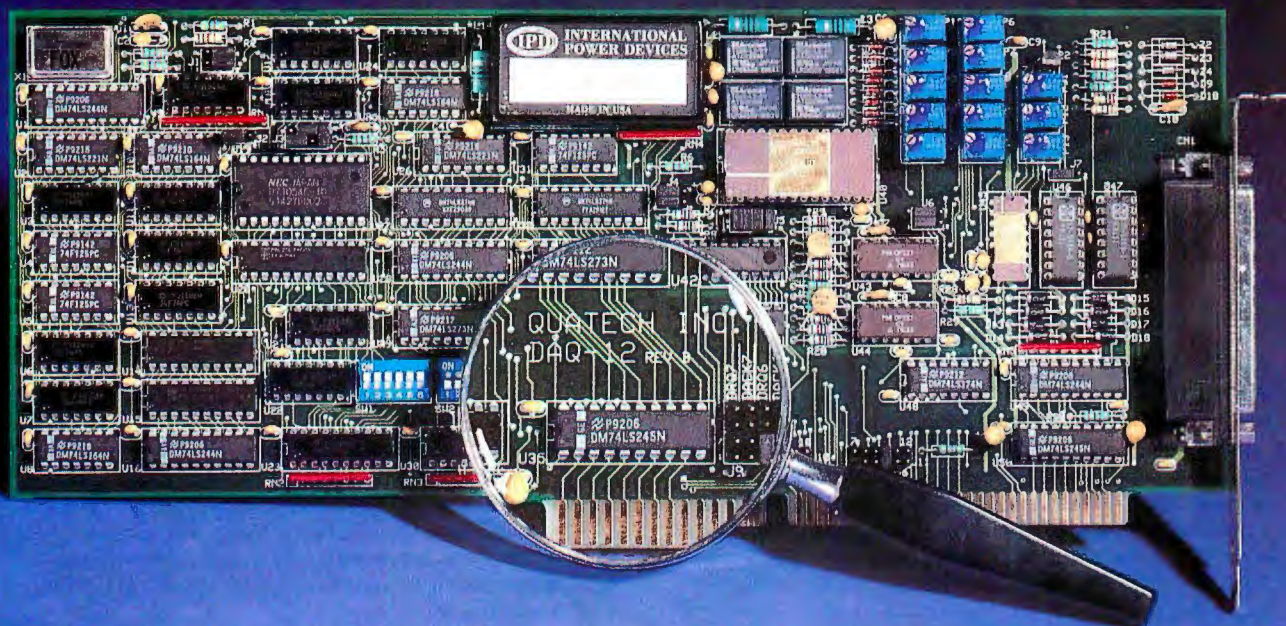
Listing 1: Dynamically allocating multidimensional arrays.

```
float **ptr;
//Allocate memory for 6 pointers.
ptr=new float *[6];
//Now allocate memory for
//6 arrays, each with 9 floats.
for(int i=0; i<6; i++)
    ptr[i]=new float[9];
//Now we can use the array!
ptr[3][5]=1.2;
```

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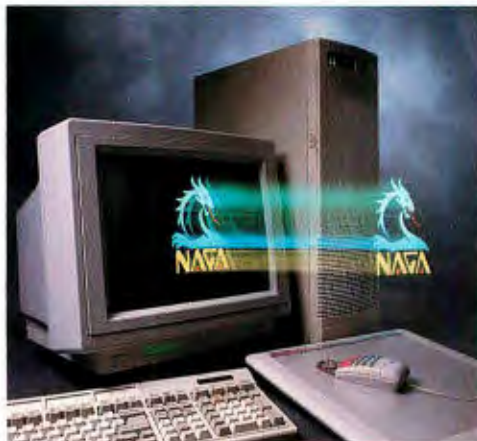


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| 80387 166666666666MHz INTEL | 80387DX-266666666666 266666666666MHz CYRIX | 287-166666666666 166666666666MHz IT |
| 80387 200000000000MHz INTEL | 80387DX-333333333333 333333333333MHz CYRIX | 287-200000000000 200000000000MHz IT |
| 80387 266666666666MHz INTEL | 80387DX-400000000000 400000000000MHz CYRIX | 287-266666666666 266666666666MHz IT |
| 80387 333333333333MHz INTEL | 80387DX-500000000000 500000000000MHz CYRIX | 287-333333333333 333333333333MHz IT |
| 80387 400000000000MHz INTEL | 80387DX-600000000000 600000000000MHz CYRIX | 287-400000000000 400000000000MHz IT |
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| 80387 600000000000MHz INTEL | 80387DX-1000000000000 1000000000000MHz CYRIX | 287-600000000000 600000000000MHz IT |
| 80387 800000000000MHz INTEL | 80387DX-1333333333333 1333333333333MHz CYRIX | 287-800000000000 800000000000MHz IT |
| 80387 1000000000000MHz INTEL | 80387DX-1666666666666 1666666666666MHz CYRIX | 287-1000000000000 1000000000000MHz IT |
| 80387 1333333333333MHz INTEL | 80387DX-2000000000000 2000000000000MHz CYRIX | 287-1333333333333 1333333333333MHz IT |
| 80387 1666666666666MHz INTEL | 80387DX-2666666666666 2666666666666MHz CYRIX | 287-1666666666666 1666666666666MHz IT |
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| 80387 4000000000000MHz INTEL | 80387DX-6000000000000 6000000000000MHz CYRIX | 287-4000000000000 4000000000000MHz IT |
| 80387 5000000000000MHz INTEL | 80387DX-8000000000000 8000000000000MHz CYRIX | 287-5000000000000 5000000000000MHz IT |
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| 80387 10000000000000MHz INTEL | 80387DX-16666666666666 16666666666666MHz CYRIX | 287-10000000000000 10000000000000MHz IT |
| 80387 13333333333333MHz INTEL | 80387DX-20000000000000 20000000000000MHz CYRIX | 287-13333333333333 13333333333333MHz IT |
| 80387 16666666666666MHz INTEL | 80387DX-26666666666666 26666666666666MHz CYRIX | 287-16666666666666 16666666666666MHz IT |
| 80387 20000000000000MHz INTEL | 80387DX-33333333333333 33333333333333MHz CYRIX | 287-20000000000000 20000000000000MHz IT |
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Now you can be sure

SAFEWARE was developed by an insurance professional who was shocked to learn that his very own personal computer was at risk. Can you imagine? What he discovered was that his homeowners insurance policy excluded coverage as soon as he began operating his first business program. Even his simplest spreadsheet voided coverage. Because most homeowners policies *won't cover any equipment used for business*, no matter how infrequently. Out of this need was born SAFEWARE. A simple, easy-to-understand coverage you can count on. Full replacement coverage of hardware, media and purchased software, after a low \$50 deductible.

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What the editors reported

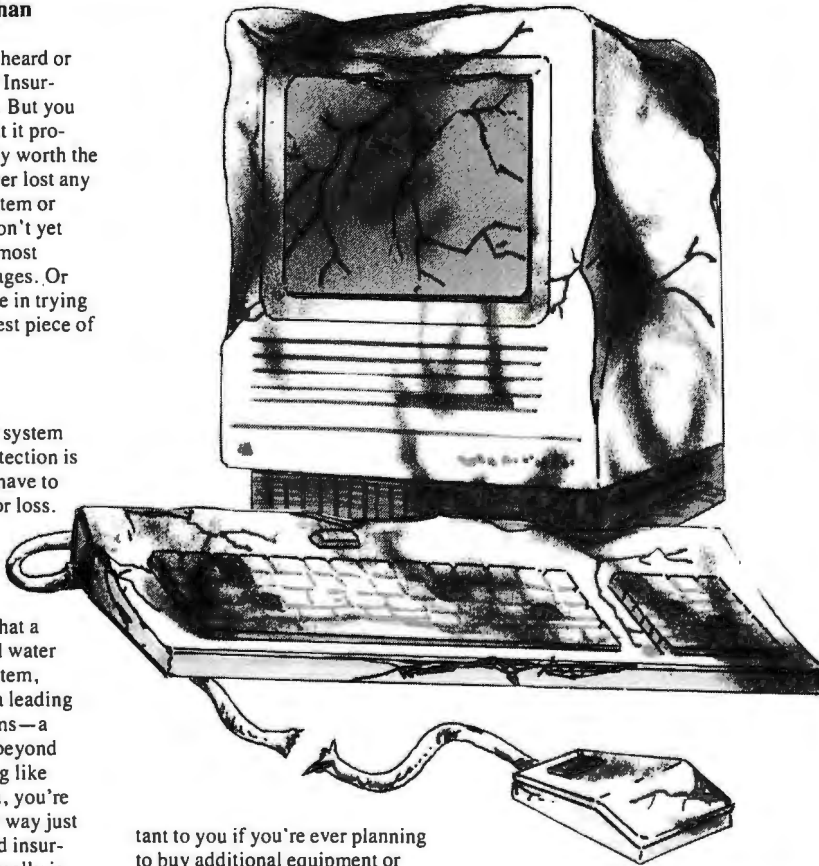
Publication editors have discovered the news about SAFEWARE and have reported to their readers. *Computer Decisions*: "... Your personal computer might not be safe at home. If it is not insured, then you're running the risk of losing the thousands of dollars you've invested..."

Personal Computing: "... Replacing hardware may be more of a problem than you thought it would be... That's why (a computer consultant) suggests that you get the computer insured..."

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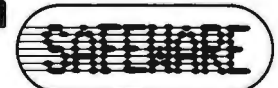
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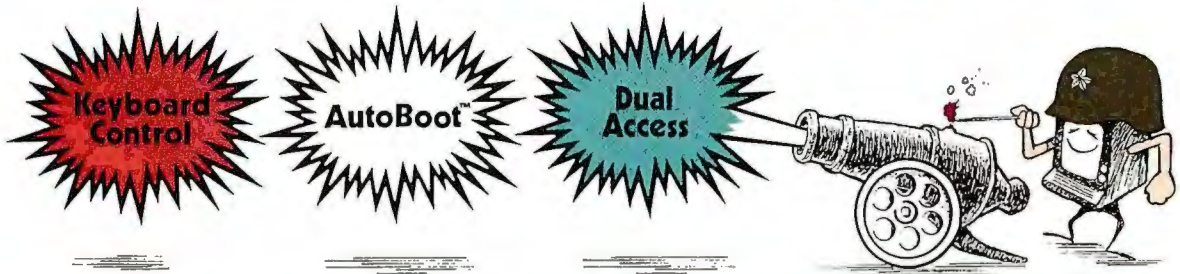
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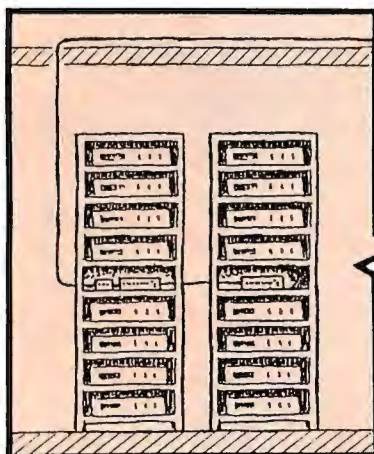
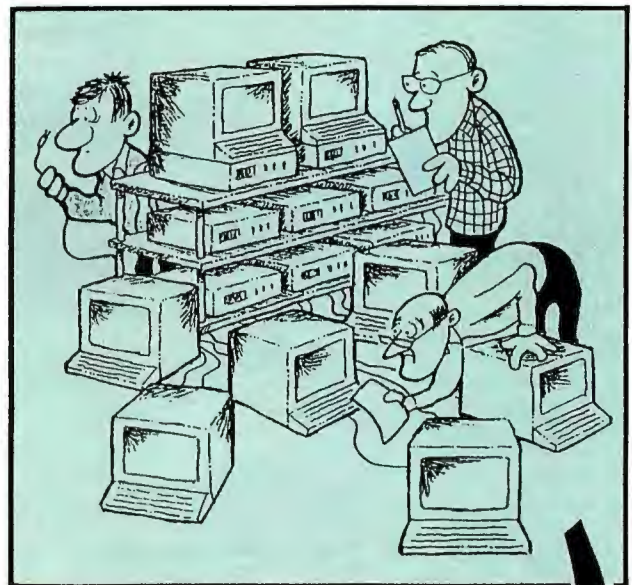
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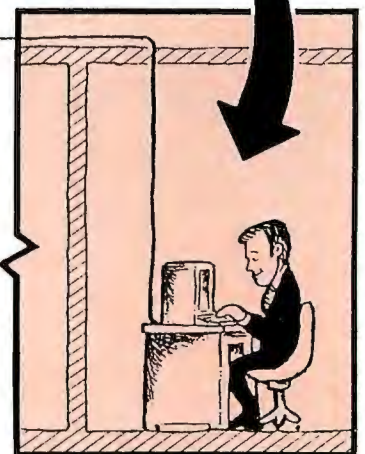
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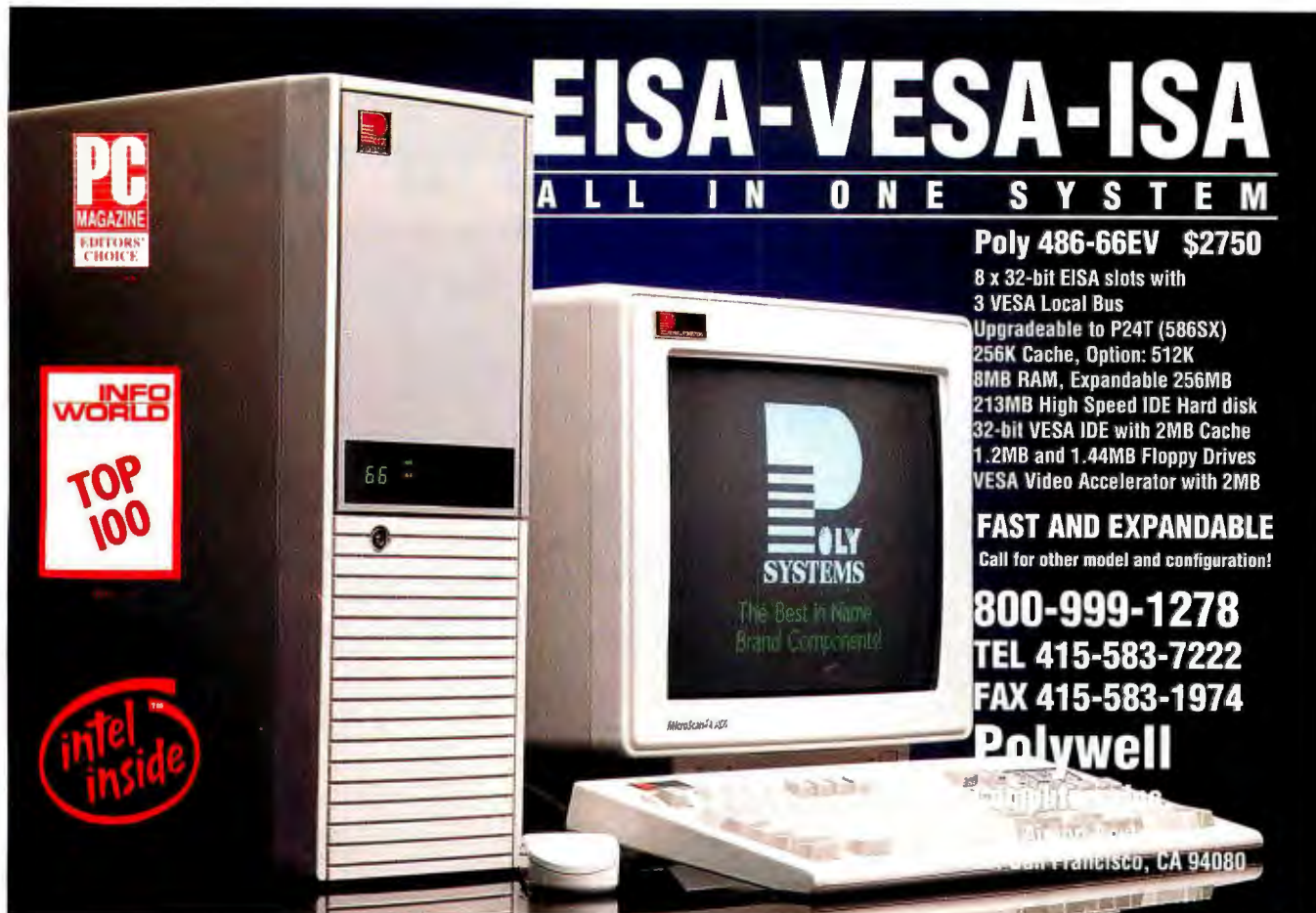
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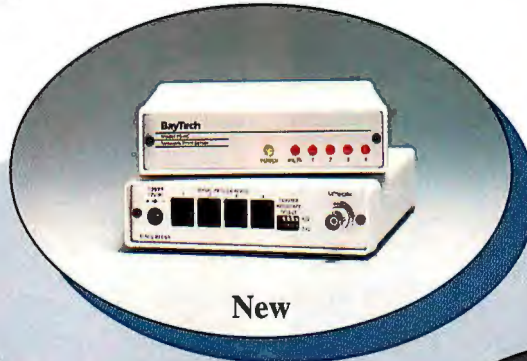


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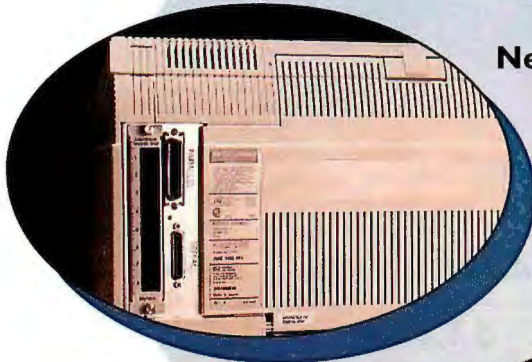
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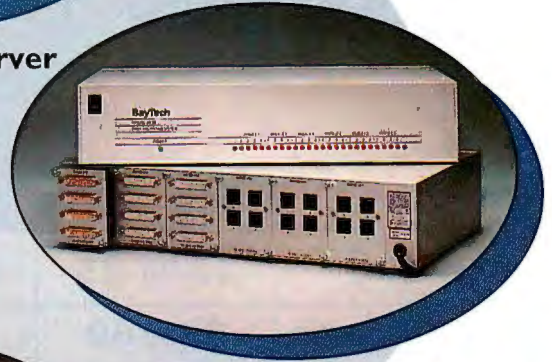


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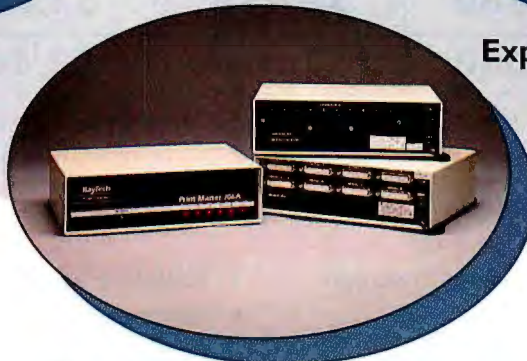
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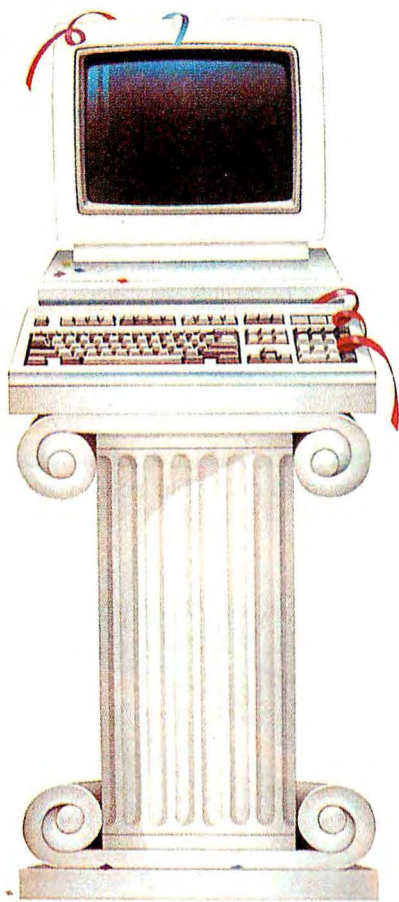
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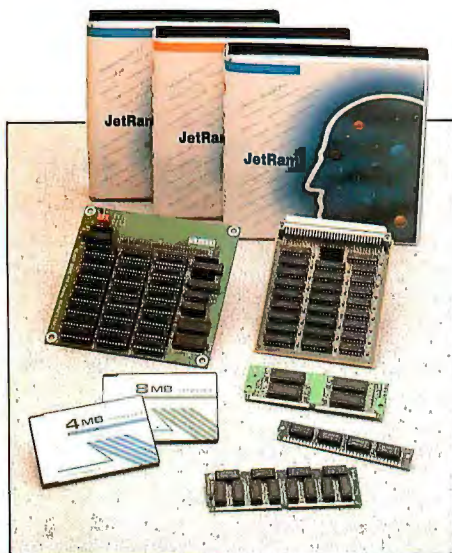
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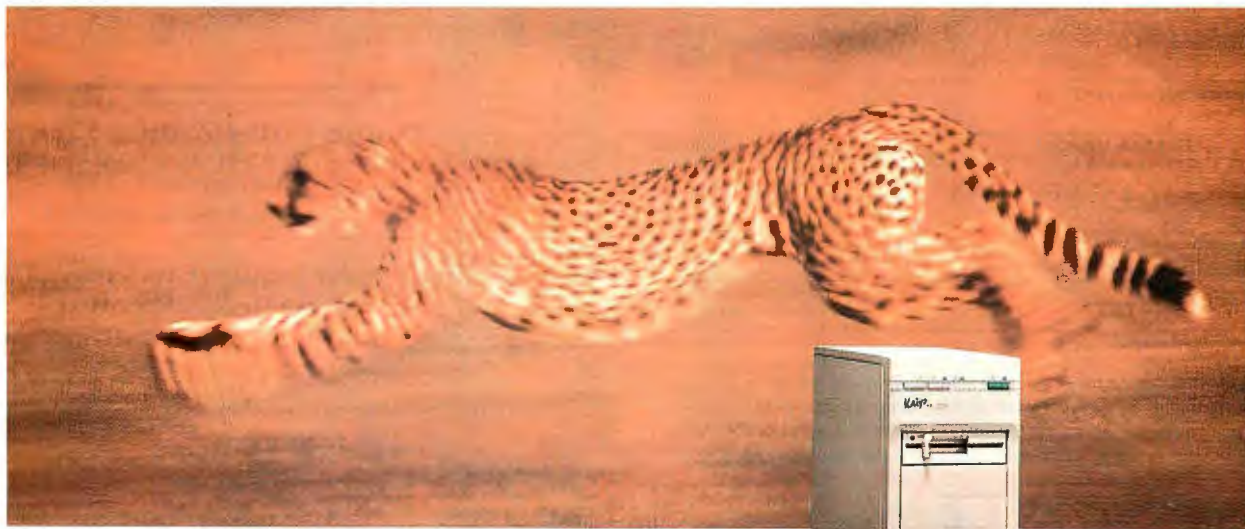
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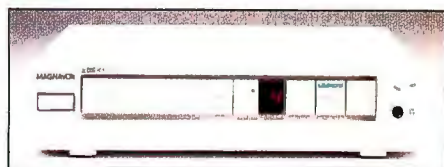
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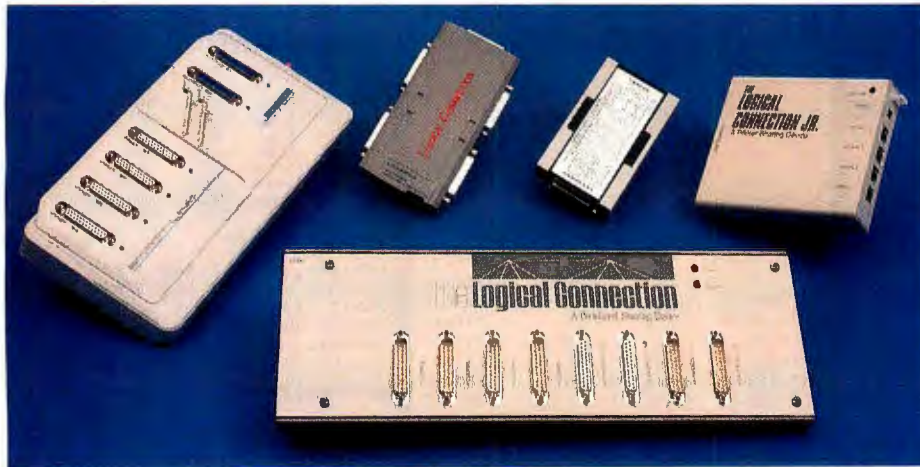
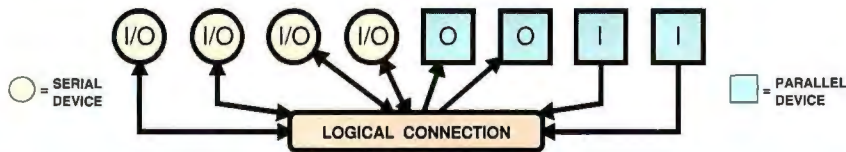
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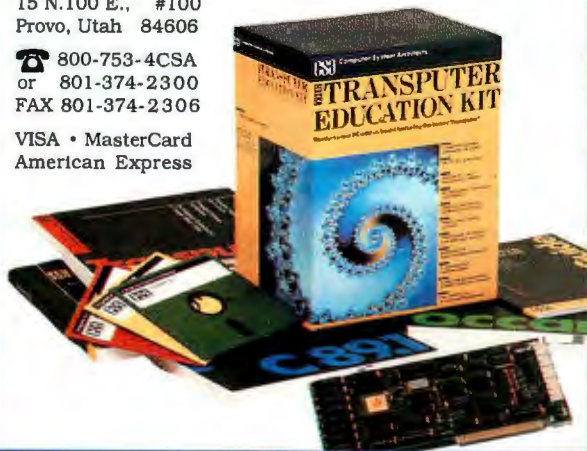
R. Eckhouse, IEEE Computer, Sept. 92, page 97

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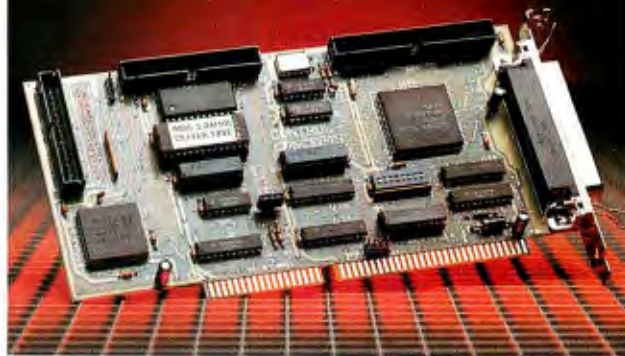
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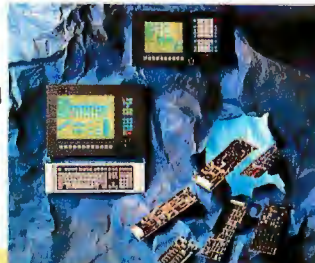
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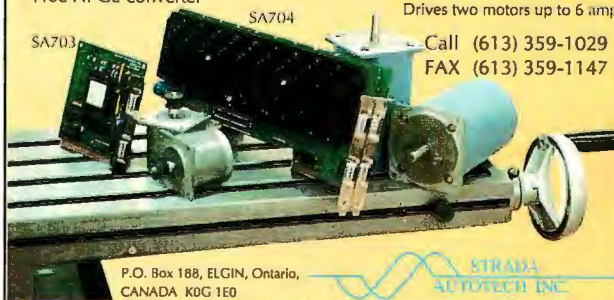
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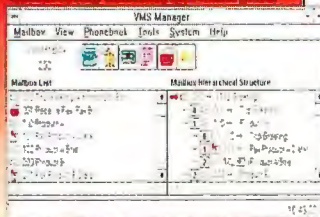
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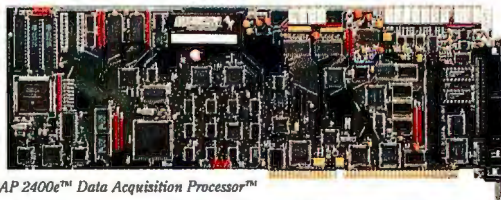
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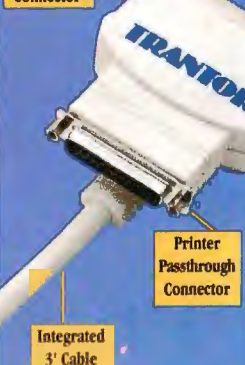
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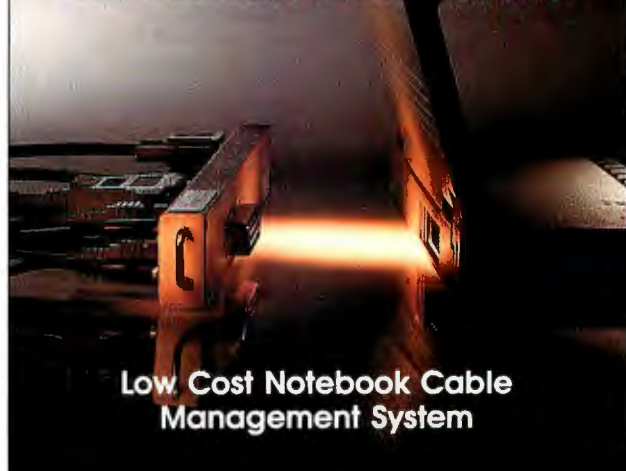
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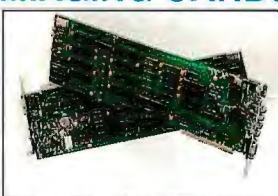
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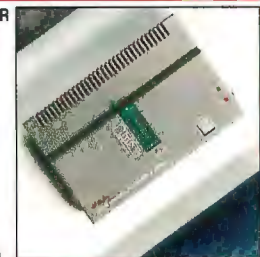


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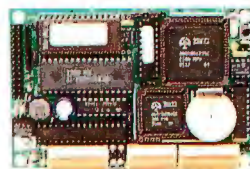
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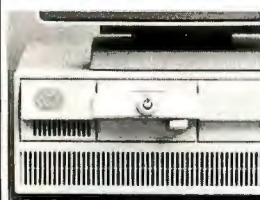
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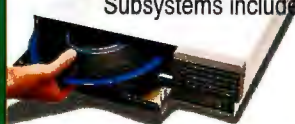
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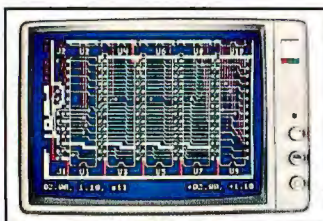
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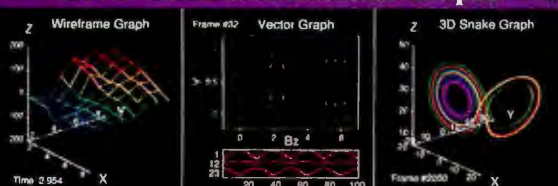
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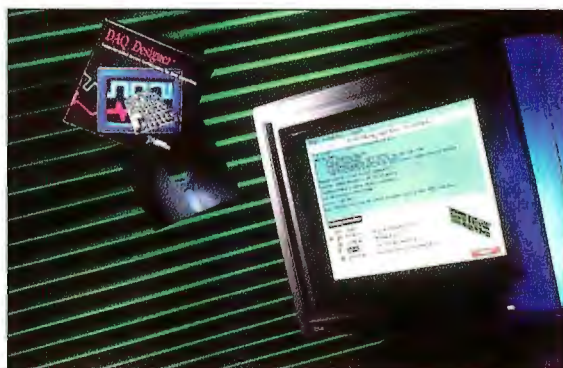
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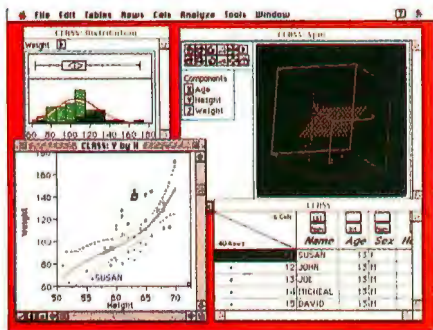
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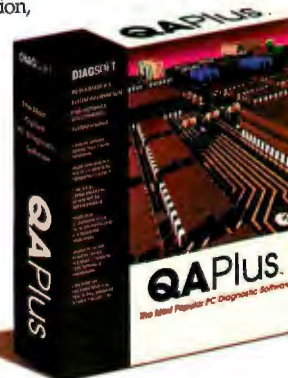
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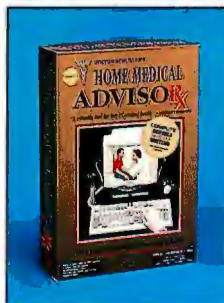
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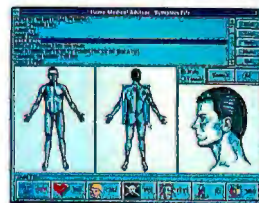
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☐ Administration/Management
☐ Sales/Marketing
☐ Engineer/Scientist
☐ Other

B. What is your level of management responsibility?

- ☐ Senior-level ☐ Professional
☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

- ☐ Yes ☐ No

D. What operating systems are you currently using? (Check all that apply)

- ☐ PCMS-DOS ☐ Unix
☐ DOS + Windows ☐ MacOS
☐ OS/2 ☐ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

- ☐ 1-25 ☐ 51-99
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Organizational productivity constitutes the missing return on investment without which our computer industry, our organizations, and our global economy have become mired in finger-pointing gridlock. New information technologies cannot solve these problems because the source is organizational in nature. Organizations still can't assimilate the technology that corporate information technologists are trying to implant today.

**No technological
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The rejection of technology is rife in most organizations. New technology comes in and is jettisoned back out or remains largely unabsorbed and unused. Why? Because people are reluctant to alter their work habits. Major changes are needed

in organizational practices, behavior, and culture.

If we are going to make companies more responsive, more flexible, and more viable in the global information economy, we have to teach our organizations to learn. For better or worse, that responsibility is falling squarely on the shoulders of the information technologist.

These de facto change agents are saddled with both designing new distributed computing applications and changing entrenched organizational behaviors that threaten to subvert their best efforts. To avoid disaster, they should follow the basic principles of organizational learning and build them into each design effort.

One key is to make things tangible and visible. The most common complaints I hear from all types of workers in information-intensive organizations are, "I didn't know," "No one told me," "How was I supposed to know that?" and "I know we must have that information somewhere, but I don't know how to get it." Despite our efforts to deploy information technology, we haven't managed to communicate relevant information.

Suppose your assignment is to design a document management system to track and maintain changes in manufacturing standards. Your company produces 50 different products in 11 worldwide manufacturing facilities. The application needs to leverage the PCs and LANs deployed throughout the company. The goal is to streamline the process of the creation, approval, and dissemination of manufacturing and packaging standards to meet your company's stringent quality requirements. This new distributed documentation application will replace the company's current, outmoded, paper-based processes.

Where does organizational learning fit in this project?

What is invisible in the current manufacturing standards process is the actual creation of the standards. Standards are created by the R&D group, with little input from the manufacturing floor. Using the principles of organizational learning, the standards development process becomes a collaborative effort among the R&D, manufacturing, purchasing, and quality-control departments.

By designing the application to solicit input from all participants in the process at the outset, you eliminate cycles of approval and modification, cutting valuable days, weeks, and months off the standards creation cycle. You're also building in the sharing of experience and knowledge across functional workgroups with different skills and opinions. The system captures information about ingredients, weather conditions, batches, and machinery, from all the participants, thus documenting the assumptions on which the manufacturing processes are based. And by instituting a set of work-flow rules that automatically route these standards for approval, you are making explicit a set of organizational procedures that can then be further refined, questioned, and streamlined.

By approaching the development of distributed applications in a way that incorporates these principles of organizational learning, you provide a huge service to your organization. You are also ensuring that the new technology has a chance to take root and make people more productive, because you're confronting the necessary changes in organizational behavior head-on.

A learning organization encourages learning and experimentation among its employees and is masterful at transforming itself to create and meet new market conditions. A learning organization can transform itself over and over again. Dynamic change is no longer feared, but becomes a way of life. Learning to share information, to document assumptions, and to question those assumptions is the first step on the long journey toward improved organizational productivity. ■

Patricia Seybold is the founder and CEO of the Patricia Seybold Group, a consulting and information services firm based in Boston, Massachusetts, and specializing in distributed computing for networked organizations. You can reach her on BIX c/o "editors."

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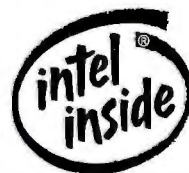
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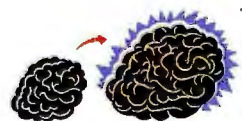
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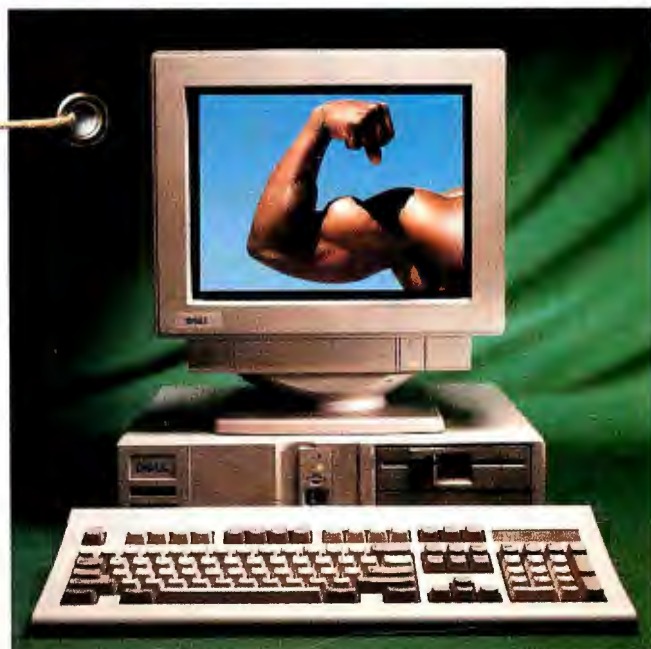
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