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JULY 1993

BYTE

THE WORLDWIDE COMPUTING AUTHORITY

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PENTIUM PCs

It might say Pentium on the outside, but what else is on the inside of the first systems?

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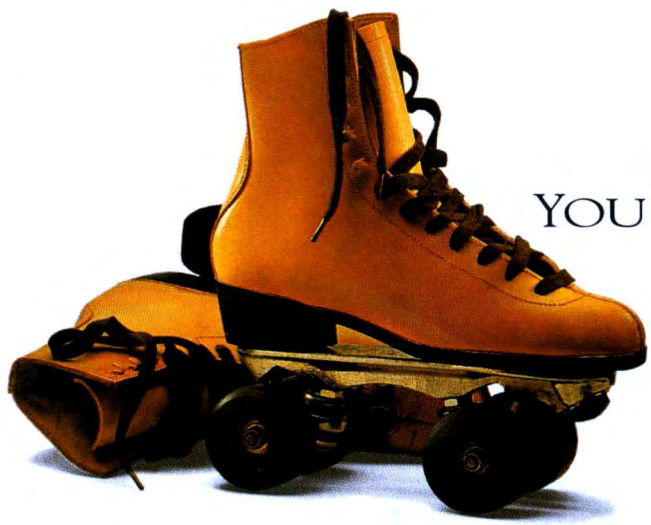

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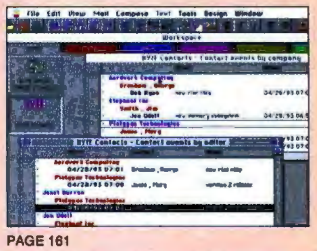

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NetWare Goes Global 141

BY JON UDELL NetWare 4.0 has arrived, claiming support for serious enterprise networking. NetWare Directory Service brings NetWare beyond the LAN, and 4.0 adds other features like file compression, CD-ROM sharing, and data migration.

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BY ROBERT SCHMIDT Folio Views 3.0 comes to Windows and brings with it some exciting new features, including an open client/server architecture, concurrent multiuser editing, embedded graphics, and multimedia support.

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BY TOM R. HALFHILL ClarisWorks is already established as the leading integrated package for the Macintosh, but it's not resting on its existing modules. Version 2.0 adds new features and applications to this seamlessly integrated software.

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BY G. ARMOUR VAN HORN Recent releases of these two popular page-layout packages duke it out both on the Mac and under Windows. Van Horn determines which of these aggressive competitors currently has the upper hand.

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The *Real* Multimedia

Videoconferencing will exploit video, sound, and network technologies in a way that makes sense

I'm tired of all the multimedia dazzle and hype. Sure, the graphics can be spectacular, but I don't want to turn my desktop computer into a Sega game machine. It's neat to be able to play stereo CDs in my CD-ROM drive, but I have a whole stereo system for that. And while it's clever to have a TV picture next to my spreadsheet, I'd rather not be distracted by reruns of *The Brady Bunch*.

Unfortunately, multimedia has become synonymous with computer trash. Almost anything with graphics or sound placed on a CD-ROM qualifies—to some folks, at least—as multimedia.

Let's face it: What useful business application have you seen for multimedia? OK, there is video production for the Hollywood types, which is an impressive application, but it's also a very narrow and vertical field. Beyond that, searching for a useful multimedia application today leaves you with nothing more than a pile of games, a little educational software, and a dash of technomarvel products that don't really do anything.

What a crying shame that all this video and sound technology is being largely wasted, because we all know instinctively that those technologies can be put to real use. It's just been difficult to figure out what that use should be.

Maybe that's all going to change, because the first *real* multimedia application is materializing, although it won't be called multimedia. Instead, this new application will be called *desktop videoconferencing*, and it will exploit video, sound, and even network technologies in a way that makes sense.

That's right, desktop videoconferencing makes sense, and before you say that this all sounds like another World's Fair videophone, please hear me out. Think about this: Would you rather write a memo to explain a questionable number in your spreadsheet or just attach voice mail to it? I'd prefer the latter. What's more, compared to a 30-word written memo, voice mail using the same word-for-word message conveys more information. Vocal emphasis on key words and phrases imparts more meaning. Or look at it this way: In lieu of a 30-word voice-mail message, you might have to write a 150-word memo to get your point across.

Similarly, adding video that captures gestures and facial expressions conveys even more information. Imagine the great loss if Groucho Marx had been only in radio and not in film—would his lines have been as good if you couldn't see his eyebrows go up and down? I don't think so.

Computer E-mail and conferencing have forced us into becoming extensions of machines instead of the other way around. It's time to change that. When I send a spreadsheet to someone across a network, let me send a message with it that's really from me—one that captures all my intonations and my eyebrows dancing up and down so that the recipient really gets the message. The technology is mostly here. Small cameras are not expensive. Sound boards are downright cheap. And with the right compression algorithms, existing LANs can carry all that information.

Some relatively small companies are already offering kludged attempts at solving the problem. Unfortunately, they don't work well, they cost too much, or both. Videoconferencing is really waiting for one or several systems manufacturers to build complete personal computers with videoconferencing built in, and that, my friends, is going to happen sooner rather than later.

Frankly, I can hardly wait, because I have a lot more than explaining spreadsheets in mind for videoconferencing. I'd like to cut down on the time spent drafting E-mail and conferencing messages. I'd also like to see communications go back to a more traditional—and successful—human standard without losing the high-tech convenience of delayed conferencing, all of which can be done right away.

But don't stop me now, because I want it all, including practical WAN (wide-area network) support. I want phone calls with BYTE's bureau offices to include real-time desktop videoconferencing, and that just isn't ready yet. The problem has more to do with deciding who can carry that information. Yes, we're talking information highway, and for that to become reality, it's going to take either an act of Congress to get something done or a decision by Congress to get out of the way.

Ah, but that's a story for another issue.

DENNIS ALLEN, EDITOR IN CHIEF

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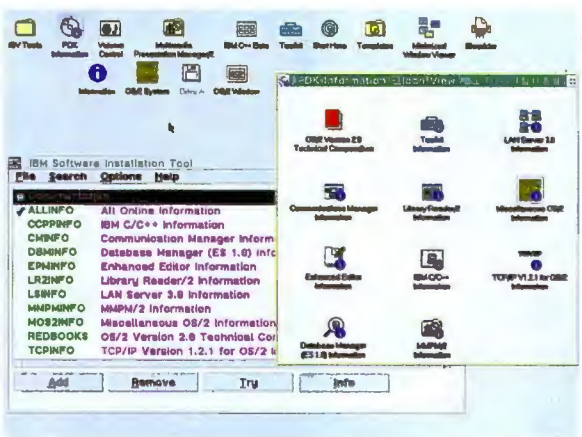

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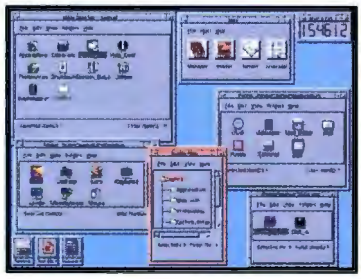

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Letters

Fighting Fatware

Your attack on fatware ("Fighting Fatware," April) should have been more scathing. Some of today's applications are 100 times bigger than their 1985 counterparts. Are they 100 times better? Not on your life!

They are not just bigger, they are badly engineered. Bloated applications resemble the gas-guzzling cars of the 1960s—they're wasteful and unreliable. We trade them in every few years in the hope that the next version will finally run right. Major bugs in commercial word processors, for example, are now a way of life.

Amid all these Edsels, we need a Volkswagen. Developers should throw away past years' accumulation of unreliable code, write programs small enough that the authors can understand them, and discover the power that comes from combining just a few features in the right ways. If they really want to take the market by storm, they should offer a warranty rather than an "as-is" disclaimer.

Michael A. Covington
Athens, GA

"Work expands so as to fill the time available for its completion."

—*Parkinson's Law*, 1957

SET WORK = PROGRAM
SET TIME = MEMORY
SET 1957 = 1993

David G. Williams
Chevy Chase, MD

It was appropriate that you put "Fighting Fatware" just before "Putting Fuzzy Logic into Focus." The first article was an example of the second, I think.

The two figures found on page 100 tell the story. The size of Lotus 1-2-3 has multiplied by a factor of about seven; the typical PC has expanded by a factor of almost 300, both in disk space and RAM. This much bigger machine is also much faster and cheaper, and the bigger Lotus 1-2-3 does much more than release 1.0 ever did.

The typical system can handle many applications that are the size of Lotus 1-2-3, whereas in 1983 we could run only from floppy disks—one slow and limited application at a time. So just where is the fatware problem? I see no sign of it whatsoever.

Bobby R. Treat
Alexandria, VA

I recently read "Fighting Fatware" and was very disappointed. Figure 3 suggests that [operating-system-specific versions of] WordPerfect are being run on each operating system. But the article's text suggests that you ran either a DOS or Windows version on OS/2. If this is true, the percentage of usage for OS/2 also includes DOS and Windows overhead that is not required if you run a pure OS/2 application.

The authors incorrectly referred to the Windows shell as an operating system and suggested that the shell helped reduce the size of PowerPoint by including TrueType fonts. They neglected to mention that OS/2 2.x provides the same savings in code using Adobe Type Manager. The authors went on to rave about OLE, but not once did they mention the major innovation that OS/2's SOM (System Object Model) represents in the eventual reduction of code.

The new Lotus 1-2-3 and Freelance packages for OS/2 2.0 use disk space efficiently by sharing common resources (e.g., graphing and checking the spelling). They make effective use of OS/2's SOM and actually share system resources, further decreasing the amount of redundant code. Your First Impression of these products (March, page 46) even states "...you save more than 4 MB on your hard disk thanks to code shared between the two applications; you also save RAM...."

A. P. Kennedy Sr.
Greensboro, NC

If you look closely at figure 3, you'll find that WordPerfect was not part of the OS/2 configuration. The reason? An OS/2 version of WordPerfect was not shipping when this story was written. Thanks for your comments.—Eds.

MS-DOS 6 Beyond Compare

I was disappointed with the article "Easy Does It with MS-DOS 6.0" (April). The question on the cover (Do you need MS-DOS 6.0?) was not addressed, nor did the author provide the information that would enable me to answer it on my own.

I also missed how MS-DOS 6 compares with products already available. It appears to me that Microsoft is only catching up.

Martin Rommel
Cambridge, MA

An Amiga First

In the April User's Column, Jerry Pournelle says that the Amiga is becoming competitive with the Mac and PC and is nearly ideal as a second computer. I believe the Amiga makes a good first computer for professional video, audio, music, graphics, 3-D modeling, animation, interactive presentations, view graphs, or writing of any kind.

As a home computer, the Amiga can perform almost any task one would desire with an easy-to-use, intuitive graphical interface. In terms of workstation capabilities, the Amiga is 68060-compatible. It has high-speed 2000- by 2000-pixel graphics boards running at up to 160 MFLOPS, runs Unix, and has a RISC processor in its future. In a world of pickup trucks (clones) and Cadillacs (Macs), maybe there's room for an elegant Mustang as a first computer.

Charles Kirchner
Huntsville, AL

BBC Correction

Some information in "Correspondence That Looks Good Globally" (February) is incorrect. The BBC World Service is not using the Multi-Lingual Scholar word processing package. Together with a number of other alternatives that can run under the Windows and Macintosh GUIs, it is being considered as a word processor for some foreign-language work. ■

Gordon Harold
Chief Engineer, World Service
London, U.K.

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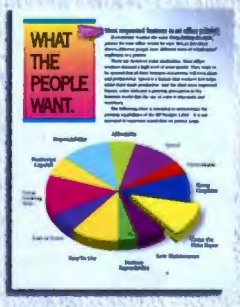

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WORKGROUP COMPUTING

WordPerfect Office 4.0

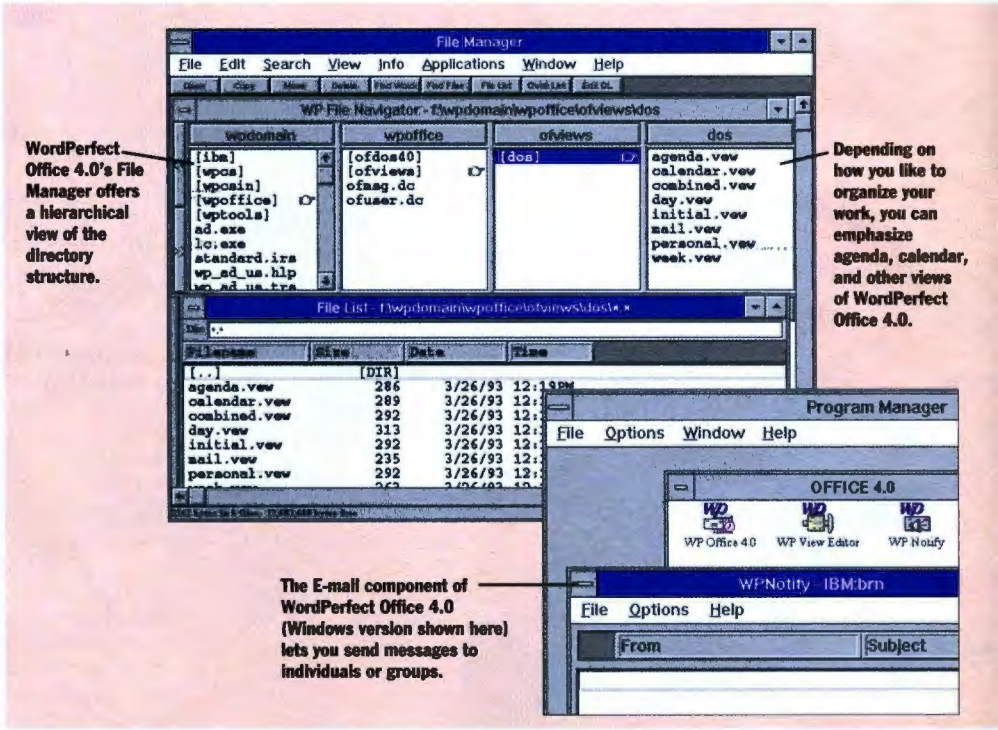
WordPerfect Office 4.0 lets users work together regardless of location, LAN, or type of system

BARRY NANCE

In a market beset with newcomers, WordPerfect Office represents a maturing workgroup product. WP Office's all-in-one approach to E-mail and group scheduling has been popular for several years. In fact, version 3.01 won a BYTE Readers' Choice Award in 1991. Version 4.0 adds support for multiple platforms, mouse support in DOS text mode, and a variety of improvements that make it easier to use.

If you have only a few Intel-based computers on your network, you probably don't need the power and features of WP Office 4.0. However, if your network includes a mixture of DOS, Windows, and Mac clients (WordPerfect plans to release a Unix client running Motif this fall)—and perhaps a Data General, Unix, or VAX/VMS host system—your company is a prime candidate for WP Office 4.0. If you have more than 25 workstations, even if they all run the same operating system, you should at least look at the product for its efficient scheduling and E-mail services. If you have more than 100 workstations, WP Office 4.0 deserves serious consideration.

WP Office 4.0 works on a variety of networks, including Novell NetWare, Banyan Vines, and IBM LAN Server. I used LAN Server and NetWare to put a prerelease version of WP Office 4.0 through its paces.



Connecting Your Operation

WP Office 4.0 provides E-mail, a calendar, a calculator, an appointment book, a task list, a shared notepad, a shell menu, a notebook with an auto-dial feature, a file manager, a macro editor, and a text editor. WP Office 4.0 integrates these functions across a LAN in a way that lets coworkers coordinate work and activities smoothly even if they're using different kinds of computers.

The group-scheduling software, for example, works across a LAN to help make light work of setting up meetings and allocating resources, such as audiovisual equipment. WP Office 4.0 scans each person's appointment book to find acceptable meeting times. Members of the group receive automatically generated E-mail requests to attend; each person can accept or decline with the click of a mouse.

If you're familiar with the usual WordPerfect function-key layout (e.g., F3 for help, F5 to list, and F7 to exit), you'll feel at home in WP Office 4.0. If you don't use WordPerfect's word processor, you'll find the menus easy to use. The Windows and Mac modules, of course, let you point and click when you want to send notes or update your task list. Now you can use a mouse the same way under DOS.

For the most part, entering personal appointments and arranging group meetings is a simple fill-in-the-form process. WP Office 4.0 automates the job of searching for common free times when you want to hold a meeting. Personal appointments can be meetings, task-list items you want to set

aside time for, or other allocated blocks of time.

Installation: An Investment in Time

While using WP Office 4.0 is a breeze, installing and configuring the software is not. Network administrators will spend a significant amount of time getting it ready for users. I spent 8 hours installing the software for a workgroup of about 50 people. Much of that time was spent reading the manual and analyzing the way WP Office 4.0 tailors a LAN to accommodate how the users get their work done. It's time well spent, however. The capability of sharing E-mail and appointment books among different types of computers creates a level playing field out of what is usually a mess.

The WP Office 4.0 shell is a DOS menuing system that you can configure to manage all your applications, not just the suite of WP Office 4.0 modules. If you find you spend more time in one part of WP Office than in others, you can select a different view to give on-screen emphasis to that part—E-mail, the calendar, or perhaps the task list.

The E-mail gateway software that comes with WP Office 4.0 supports wide-area connections between WP Office LANs, MHS (Message Handling Service), SMTP (Simple Mail Transfer Protocol), and X.400; you also get remote modem-based access to WP Office 4.0 when you're away from the office. If you write E-mail notes on a plane or in a hotel room, WP Office 4.0 will send the notes for you automatically when you return to the office and connect to the LAN.

In a bid to strengthen WP Office 4.0's ties to other mail packages, WordPerfect will provide a gateway between WordPerfect Office 4.0 and Lotus Notes' groupware database. In addition, WordPerfect InForms software, which allows the electronic design and distribution of forms, will also have direct database format support for Notes.

Both Office and InForms support the VIM (Vendor Independent Messaging) standard, which allows users to exchange mail across multiple applications. Although WordPerfect has not finalized pricing of the gateway to Notes, David Clare, WP's senior director, workgroup applications, noted that the company is essentially "giving the technology away" to E-mail customers with the pricing of $30 to $40 per seat in large quantities.

A Mixed-Systems Blessing

WP Office 4.0 adds useful features—and support for more platforms—to an already-proven product. If groupware is in your plans but you have to contend with DOS, Windows, Mac, and Unix systems, put WP Office 4.0 near the top of your list of possibilities.

WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057
(800) 321-4566, (801) 225-5000, fax: (801) 222-4477

Server Pack: $295; Client Pack: $495 for five users

GROUPWARE'S BIG THREE

Over the last five years, groupware has grown up. The early DOS-only pioneers didn't always have intuitive interfaces and typically worked with only a limited number of network operating systems. While the situation has improved drastically, no clear overall best choice has emerged. However, three products—each of which excels in different areas—are leading the groupware charge.

THE BEST INTERFACE

If you've seen Windows for Workgroups in action, you know that Microsoft's Mail and Schedule+ modules are easy to use and highly visual. The Workgroup Connection companion product to Windows for Workgroups (for DOS users) includes E-mail but no scheduling module. If you want to use Schedule+, you need Windows. Mail and Schedule+ are also LAN-traffic-intensive; if you have more than 20 workstations running the E-mail software at the same time, the network can bog down.

THE MOST NETWORKS AND COMPUTERS

With its comprehensive coverage of popular networks and diverse computers, WordPerfect Office 4.0 is a universal translator for large, mixed-environment LANs. The programs may load slowly, and you'll need to adjust to the function-key layout, but WP Office 4.0 is a groupware workhorse.

THE BIGGEST

Lotus Notes, literally speaking, covers more ground than other groupware products. Notes is particularly effective for geographically dispersed users. Also, it lets a group share more than E-mail and scheduling information. If you have a database of sales information and prices, for instance, Notes will automatically make sure that everyone has the latest version of the data.

COMMUNICATIONS

Beep Beep: Your E-Mail Is In

WordPerfect Office, Lotus Notes, and other programs that offer remote-access capabilities solve many problems for mobile workers who need to stay in touch with the home office. However, what if you're usually in the building but often away from your desk and can't afford to miss an urgent E-mail message or fax?

To help mobile, on-site workers, Motorola's Customer Owned Paging Group (Boynton Beach, FL) has introduced a family of products that can notify you within seconds via alphanumeric pagers of an important phone call, E-mail message, or critical situation in a manufacturing environment. One of the initial modules of the family, called Site Message, will transmit urgent information that arrives in your computer as an E-mail message, a LAN management message, or a groupware calendar update.

Site Message, expected to ship in 1993, will use paging engine software created for Motorola by several independent developers, including New York City–based Ex Machina. Site Message–enabled programs will automatically forward time-critical messages to a Motorola alphanumeric Site Pager without the sender knowing the receiver's pager phone number. To filter out unimportant messages from critical ones, end users will be able to use their program's rules engines to forward only those messages with key words like *Urgent*. Motorola expects hundreds of programs to become Site Message–enabled in the next 12 months.

Site Message is just one example of new technologies that aspire to overcome the obstacles of reaching mobile workers. Motorola's Paging and Wireless Data Group plans to start beta testing later this year of its MONET (for Mobile Networks Integration) software that will link wireless networks from RAM Mobile Data, MTel, General Magic, and Ardis. Novell and Microsoft have announced plans with AT&T and Intel, respectively, to strengthen their operating systems' links to the telephone.

—Dave Andrews

PRINTER TECHNOLOGY

QMS Strikes with Color Laser Printer

Color laser printers aren't new, but until now you could expect to pay up to $50,000 for a splash of laser color. QMS's ColorScript Laser 1000 brings the technology into a much lower price range. Pricing was not firm at press time, but the company says it will fall between $10,000 and $15,000.

The ColorScript Laser 1000 uses electrophotographic recording to produce 300-dot-per-inch color output. What makes this printer even more attractive is a unique print-engine design that lets it serve as both a black-and-white and a color printer. The print engine accomplishes this feat using dry toner and a special OPC (organic photoconductor) belt.

The belt revolves at a continuous rate of eight times per minute. When you print a color image, four belt rotations—one for each toner color—and numerous swipes of the laser beam assemble a complete color image on the belt. A charged transfer drum and transfer roller extract this image off the belt and onto the medium, which can be plain paper, labels, or transparencies. Because the belt travels at a fixed speed, the ColorScript Laser 1000 is capable of printing 2 color pages per minute. If you print a black-and-white document, only one belt rotation and the black toner are required to produce a page, and the printer output approaches 8 ppm.

On the inside, the printer uses a 25-MHz 80960CF RISC controller. Standard memory is 12 MB of RAM, expandable to 32 MB using 4- and 8-MB SIMMs. The ColorScript Laser 1000 provides emulation of PostScript Level 2, Hewlett-Packard PCL (Printer Control Language) 5, and HPGL (Hewlett-Packard Graphics Language) PDLs (page-description languages). A 40-MB internal hard drive stores various programs, PDL emulations, and fonts. Upgrading the printer software or adding another PDL emulation becomes a matter of copying new files to the hard drive. The hard drive also functions as virtual memory for large print jobs.

A SCSI connection lets you add external hard drives to expand the printer's capacity for fonts or virtual memory. Standard interfaces include LocalTalk, serial, and parallel printer ports. An optional Ethernet interface supports Apple EtherTalk, TCP/IP, DECnet, and NetWare protocols. Special ESP (Emulation Sensing Processor) logic scans all the interfaces and detects incoming data. This ESP logic then analyzes the data stream and selects the PDL that will process the job. QMS's Crown multitasking operating system manages the printer's functions, and it can handle two different print jobs—each coming in on a different port and using a different PDL—simultaneously.

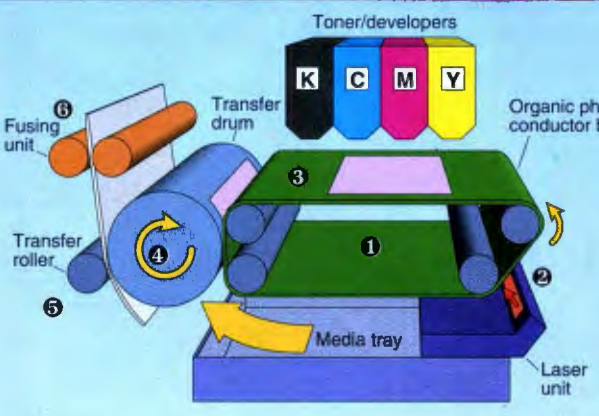
Unlike a thermal-wax printer that consumes a fixed amount of all four dye materials whether you use one color or black and white, the ColorScript Laser 1000's engine consumes only those toners required to make the page. This smart use of consumables lowers the cost per color page from about 50 to about 45 cents, so the printer can inexpensively mass-produce documents that, for example, use a company logo or highlight important information with spot colors.

Using the black toner alone, the cost is 3 to 3.5 cents per page. That's low enough that the ColorScript Laser 1000 can serve as both a black-and-white and a color printer. This makes it ideal for businesses that occasionally need to produce large volumes of color output.

—Tom Thompson

QMS, Inc., P.O. Box 81250, Mobile, AL 36689, (205) 633-4300; fax (205) 633-0013

INSIDE THE QMS COLORSCRIPT LASER 1000



❶ A precharger unit inside the OPC belt lays a charge evenly across the belt.

❷ The printer controller steps through one color plane of image data. This data controls the intensity of a laser beam as it sweeps a line across the OPC belt. When the beam is on, a corresponding spot on the belt is discharged. As the belt moves, a latent image composed of discharged areas is built line by line.

❸ The portion of the belt storing the latent image passes under four toner/developer units. The toner unit that corresponds to the color plane just applied to the belt opens. Toner sticks to the discharged areas and is repelled from the charged areas. In the figure, magenta toner is being added to the image on the belt. For color images, this operation occurs several times as the belt rotates and all four process colors are applied. A complete color image exists on the belt after four belt rotations.

❹ The transfer drum is charged and peels the image off the belt.

❺ A bias voltage between the transfer drum and transfer roller pulls the color image off the transfer drum and onto the medium.

❻ The fuser unit uses heat and pressure to adhere the image to the medium.

HP SAYS NO (FOR NOW)

While Hewlett-Packard holds a commanding lead in the laser-printer market, the company has not yet announced plans to follow QMS into the color laser-printer market. Regarding speculation about its plans, HP spokesman Bill Hornung would say only that the company is studying color laser printers and would enter the segment only when it is feasible from a cost and quality standpoint.

HP's cautious approach stems from concern over the reliability of color laser printing and cost factors. "There are two issues: One is the reliability, and another, the pricing. And in our mind, we have to have both," said Hornung. "Over history, we're pretty methodical about it. We've had to make sure that we could sell a lot of [printers] but also that they were of high quality and reliable. Without that, we would shoot ourselves in the foot."

Since HP's color ink-jet printers have done well, Hornung noted, there is not a great demand for color laser printers. "Customers are really satisfied with color ink-jets, and many don't see the need at this time for color laser."

—Patrick Waurzyniak

INK-JET PRINTERS

Testing the Colorful DeskJet 1200C

The DeskJet 1200C produces impressive color, especially when you use HP's glossy paper.

Hewlett-Packard's DeskJet 1200C (see "HP Takes Color Mainstream," June News & Views) takes a different approach to color printing than does QMS's ColorScript Laser 1000. The 1200C is also aimed at businesses looking for color output, but its speed and cost per page make it more suited for generating presentations and small quantities of high-quality color documents.

While the DeskJet 1200C isn't designed for high-volume jobs, it also doesn't cost much: $1699. It uses the PCL (Printer Control Language) 5 PDL (page-description language) and a Centronics parallel port. The DeskJet 1200C/PS costs $2399; it adds Adobe PostScript Level 2 support and a LocalTalk interface.

These 300-dpi color ink-jet printers are equipped with HP's Resolution Enhancement Technology. The controller can switch between interfaces and PDLs automatically. An MIO (modular I/O) slot lets you add an Ethernet or Token Ring interface to either printer. The printers can turn out 6 pages per minute for text; it takes 2 minutes per page for color.

The DeskJet 1200C comes with drivers for Windows 3.1, Mac System 6.0.x, and System 7. I used Adobe's PSPrint, a PostScript Level 2 print driver, and a Mac Centris 650 to conduct my tests in the BYTE Lab. I printed a small scanned image out of Adobe Photoshop 2.5 successfully, but images larger than 2 MB generated a PostScript error. I added 8 MB of RAM, which brought the total to 12 MB. With the extra RAM, I printed images as large as 11 MB with no problems.

I also unplugged the LocalTalk card from the MIO slot and replaced it with an HP JetDirect card that provides 10Base-T and 10Base-2 Ethernet support. The interface change took 3 minutes. It took another minute to connect a thin-wire Ethernet cable to the JetDirect's BNC connector.

With the ample memory and a high-speed network interface (cost of the unit as tested: $3456), the DeskJet handled everything I threw at it. The output looks fine on plain paper and great on HP's special glossy paper. The cost per page can range from 8 cents to $1.61, depending on the medium and the amount of ink used.

—Tom Thompson

Hewlett-Packard Co., Santa Clara, CA 95051, (708) 752-0900

COLOR MATCHING

Apple's ColorSync: WYSIWYG Color

Color desktop publishing has a problem—color fidelity, or color matching. Simply put, color WYSIWYG is difficult at best. Printing costs can skyrocket because of the numerous attempts to obtain a reasonable color match between the scanned images or artwork that went into the document and the printed pages.

Some calibrators and color-matching software address this problem, but they usually tie you to a specific printer or set of applications. Apple's ColorSync is a color-matching solution implemented in the Mac OS. As part of the Mac OS, color-matching algorithms can be applied automatically to all color devices (i.e., the scanner, printer, and monitor) connected to the Mac.

ColorSync consists of a Control Panel and device profile files. Each profile contains a description of the device's color characteristics, and ColorSync uses this information to apply the color corrections. ColorSync features an open architecture, so vendors such as Kodak and EFI can supply their own color-matching software modules, which transparently replace ColorSync's default color-matching algorithms.

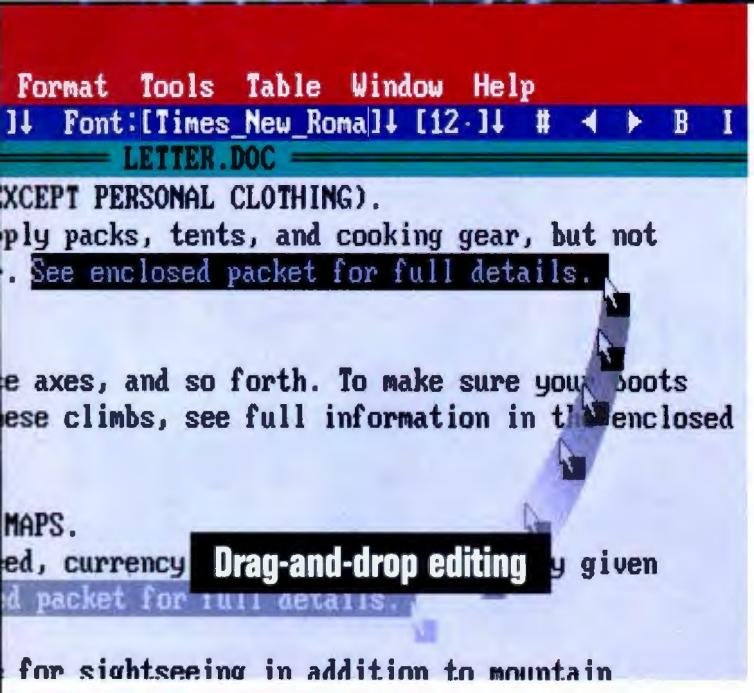
I used a Mac Centris 650, an Apple Color OneScanner, and two color printers to explore ColorSync's capabilities. The first printer was Apple's Color Printer, an ink-jet printer, and the second was the Tektronix Phaser II SD, a dye-sublimation printer. The Color Printer came with a profile, while none was available for the Phaser II SD.

I used Light Source's Ofoto 2.0 software to scan in a variety of color images. Output on the Apple printer was good, although I've seen better color dithering patterns from a Canon printer. However, the color fidelity between input and output was excellent, and I had just picked the printer name from a pop-up menu in Ofoto.

For the Phaser II SD, Ofoto has a clever mechanism for producing calibrated output: You print a color test pattern on the target printer, place this output on the scanner, and scan in the image. Ofoto generates color-correction data that is available from the pop-up menu the next time you print. The colors on Phaser II SD output, while not perfect, were close to the original.

In its current form, ColorSync is not a panacea. It will take time for vendors to create profiles. Applications that make heavy use of color will have to be modified to use some of ColorSync's services. Finally, how does ColorSync deal with color matching for an image that was made with one color-matching method, while the host computer uses a different one? Still, based on the Apple Color Printer output, ColorSync is a big step toward making color WYSIWYG a reality.

—Tom Thompson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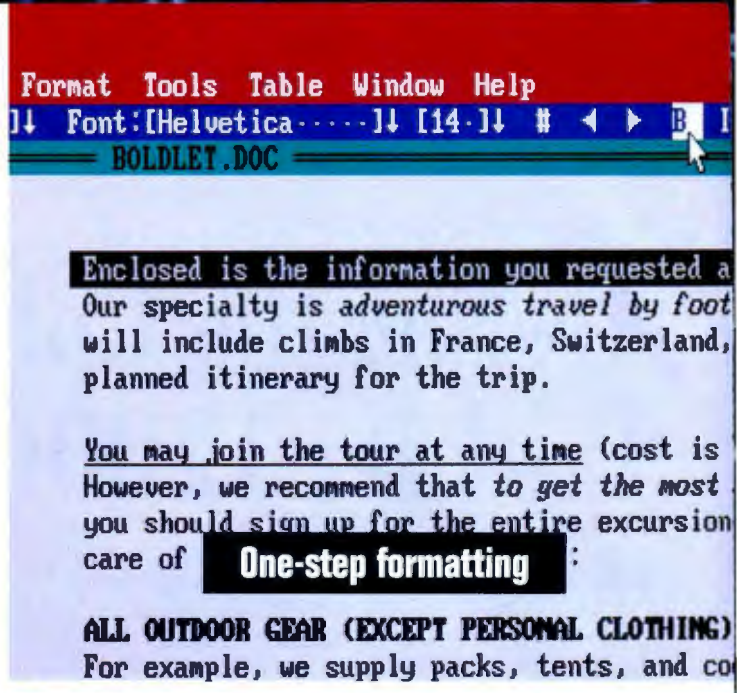
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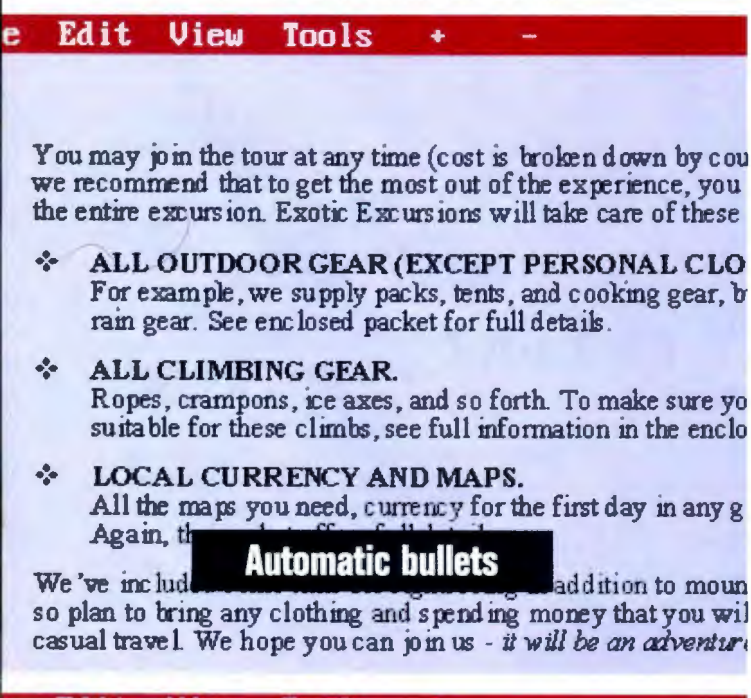
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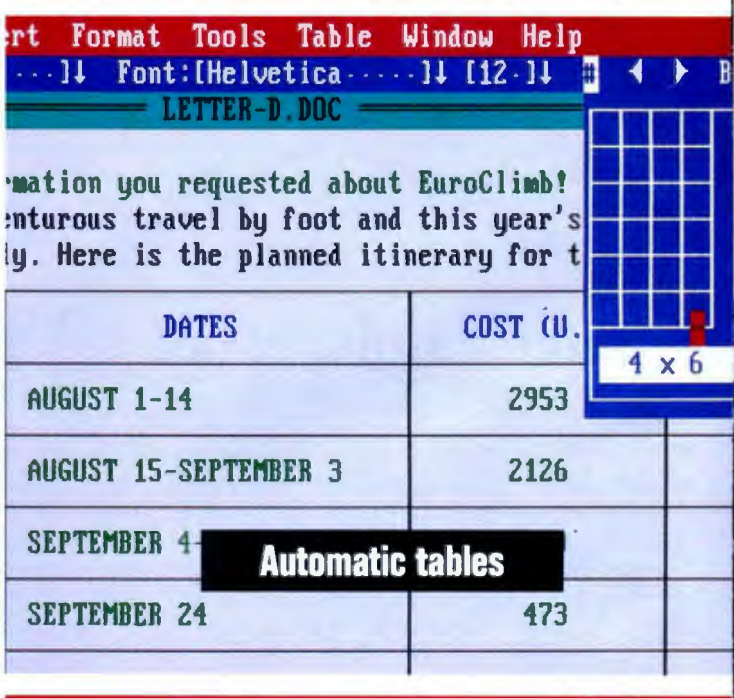
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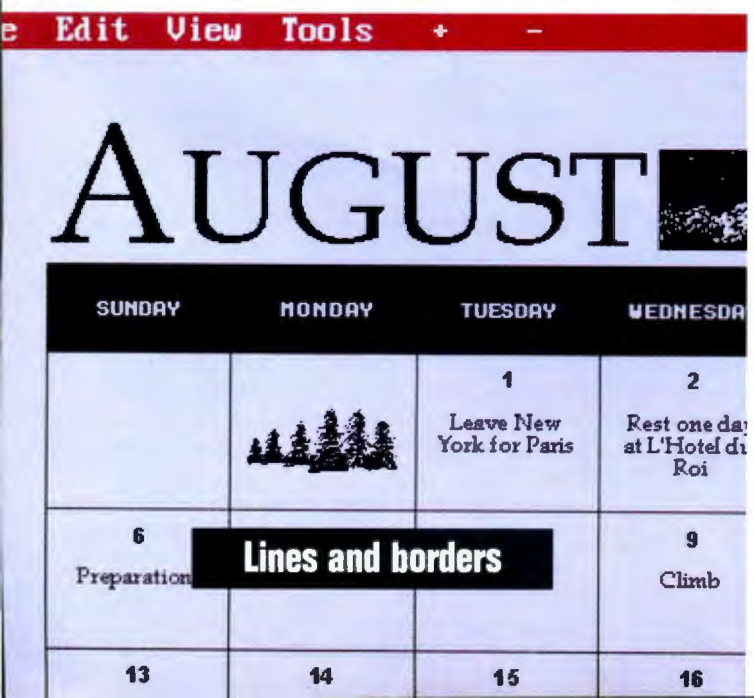
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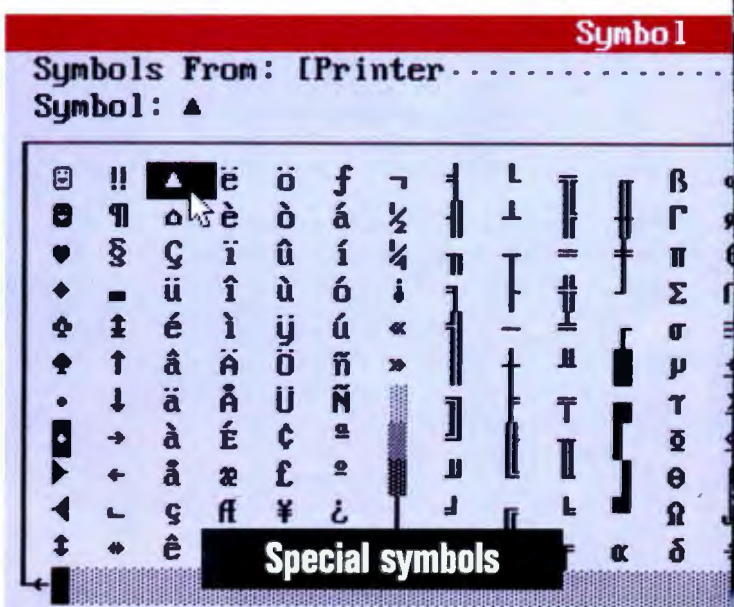
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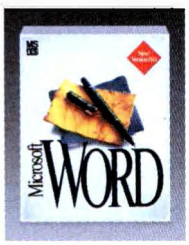

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STORAGE

RAID Down to the Desktop

RAID (redundant array of inexpensive disks) technology has been the province of mainframe computers and networks that require uninterrupted access to important data, even in the case of a drive failure. Although the word *inexpensive* is used, a RAID system for NetWare LANs that provided 1.3 GB of storage cost as much as $24,000 ($18.46 per megabyte) in 1992.

Now, thanks to the combination of declining hard drive prices and new products from companies like Corel Systems (Ottawa, Ontario, Canada) and Micropolis (Chatsworth, CA), low-cost RAID solutions are available to LAN managers and stand-alone workstation users. Daniel Levesque, president of Proengineering (Ottawa, Ontario, Canada) and developer of CorelRAID, said the benefit of the $995 program is that you can implement RAID level 5 using a standard SCSI controller and three SCSI hard drives for as little as $3500.

Micropolis, which sells a low-cost RAID system for NetWare, just reduced the price of its new modular Raidion LT array system for OS/2 and LAN Server. Prices for the system start at $6225. Taroon Kamdar, executive vice president and general manager of Micropolis's storage systems division, said Raidion LT will be used by engineers, programmers, and anyone else whose work is time sensitive.

"Users are being led on that RAID is a very complex technology, and it's not," said Maury Loomis, director of sales and marketing at Pacific Micro Data (Tustin, CA). Loomis said that too often RAID is sold as a proprietary solution, where a user buys a subsystem, software, and storage medium from the same company at a premium price. Loomis said that the support for RAID in operating systems like NetWare and Windows NT will increase awareness of the technology among desktop users. The result, he said, is that solutions where customers can pick and choose components will become the norm.

Bob Katzive, vice president of the consulting and market-research firm Disctrend (Mountain View, CA), agrees that the price of RAID is dropping but notes that while proprietary RAID solutions are generally more expensive than nonproprietary solutions, they can also be easier to install and maintain. Katzive warns that "there's always room for a surprise" when you're installing a so-called open RAID solution.

—Dave Andrews

RAID ON THE SERVER

Predicted worldwide RAID market value of shipments for PC servers

Source: International Data Corp. (Framingham, MA)

LOW-POWER RISC FROM MIPS

Promising "Pentium performance in a notebook," Mips Technologies (Mountain View, CA) has announced the first power-saving chip in its R4000 microprocessor family, an important step toward moving RISC chips from workstations to mainstream PCs. The R4200 is intended primarily for laptops that can run Windows NT.

Sample silicon wasn't available at press time, so all performance specifications are preliminary. According to Mips, the 3-V chip will use only 1.5 W at its top internal clock speed of 80 MHz (the external bus runs at 40 MHz). A reduced-power mode requires only 0.4 W, and a power-down mode turns off the chip altogether. Mips says the R4200 can be powered down and reactivated so quickly that a system could force the chip into power-down mode between keystrokes when you're typing.

Mips estimates the R4200 will deliver 55 SPECmarks for integer operations (SPECint92) and 30 SPECmarks for floating-point operations (SPECfp92). By contrast, Intel's Pentium delivers 64.5 SPECint92 and 56 SPECfp92, respectively. The R4200 lacks the parallel pipelines found in the Pentium, but it does have separate hardware units for integer and floating-point instructions.

Based on 0.6-micron process technology, the R4200 squeezes 1.3 million transistors onto a small die of 9.2 by 8.8 millimeters. It has a 16-KB instruction cache and an 8-KB data cache. The caches, MMU (memory management unit), and system interface can be removed from the chip, so the logic core can be used in embedded applications.

Mips says the R4200 will be available in quantity late this year. Versions will be manufactured by Mips, NEC Electronics, and possibly other partners. No pricing was announced, but Mips says the goal is to sell the chip for $55, or $1 per SPECint.

—Tom R. Halfhill

MICROPROCESSORS

Ruling Won't Mean Lower Prices for 486 Chips

Don't expect the prices of 486 microprocessors to plunge just because Advanced Micro Devices (Sunnyvale, CA) won the latest round in federal court and is finally competing against Intel for the lucrative 486 market. Although the surprise ruling cleared the way for it to begin selling 486 chips, even AMD admits it won't be able to make enough chips this year to dent Intel's market share or spark a price war.

AMD expects to sell a few hundred thousand 486 chips this year. AMD and industry analysts estimate the worldwide 486 market at 25 million chips this year. They also estimate that Intel sold 5.5 million chips in the first quarter alone. In 1994, demand is expected to grow to 35 million chips, and AMD predicts it will win a 10 percent to 20 percent share.

Still, AMD's 486 microprocessors give system vendors an alternative source of supply and allow AMD to tap Intel's single largest revenue stream. Until now, the only other commercial source for 486 chips was Cyrix (Austin, TX).

On April 15, a judge ruled that Intel did not submit documents that could have affected the jury's decision. He granted AMD's motion for a new trial, opening the door for AMD to sell 486 chips based on Intel microcode.

AMD is completing work on clean-room versions of the 486 that don't use Intel microcode. Those chips, which are scheduled to be announced on July 4, will eventually supersede the Intel-microcoded chips that AMD began shipping in late April. Although the clean-room versions are almost finished, AMD says it wants to begin selling 486 chips as soon as possible.

—Tom R. Halfhill

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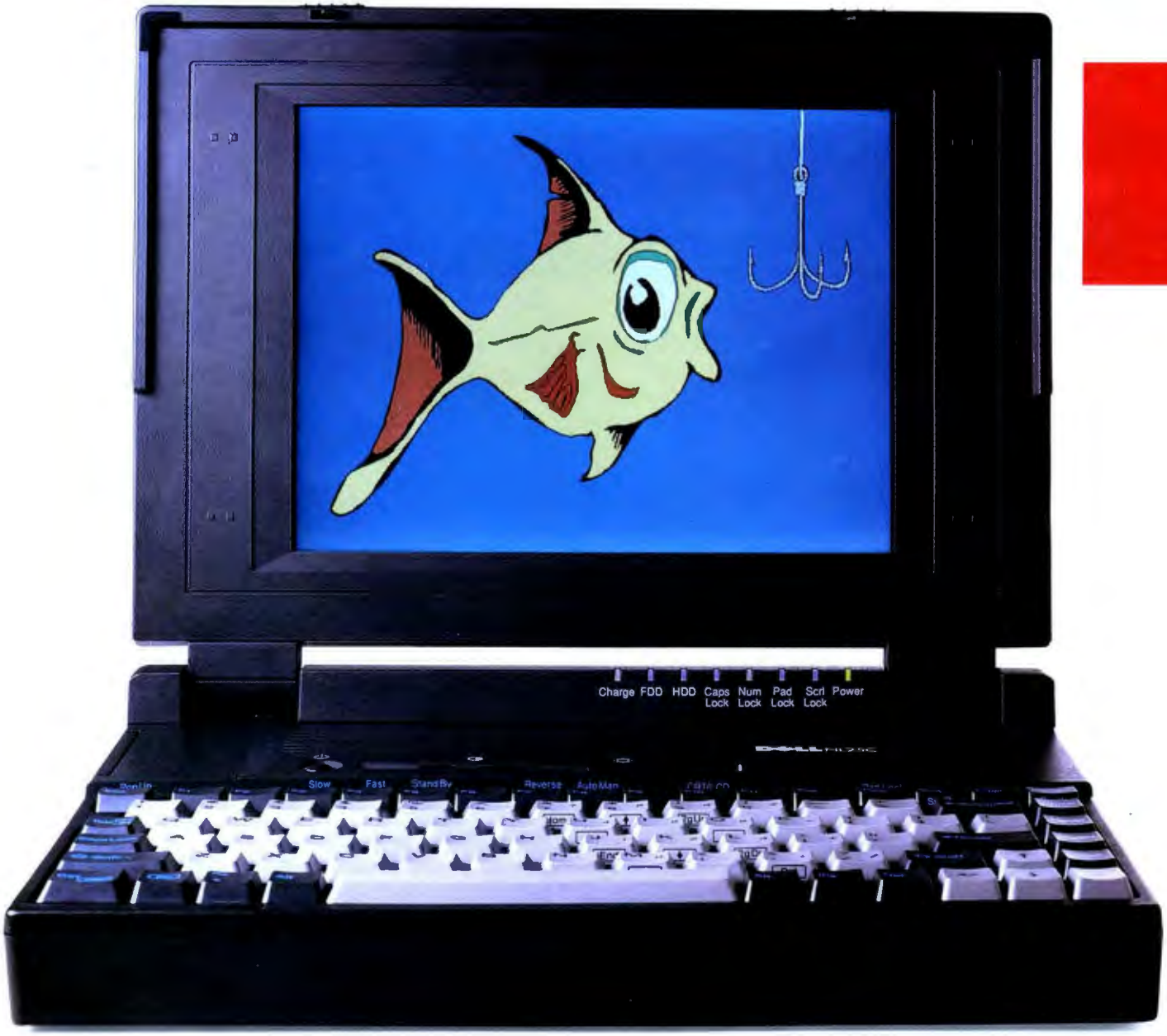

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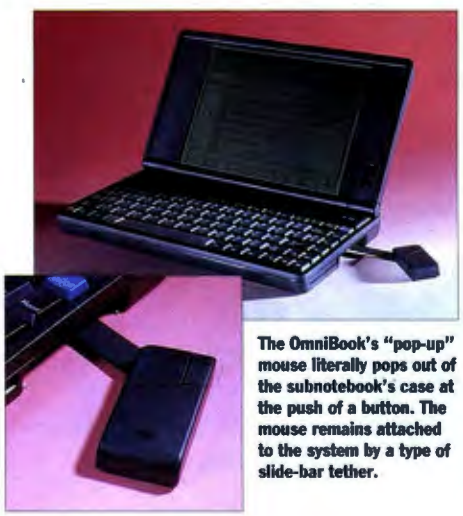
MOBILE COMPUTING

HP's Superior Subnotebook

Hewlett-Packard has taken its mobile-computing ambitions a notch higher with the introduction of the HP OmniBook 300, a 386-based subnotebook. It weighs less than 3 pounds and runs ROM-based Windows as well as ROM versions of Word for Windows and Excel 4.0.



The OmniBook's "pop-up" mouse literally pops out of the subnotebook's case at the push of a button. The mouse remains attached to the system by a type of slide-bar tether.

The OmniBook boasts several cutting-edge features. In addition to running its applications, Windows 3.1, and DOS 5.0 in ROM, it uses Advanced Micro Devices' 3.3-V, 20-MHz 386SXLV chip set and a rechargeable nickel-metal-hydride battery pack for long battery life. It also offers mass storage through either a PCMCIA-based 42-MB hard drive or 10-MB flash-memory disks in PCMCIA slots.

After testing a preproduction OmniBook, I found its full-key-spacing keyboard suitable for touch-typing, a sharp contrast to the tiny keyboard offered on the 95LX and 100LX. It lacks the color graphics found on many high-end notebooks, but its screen—a 9-inch, VGA-compatible FTN-reflective (Film Supertwist Nematic) LCD with 16 levels of gray—is acceptable.

One of the most unusual features of the OmniBook is its pop-up mouse, which pops up to fit your hand in an ergonomically correct way. It takes some getting used to, but I find it preferable to most trackballs.

Although it has no floppy drive, you can pass data or applications between the OmniBook and other machines by way of PCMCIA cards, the OmniBook's standard infrared port, or serial-port connections using Traveling Software's LapLink Remote, which is provided with the OmniBook. The subnotebook is available with either two PCMCIA Type II slots for use with flash-memory disks or one slot for the PCMCIA-based hard drive option.

With sophisticated memory management and the execute-in-place, ROM-based Microsoft applications, HP claims that an OmniBook equipped with flash-memory cards can run for up to 10 hours while using only four AA batteries. Battery life with the rechargeable nickel-metal-hydride batteries figures to be about 5 hours.

The OmniBook base system without flash-memory cards or a hard drive is priced at $1515. With an optional 42-MB hard drive, the system lists for $1995, and models with SunDisk's 10-MB flash disk, which uses built-in Stacker data compression, will cost $2375.

—Patrick Waurzyniak

Hewlett-Packard Co., Santa Clara, CA 95051, (708) 752-0900

OMNIBOOK'S KEY FEATURES

- weighs less than 3 pounds
- ROM-based Windows
- Word for Windows and Excel 4.0 in ROM
- pop-up mouse
- superior keyboard
- PCMCIA 42-MB hard drive
- 10-MB flash-memory disks
- infrared port

SHARP COLOR DISPLAY

It seems too good to be true: a passive-matrix display that rivals the quality of active-matrix but requires less battery power and costs less—partly because it avoids the active-matrix display tariff.

Sharp Electronics (Camas, WA) recently introduced such a display housed in an overhead projection panel, and its Microelectronics Components Division says it will offer this dual-scan display for use in notebooks. Dual-scan displays scan two horizontal halves of the screen simultaneously, resulting in a quicker refresh, better contrast with little or no ghosting, and more uniformity of color.

Sharp, according to Dataquest's Jack Roberts, already claims a majority of the market share for notebook displays.

—Ed Perratore

NOTEBOOK DISPLAYS

Toshiba Gets Aggressive with Passive Color

A 486SX passive-matrix color notebook that sells for about $2500 may not sound like big news. But it might look like it, if you've been disappointed with the quality of passive-matrix color displays but don't want to spring for the price of an active-matrix color notebook.

A comparison of Toshiba's display technologies: traditional passive color (left) versus Toshiba's new Dynamic color (right). The two displays were photographed under the same lighting conditions. The differences are apparent. The Dynamic-color display is a major improvement over a passive-color display, but it still offers about the same battery life.

The Toshiba T1900C uses an impressive display technology called Dynamic STN-Color LCD. The colors are unusually saturated and intense for a passive-color display. The improved display is primarily the result of new high-density bonding techniques used for the 9½-inch display. The screen is split horizontally. The top half of each vertical pixel column is driven from above, and the bottom half is driven from below, essentially creating two screens in one package. Thus, each pixel is updated twice as often as formerly. With a custom video-controller chip and brighter side lighting, the result is a noticeable improvement over typical passive color.

Although prices were not set at press time, you can expect the T1900C to sell for about $2500, according to Toshiba (Irvine, CA). A monochrome version will be available for less than $2000. Those prices include 4 MB of RAM and an 80-MB hard drive.

—Gene Smarte

Read this and see what develops.

First came the best-selling 32-bit operating system IBM OS/2,® with over 2,000,000 copies sold since March 1992.

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Authors Bob Orfali and Dan Harky provide a comprehensive description of how to create and utilize OS/2 client/server applications, LAN communications, the DataBase Manager, presentation services, transaction servers and the new 32-bit C Set/2 compiler.

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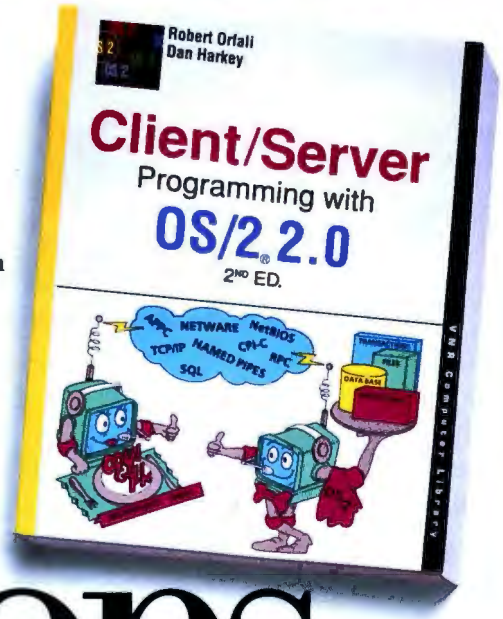
For an authorized IBM dealer near you, or to order OS/2 2.0, call **1 800 3-IBM-OS2.**



Client/Server Programming with OS/2 2.0 is available in bookstores. You can also order it from either Van Nostrand Reinhold at **1 800 842-3636** (ISBN Order #0442-01219-5), or from IBM at **1 800 879-2755** (Order #G325-0650).

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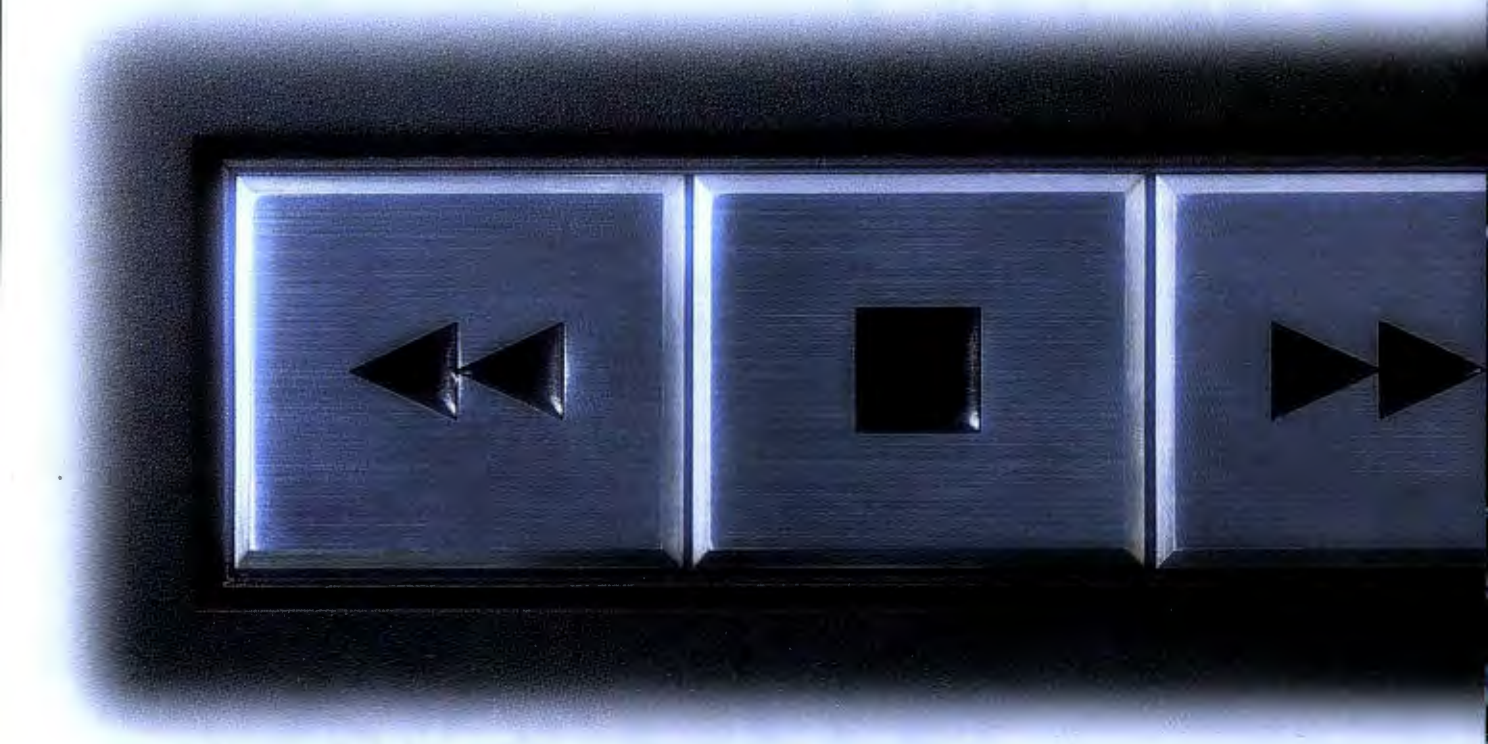

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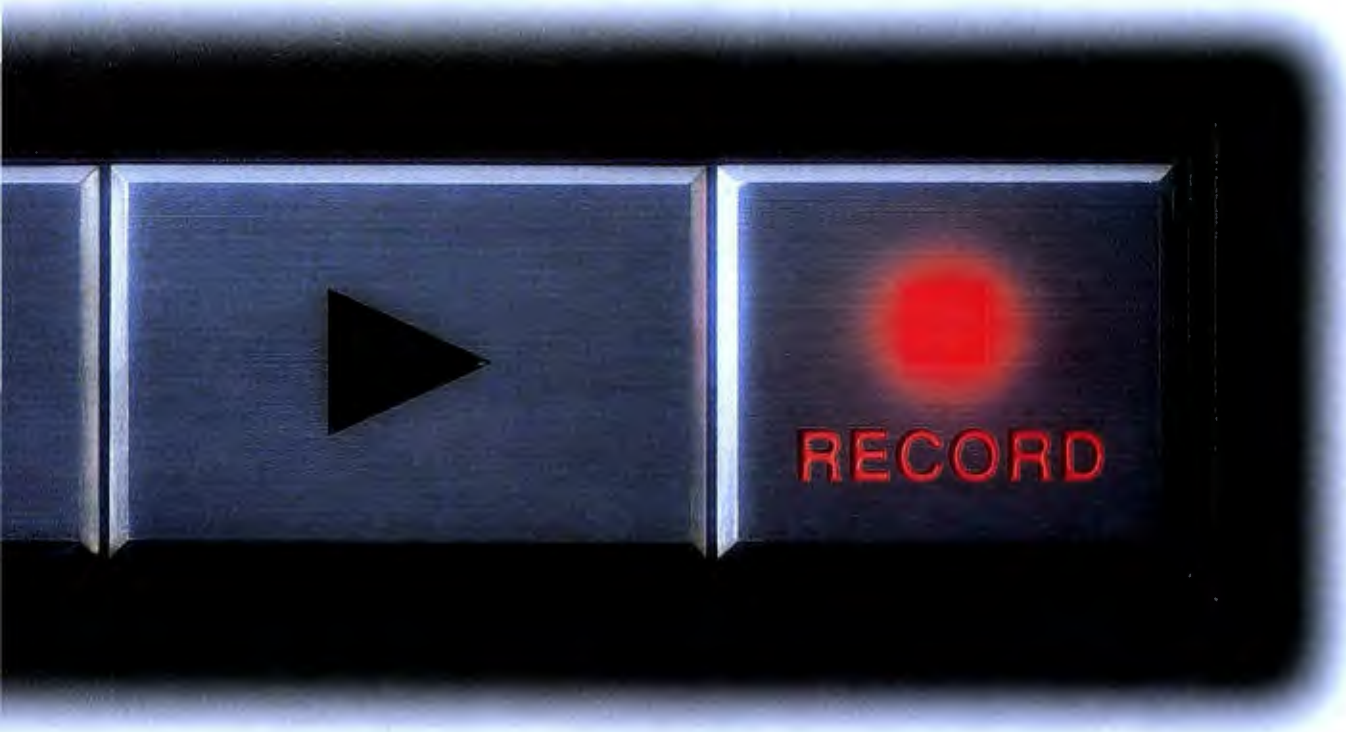

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DATA SECURITY

Clipped Wings?

Encryption Chip Draws Fire

Part of the Clinton administration's vision for a digital America is a fast encryption chip to help companies and individuals protect their secrets from prying eyes as voice and data messages are sent over communications wires. The catch is that this encryption chip includes a trapdoor that will let law-enforcement agencies listen in. The White House believes that the hardware will protect all Americans' right to privacy while also protecting them from those who break the law.

The chip is named Clipper (because Intergraph in Huntsville, Alabama, manufactures a processor with the same name, the Clipper moniker will likely be changed). It is a 12-Mbps encryption coprocessor designed by Mykotronx (Torrance, CA) and manufactured by VLSI (San Jose, CA). The chip is built in a tamper-resistant package to prevent reverse-engineering efforts to reveal the classified algorithm used inside.

Along with privacy concerns that the government could abuse its ability to tap digital wires, another impediment to widespread acceptance of Clipper will be its cost. Ben Stoltz, a member of the technical staff at Sun Microsystems (Mountain View, CA), says, "Our rule of thumb is that a part that costs n dollars adds $3n$ to $4n$ dollars to the final price [of a computer]." Raymond Kammer, acting head of the National Institute of Standards and Technology (Gaithersburg, MD), recently told a U.S. congressional committee that he hopes the Mykotronx chips will eventually cost $26 each if purchased in large quantities. That means a potential $75 to $100 addition to the price of each computer that uses the chip.

Critics of the Clipper chip note that less expensive chips that provide DES encryption have not received widespread acceptance because software encryption, although usually slower than hardware, is less expensive. Jim Bidzos, president of RSA Data Securities (Redwood City, CA), says, "This is just another arrow aimed at preventing people from using RSA." RSA's cryptographic routines will be included in new releases of system software written by Apple and Novell and are already used in Lotus Notes.

The government will undoubtedly provide a large market for the Clipper chip initially. President Clinton has already directed the U.S. Attorney General Janet Reno to purchase several thousand units for use in computers and secure phones. The impact of the chip on the rest of the world, though, will be governed by economics.

—Peter Wayner

Under the Clipper scenario, the police get legal permission to eavesdrop and use their special key to unlock the "lockbox" containing the serial number of the chip that produced the message. The government theoretically obtains legal authorization (e.g., a court order) and presents documentation to the two agencies safeguarding the keys. Then the government decodes the message using the two keys.

LONDON—

ISO9000: A Quality Opportunity

Companies wishing to do business in the European Community are finding it increasingly necessary to register for ISO9000 quality certification. This evolving standard ensures that an organization has the necessary procedures in place to deliver consistent products. Certification requires controlled documentation and management of all processes leading to a product's delivery—a task that is ideally suited for software automation if only the right tools were available.

The size of the potential market for such computer-aided quality management tools is large. In the U.K. alone, more than 20,000 companies are registered for ISO9000, and the remaining 200,000 will have to do so by the 1996 deadline. One company that offers software for ISO9000 record keeping is Rede Products (Swindon, U.K.). Its Quality Records Management System is a modular package for the PC that covers most aspects of the standard. Also, according to Micrografx (Richardson, TX), conventional flowcharting software is finding renewed interest among U.S. companies seeking to document and disseminate their internal procedures. Gordon Sellers, product manager for Micrografx's ABC FlowCharter, said the program is the leading revenue generator for the company. Companies wishing to do business in Europe should be learning about ISO9000 compliance, Sellers said. "American companies and Japanese companies that aren't headed in that direction are going to be sorry they aren't."

—Osman Kent

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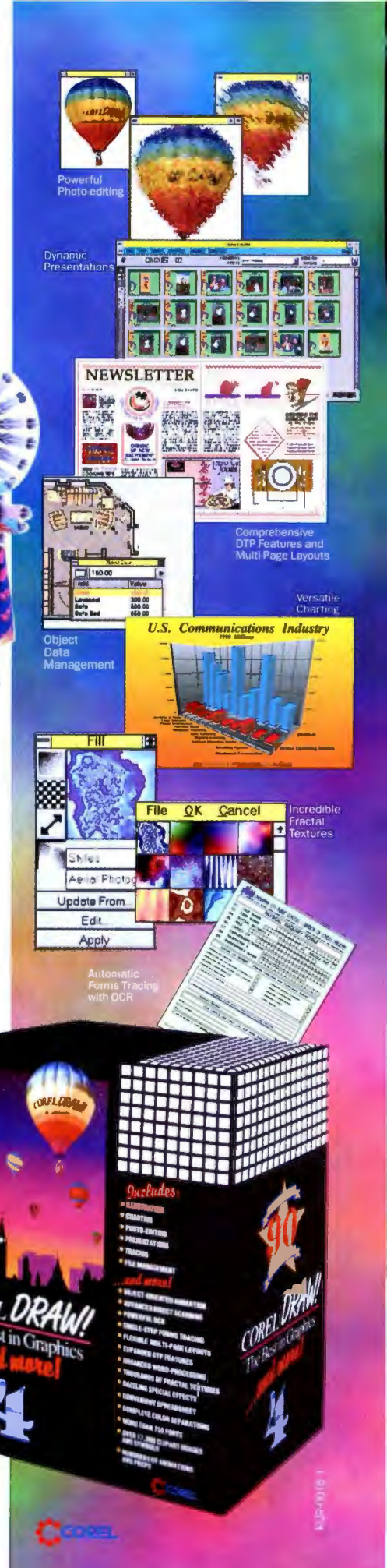

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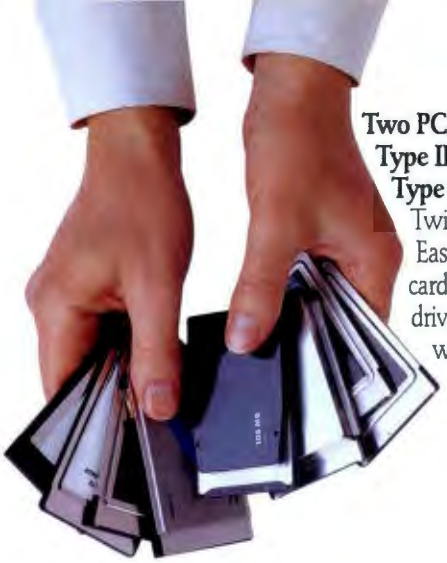

Two PCMCIA 2.0 Slots, Type II (5mm) and Type "IV" (16mm): Twice the expandability. Easily accepts multiple cards including hard disk drives, modems and network adaptors.

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Blazing 33MHz i486™SL: With built-in coprocessor support, delivers the ultimate in notebook processing power.

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- 120/200/340MB HDD
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- 120/200MB HDD
- 6.4 lbs.
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BOTH MODELS
- Intel 486SL/ 33MHz, 3.3 volt processor with 8K cache
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Large 9.5" Color Active Matrix TFT-LCD Screen: This exceptional technology delivers spectacular color for vivid graphics and dazzling presentations.

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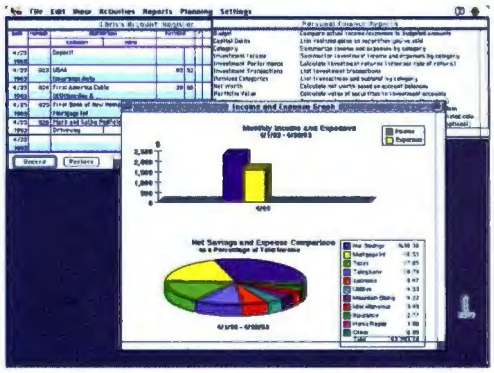
FINANCES

The Bottom Line: A Quicker Quicken



A welcome addition to Quicken 4 for the Mac's menu bar is graphing, which offers a handy way to view budgets, net worth, and investments.

An old favorite has just gotten better. Intuit's Quicken 4 for the Mac has reached new levels of speed and convenience by enhancing the data-entry aspects of its reliable checkbook-based bookkeeping program. Its price is $69.95.

Primarily a personal-finance program, Quicken 4 for the Mac can also serve as a cash-based bookkeeping system for a small business. Its advantages are that it is organized as a traditional checkbook, and it lets you build a bookkeeping system one account at a time. However, Quicken 4 has to be "fooled" to accommodate bookkeeping issues such as early-payment discounts for accounts payable and accounts receivable.

Intuit offers a more complete bookkeeping program called QuickBooks for small businesses with DOS-based PCs, but this program is not available for Windows or the Mac. Sources say the company will likely release the Windows version this year and the Mac version in 1994.

Intuit has added a rich handful of features to Quicken 4. One is QuickFill, which works as a "clairvoyant." As you make entries into the register, Quicken 4 rapidly searches for previous transactions that start with the same letters. With this new feature, the entry of regular transactions takes about half as much time as it did in Quicken 3. You can also program repeated transactions (e.g., a mortgage payment) to enter themselves automatically.

Intuit has added more subtle improvements to nearly all its Quicken 4 windows for the sake of saving keystrokes and mouse-clicks. Creating reports (e.g., profit and loss and net worth) is simplified through a report-creation dialog box that is much clearer than that found in the previous version. You can access report transaction detail with the new QuickZoom feature. Once a report is displayed, you can move the mouse pointer to any transaction and double-click for more information.

Quicken 4 tracks loans, offers its own credit card (credit-card statements are available on-line, on disk, or in printed form), and manages investments such as mutual funds or foreign currency. You can pay bills electronically with CheckFree, with computer-printed checks, or with handwritten checks. New financial planning calculators help you refinance a mortgage, budget for college, and plan for retirement.

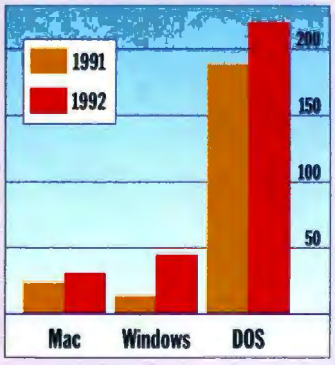
Quicken 4 is a welcome upgrade to an already excellent program. The program has not moved toward becoming a more complete business accounting system, but it should serve the needs of many small businesses. Useful additions for businesses would be integrated invoicing, more sophisticated accounts payable management, and payroll calculation.

—Chris Kofer

Intuit, Menlo Park, CA, (415) 322-0573; fax (415) 329-3689

PERSONAL FINANCE TAKES OFF

Consumer-oriented finance software experienced exceptional growth in 1992, according to the Software Publishers Association (Washington, DC). Sales in this category, largely personal-finance and tax programs, were up 34 percent from 1991.



Estimated North American home-finance software sales (measured at retail in millions of dollars)

HOME OFFICE

Computer Associates Heads for Home

Computer Associates' PC group has decided to enter the small/home office market. It is taking on mighty Intuit, whose flagship finance product Quicken even Microsoft has failed to topple.

The product, Kiplinger's CA-Simply Money, relies on CA's association with financial publisher Kiplinger to provide advice on short- and long-term topics like home equity loans. CA-SM ($69.99 retail) relies on drag-and-drop features to simplify many of its operations and uses larger-than-normal program icons (see the screen) that are clearly labeled. You can access CA-SM's refinancing, interest, and loan financial calculators from anywhere in the program.

CA has established a link with BillPay USA, a service accessible to Prodigy users that lets you pay bills electronically. CA-SM also includes communications functions that let you download up-to-the-minute stock updates from CompuServe and from CA's own 900 number.

—Ed Perratore

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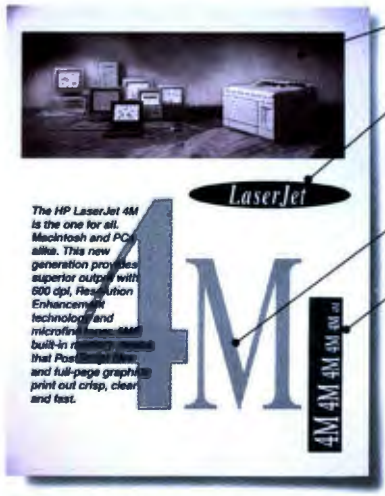
Greater flexibility for mixed environments. Because it's designed to be shared simultaneously, the LaserJet 4M gives you greater flexibility for mixed environments without compromise to either. Automatic language switching between PCL 5 and PostScript, 3 hot I/O ports, and new RISC processor make sure no one will have to wait around for this printer.



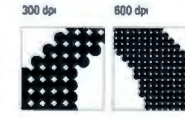
True 600 dpi creates rich, full-dimensional text and graphics.

Smoother curves, no jagged edges, thanks to HP's exclusive Resolution Enhancement technology.

Microfine toner makes 600-dpi output look even sharper.

35 PostScript Type 1 typefaces for Mac and PC PostScript language users, 35 Intellifont and 10 TrueType typefaces for PC users produce a broad range of document styles.

The finest print quality in its class. With HP's microfine toner, Resolution Enhancement technology, and 600 × 600-dpi engine, the new LaserJet 4M printer also delivers the finest 600-dpi print quality available.



Four times the dots for better resolution.

Its wide range of typefaces, two integrated paper trays, and the options of a 500-sheet tray and a power envelope feeder set a new standard in versatility.

HP quality and reliability. Of course, with the LaserJet 4M printer, you'll enjoy HP's renowned quality and reliability. All for only $2,399.* So call **1-800-LASERJET (1-800-527-3753), Ext. 7341**** for a free print sample.† Or visit your nearest authorized HP dealer.

If it isn't a LaserJet, it's only a laser printer.

HEWLETT PACKARD

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ENERGY STAR

Big Blue's Green PC

Long before President Clinton's decree in April that the federal government should buy only computer equipment that's compliant with the specifications of the EPA's Energy Star program, IBM, AST Research, and other vendors had been preparing energy-efficient models.

In developing its family of energy-conserving PS/2s, IBM borrowed power management and other features from its high-end notebook, the ThinkPad 700C. The most obvious appropriation is the 10.4-inch, color, TFT (thin-film transistor) flat-panel monitor developed with Toshiba. This display, which is expected to sell for less than $2000, draws just 21 W when active and a mere 3 W in sleep mode. A power-managed CRT will also be available as an option for about $750.

The system itself, expected to sell for about $3000 ($2000 for diskless systems), redefines the term *small footprint* with its 12- by 12- by 2½-inch size, or about the size of a large 3-ring binder. A 3.6-V, 25-/50-MHz 486SLC2 processor powers the system, which comes with a media-sensing 1.44-MB floppy drive, an ISA passive backplane with integrated serial and parallel ports, support for XGA-2 (Extended Graphics Array) graphics (1024 by 768 pixels with 256 colors), and PS/2 mouse and keyboard ports. The system ships standard with 8 MB of RAM, which you can upgrade to 16 MB.

Three of the five systems in IBM's new PS/2 family will come with a PCMCIA interface card that installs atop the system's passive backplane. The card has two controllers, each of which can run either two PCMCIA Type 1 or 2 cards or one of the thicker Type 3 cards. Thanks in part to their use of PCMCIA, the systems typically draw just 24 W in normal use and only 16 W in sleep mode. By the time you read this, IBM expects to have PCMCIA Ethernet, Token Ring, and 3270 cards available. Plans call for PCMCIA fax modems, solid-state memory cards, and even a 105-MB hard drive in 1993.

—Ed Perratore

OPERATING SYSTEMS

OS/2 Without Microsoft Windows?

A chief marketing and technical strength of OS/2 2.x has been its capability to run 16-bit Windows and DOS applications concurrently with native OS/2 applications. In releases following OS/2 2.1, however, the version of Windows that IBM includes in OS/2 probably won't be identical to the Windows from Microsoft.

This dichotomy is due to the expiration in September of IBM and Microsoft's JDA (Joint Development Agreement), which permitted IBM to use Microsoft's Windows source code. It also gave Microsoft free use of OS/2 code. But unless the two companies renew the JDA—and sources at IBM say the company will indeed let the JDA expire—the version of Windows in OS/2 won't contain any new Microsoft Windows code at all.

"Source code is a real nice thing to have, but remaining compatible is not rocket science," said IBM media spokesman Rob Crawley. He said that although the source code tap will be shut off this September, IBM retains the rights to the API "forever." In theory, this would permit IBM to create its own version of Windows, although Crawley would not comment on this option. Neither would he confirm the rumored possibility of a version of OS/2 without Windows that might coexist with a system already equipped with DOS and Windows. Sources also said IBM is considering adding support for Microsoft's Win32s API.

Another avenue for IBM to add Windows compatibility to OS/2 could come from Insignia Solutions (Mountain View, CA), developer of the SoftPC line of products. Insignia officials said that the company's agreement with Microsoft does not preclude it from developing a SoftPC for OS/2.

Meanwhile, sources say that units of IBM at Boca Raton, Yorktown Heights, and elsewhere are quietly developing software products for Windows NT in addition to OS/2, AIX, and lower-end platforms. News of an NT version of DB2 has already leaked out.

—Ed Perratore

UNIX DOES WINDOWS

Microsoft recently announced that it will provide Insignia Solutions with early access to Windows source code and API directions. Insignia will be able to improve the performance of native Windows applications as they run on top of Unix. Insignia already provides the technology to Microsoft that gives the non-Intel versions of Windows NT their backward compatibility with Windows applications.

"The Windows APIs are moving on," said Nick Samuel, CEO of Insignia. He said that the Microsoft-Insignia agreement will let his company be better prepared to provide high-performance Windows-emulation solutions for Unix as Microsoft adds video, object-oriented technology, mail, and sound to Windows. "We need to stay current. It is extremely difficult...to stay current if you're having to do it after the [operating system] is released."

Meanwhile, SunSelect (Chelmsford, MA) continues to work on its WABI (Windows Application Binary Interface) technology for running popular Windows applications on Unix "at full performance" and without the need for DOS or Windows itself. (For more information on WABI, see "SunSelect Intrigues with WABI for Unix," February BYTE, page 36). SunSelect plans to release the initial version of WABI sometime this summer. Unix System Laboratories says it will integrate versions of its operating system with WABI so that Windows and Unix applications will run on System V release 4.2 desktops.

—Dave Andrews

Not just a new Sound Blaster. A new 16-bit audio standard.

Introducing the Sound Blaster™ 16 Digital Audio Platform. A new concept in sound cards. And a new standard for 16-bit PC audio.

The new 16-bit PC audio standard: Includes programmable mixer, microphone, VoiceAssist speech recognition software, plus more than $1000 in software applications.

YOU WON'T BELIEVE YOUR EARS.

PC audio never sounded so good—genuine CD-quality audio with fully 12% more dynamic response and 15% better signal-to-noise ratio than any competing 16-bit sound board. Plus software data compression that delivers 16-bit fidelity while maximizing disk storage capacity.

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But there's more. Included in the Sound Blaster 16 package is the biggest advancement in PC control since the invention of the mouse: our exclusive VoiceAssist™ software. It's a sophisticated speech recognition interface that uses a 32,000-command library to control Windows applications *hands-free!*

THE ONLY SOUND CARD THAT GROWS WITH YOU.

Unlike other 16-bit cards, Sound Blaster 16 comes with built-in interfaces for CD-ROM, MPU-401 MIDI and joystick control. And the unique modular, scalable architecture lets you add more advanced features and technologies *as you need them.*

FEATURES

State-of-the-Art PC Sound *with 16-bit Codec digital audio chip.*

16-bit Data Compression *saves disk space without loss of signal quality.*

Upgradable, Modular Platform *makes it easy to add new technologies like Advanced Signal Processing and Wave Blaster.*

100% Compatibility *with all Sound Blaster applications, plus cross platform support for Windows 3.1, DOS or OS/2.*

Upgrade to Advanced Signal Processing with one chip.

Like our Advanced Signal Processing chip that delivers 4:1 real-time hardware data compression while reducing CPU time up to 65%. Or professional-quality sampled wave synthesis with our plug-in Wave Blaster™ daughter board.

Upgrading is as simple as plugging in a daughter board.

And—unlike other cards—the Sound Blaster 16 is 100% *compatible with every game and application ever written for the Sound Blaster*...which is to say virtually every game and application available for sound.

NOBODY PACKS IN MORE VALUE THAN THE INDUSTRY LEADER.

And as if that weren't enough, we've completed the package with more than $1000 worth of leading software—not too shabby considering the entire package retails for just $249.*

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For more information about Creative Labs products and the name of your nearest Sound Blaster Dealer, call 1-800-998-5227.

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Even a *free* memory manager may not be a bargain—especially if it can't give you all the memory you need.

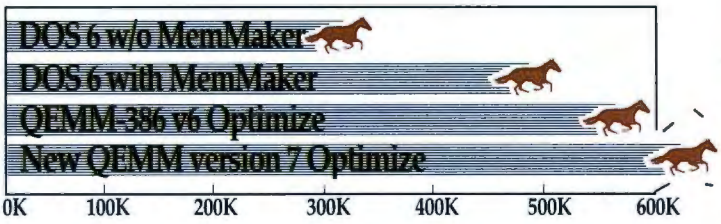
Introducing QEMM 7
The Memory Manager Worth Paying For

The newest version of the Quarterdeck Expanded Memory Manager (QEMM), version 7, once again is extremely innovative in using the critical area between 640K and 1024K. It finds space for more TSRs and drivers in this area than anyone thought possible. It optimizes this area, taking into account the many drivers that need more memory at start-up than when running; instantly calculating millions of possible memory configurations to find still more memory for your programs to use. And it treats the rest of memory as a giant pool to instantly fulfill the needs of all of your programs—whether they use extended or expanded memory. Whether your PC has 1 megabyte or 16, you can benefit from new QEMM 7.

Instant Riches

What does more memory mean in a practical sense? It means that your DOS and MS Windows programs run faster, smoother and more reliably. It means you can continue to add valuable utilities, drivers, TSRs and new capabilities to your PC. Whether it's workhorse drivers like LAN utilities and fax drivers; productivity-enhancers like disk caches and disk compressors; or fun and exciting capabilities like sound boards, CD ROM drivers, graphics tablets, etc. The better your memory is managed, the more versatility and flexibility your PC has. QEMM 7 lets you have it all without fear of 'out of memory' messages or crashes.

How to Look a Gift Horse in the Mouth



We tested DOS 6 with and without MemMaker and with QEMM 6 and our new QEMM 7 runs away from all of them. See details of test conditions listed below.

DOS 6 Giveth; DOS 6 Taketh Away

The best feature of new DOS 6 is the stable of utilities it includes. Trouble is, they all eat up memory. DoubleSpace file compression needs 43K, Vsafe anti-virus needs 7-45K, Smartdrv disk cache needs 28K and even Undelete takes 10-14K as a resident program. Using Microsoft's free memory utility, MemMaker, you could easily end up with a net loss of available 'conventional' memory in DOS 6.

New QEMM 7 takes the best of the new DOS 6 features into account, finding ways to give you more free memory for your program while taking full advantage of DOS 6. One new QEMM 7 feature, DOS-Up, moves the DOS 6 kernel, its data and resources to memory above 640K (this feature also works with DOS 3-5), freeing 7-70K. Another new QEMM 7 feature, Stealth DoubleSpace, frees 40K of the memory addresses used by DoubleSpace and makes them available for other drivers and TSRs. Both features ensure that the all-important memory below 640K is free for your programs. And QEMM 7's seemingly small feature of supporting DOS 6's multiple configurations gives you the flexibility and ease of setup that you expect. (MemMaker doesn't work well with this important DOS 6 feature.) That's why it makes more sense than ever to put your money on the best memory manager—QEMM.

Page Frame: the Key to Your Future

There's been a lot of talk about our patent-pending Stealth technology. Jealous talk, mostly. Because nobody else can touch its performance. Our Stealth ROM feature, pioneered in QEMM 6, frees 48-115K of ROM addresses for use by TSRs and drivers. Our Stealth DoubleSpace feature, described above, frees another 40K. And as you might imagine, there's more to come.

Prior versions of QEMM won just about every competition in sight, as well as remaining the #1 best-selling memory manager 5 years straight.

The key to Stealth is its use of a 64K reserved area above 640K called the page frame. Besides being used by Stealth, the page frame is used by Lotus 1-2-3 r2.x for larger spreadsheets and WordPerfect 5.x for larger documents, DESQview for multitasking, Novell Netware, IBM LAN Server and DECnet for reducing the network driver memory footprint, plus games like Wing Commander, Car and Driver, Ultima Underworld II, Wolfenstein and others for fast action. You sacrifice all this when you turn off the page frame (which other memory managers do to maximize available memory above 640K). It's this use of the page frame by Stealth that lets you set up your PC with a mouse, CD ROM, sound board, a network such as Novell NetWare, reserve 8-24K of extra memory for optimal MS Windows performance, use all of DOS 6's memory-hungry utilities and still have more than 630K available for your programs. (Compared to DOS 6's 527K available in the same configuration, after using MemMaker).

There's lots more to QEMM 7:

- Tuned for MS Windows
- New ability to use Vidram inside MS Windows
- DPMI Host
- Pentium Support
- Laptop suspend / resume support
- PS/2 micro channel adapters
- Compaq support
- Fine tuning tools for power users
- 32-bit architecture for speed
- Enhanced compatibility in response to hardware needs of our millions of users:
  - Detects adapter RAM and ROM and bus-mastering hard drive controllers
  - Monitors DMA access into memory
  - Supports Shadow RAM

Easier to use for Novices, More Power for Experts; More Memory for Everyone

Our seventh-generation thoroughbred QEMM has improved ease-of-use, with Express Install and Help features. And for power users, Advanced Install and editable parameters and troubleshooting hints.

And QEMM 7 comes with Manifest, the award-winning memory analyzer—enhanced for more flexibility—from Pentium testing to laptop battery reporting; network analysis to editable configuration files.

The new and ever more exciting capabilities coming to your PC will all compete for memory with your favorite applications, TSRs and drivers. And that makes QEMM 7 the front runner in your efforts to get get the best performance out of your PC today—and tomorrow.

Quarterdeck

Quarterdeck Office Systems, 150 Pico Boulevard, Santa Monica, CA 90405 (310) 392-9851 Fax (310) 314-4219
Quarterdeck International Ltd., B.I.M. House, Crofton Terrace, Dun Laoghaire Co. Dublin, Ireland Tel. (353) (1) 284-1444 Fax: (353) (1) 284-4380

QEMM Users: upgrades are available from dealers.

You can also buy direct from Quarterdeck. Call (800) 354-3222 ext. 1D7 and ask about our special Game Pack offer with your upgrade!

How we got the chart numbers CPU—486/33 ALR Power/business VEISA machine equipped with 16 megs of RAM and running MS-DOS 6. Comparisons were done using the following memory managers: QEMM 7, QEMM 6.02, MS-DOS 6 MemMaker. In addition to the driver (or drivers) required by each memory manager, the following drivers, DOS resources and programs were loaded for all comparisons: in the CONFIG.SYS file: SETVER.EXE, DOS=HIGH, FILES=20, BUFFERS=10, STACKS=0,0, MVSOUND.SYS, SNDBK12.SYS, SLCD.SYS, DOS SHELL=statement, in the AUTOEXEC.BAT file: VSAFE, MSCDEX, UNDELETE, LSL.COM, NE2000.COM, IPXODI.COM, NETX OR EMSNETX, MOUSE.COM, SMARTDRV.COM, PRTSCCAP.COM.

Circle 135 on Inquiry Card.

KHALDOON TABAZA

Windows on Arabia

The Middle East is one of the fastest growing computer markets. So it's not surprising that the first version of Microsoft's Multilingual Windows (above) is an Arabic version that includes localized menus and error messages.

Arabs take great pride in their language. It remains the most important cultural factor bringing together more than 215 million Arabs living across the Middle East. Its flexibility and variety make it a source of beauty and creativity in Arab literature and art. But for many years, the technology enabling the use of Arabic in computing lagged. Now, thanks to Microsoft and a host of Middle Eastern software companies, Arabic is catching up fast.

Arabic differs from Latin languages in many aspects, the most important being that it is written from right to left. Also, some Arabic characters are connected to each other, and the shape of a character usually differs according to its location in a word. Some characters have up to four different shapes. Another important aspect of Arabic is its use of diacritics over certain characters. The pronunciation of the character—and the meaning of the word containing that character—differ according to the diacritic imposed over it.

Early attempts at "Arabizing" software involved writing pure Arabic applications from scratch using English programming languages and operating systems. Producing Arabic characters on a computer screen required adding about 65 new characters to the usual Latin ASCII code. Writing programs from scratch, however, proved to be a tedious and financially unrewarding job.

Arabization really took off with the concept of "transparent Arabization": producing a software layer that ran over the existing version of DOS and let the user write in Arabic using existing Latin applications. Because of widespread piracy, the first transparent solutions included pieces of hardware that converted Latin characters in the original application into Arabic characters.

Many companies in the Middle East established their own Arabization layers. They used cheaper and easier-to-install software solutions to run over DOS. A program called Nafiatha from 01 Systems in Bahrain is the most popular. Another successful Arabization shell, from a Cairo-based company called al-Alamiah, was unique in offering the first Arabic spelling checker. Microsoft also recently released an Arabic support disk that will accompany DOS 5.0 and DOS 6. These different methods for Arabization have caused incompatibility problems for users and deprived developers of a solid platform to develop Arabic applications.

On the GUI side, Macintosh users had a strong version of the operating system developed by Apple in 1986. PC users, however, had to wait until 1992 for Microsoft to provide Windows 3.1 with Arabic Language Support.

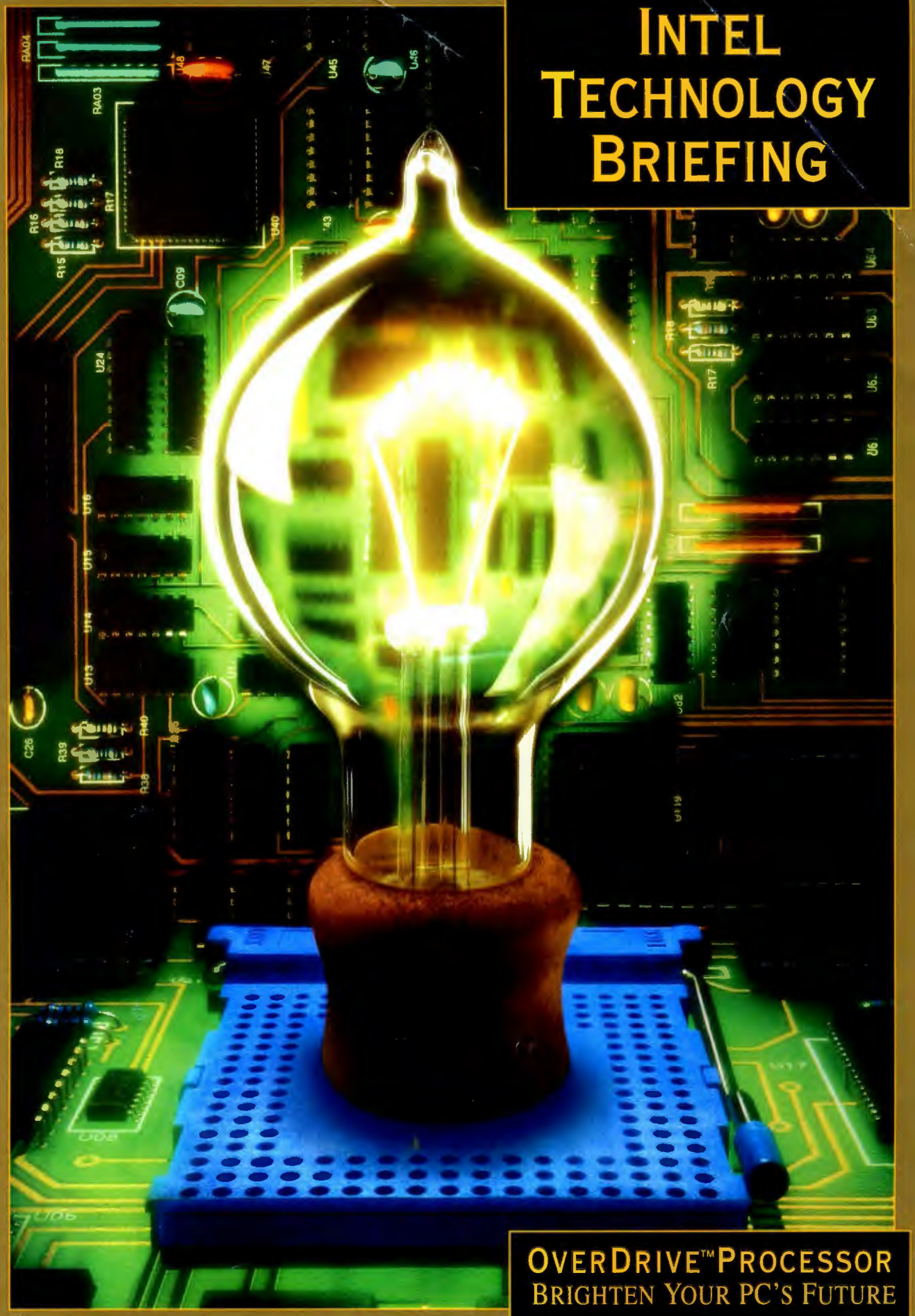
Windows 3.1 with Arabic Language Support has Latin menus and messages but provides a degree of transparent Arabization that lets users use Arabic in most Latin applications. It also provides compatibility with existing Arabization systems and an Arabic version of Windows Write. Most important, it provides a solid platform on which developers can write purely Arabic or Arabic-aware applications.

Microsoft Windows 3.1 with Arabic Language Support is just an enhanced version of the original English release, but Microsoft promises more direct support for Arabic. The first version of Multilingual Windows, which was slated to be available in June, will be a fully localized Arabic Windows.

This release will give Arab users an early taste of the technology planned for the forthcoming versions in other languages. It will let users with only one copy of Windows install and use as many languages as they wish. Users can purchase various Language Kits and switch to different languages on the fly. Arab users, for example, will get a basic English-Arabic version of Windows. Later they can buy additional kits for languages such as French or Japanese. ■

Khaldoon Tabaza is an Amman-based computer writer. He can be reached on BIX c/o "editors."

Intel Technology Briefing



OverDrive™ Processor
Brighten Your PC's Future

SEE UPGRADABILITY IN A WHOLE NEW LIGHT.

Intel's OverDrive™ Processor technology represents a new upgrade philosophy. Based on a single chip form factor—not boards, or modules. It lets you add future processor technology to your current PC.

This second Technology Briefing will explain how our OverDrive Processor technology works.

SINGLE CHIP PROCESSOR UPGRADE.

Intel has designed its new microprocessor families to be upgradable with OverDrive Processors. To do this, OverDrive Processors are actually based on and designed in tandem with our latest microprocessors. To make OverDrive Processors compatible with the previous Intel microprocessors, they have been designed with a special external interface. This enables OverDrive Processors to plug directly into existing systems equipped with OverDrive Processor sockets. Once installed, they will increase application performance by 40 to 70%.

THE UPGRADE PATH.

The first OverDrive Processor is based on an Intel486™ DX2 CPU core. It upgrades your Intel486 SX or DX CPU-based system to near Intel486 DX2 performance. Pentium™ OverDrive Processors are under development for Intel486 systems and next-generation OverDrive Processors are already being designed for Pentium processor-based systems.

THE ENABLING TECHNOLOGY.

The core of every OverDrive Processor is a microprocessor, enhanced with new technology such as the DX2's "speed doubling" technology or the Pentium processor's "superscalar" technology.

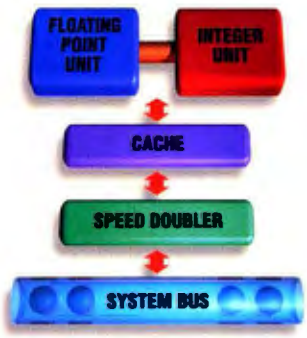
This enhanced microprocessor core allows faster instruction execution without having to modify the external system clock speed or memory subsystem.

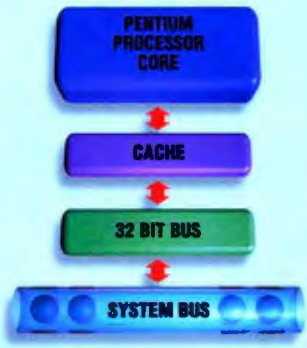
THE CACHE IS KEY.

Simply putting a faster processor core into a PC doesn't help much unless the system can supply enough data to keep it busy. That's why every OverDrive Processor also contains a large on-chip cache. The cache frees the OverDrive Processor to work independently of the memory subsystem. In fact, 90% of the time the cache contains the necessary instructions and data.

BIU CONNECTING THE PIECES.

The final component of an OverDrive Processor is the Bus Interface Unit (BIU). Its job is to transfer data between the OverDrive Processor and the external system in a way that is completely compatible with the original microprocessor. In addition, each BIU is designed to maximize system performance, based on the bus bandwidth of the original system and core microprocessor technology.





SOFTWARE POWER.

The new "speed doubling" core of the Intel486 DX2 OverDrive Processor roughly doubles your original CPU performance. Overall, this translates into an application performance gain of 40 to 70% (see chart on the back page). Naturally, system bottlenecks such as disk drive accesses, bus bandwidth and graphics speed keep the i486™ DX2 OverDrive Processor from fully doubling system performance.

OVERDRIVE™ PROCESSORS

INTEL486 DX2 OVERDRIVE PROCESSOR FOR INTEL486 SX OR DX SYSTEMS.

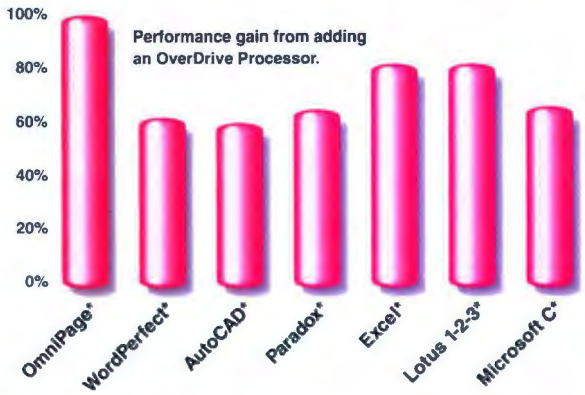
TODAY'S i486 DX2 OVERDRIVE PROCESSOR COMBINES i486 TECHNOLOGY (AN INTEGER UNIT, A FLOATING-POINT UNIT AND AN 8K CACHE ON ONE CHIP), WITH SPEED DOUBLING TECHNOLOGY. FOR EXAMPLE, THE OVERDRIVE PROCESSOR DOUBLES THE INTERNAL OPERATING SPEED OF A 33-MHz INTEL486 DX CPU-BASED SYSTEM TO 66 MHz. AND WHILE THE CPU IS OPERATING TWICE AS FAST INTERNALLY, IT KEEPS ITS ORIGINAL EXTERNAL SPEED TO MAINTAIN SYSTEM COMPATIBILITY.

PENTIUM OVERDRIVE PROCESSOR ARCHITECTURE FOR INTEL486 SYSTEMS.

THE NEXT GENERATION PENTIUM OVERDRIVE PROCESSOR WILL USE PENTIUM PROCESSOR SUPERSCALAR TECHNOLOGY THAT EXECUTES TWO INSTRUCTIONS SIMULTANEOUSLY, A 16 KB ON-CHIP CACHE MEMORY, A REDESIGNED FLOATING-POINT UNIT CAPABLE OF ONE INSTRUCTION PER CLOCK CYCLE, WITH A BUS INTERFACE UNIT OPTIMIZED FOR A 32-BIT i486 CPU BUS.

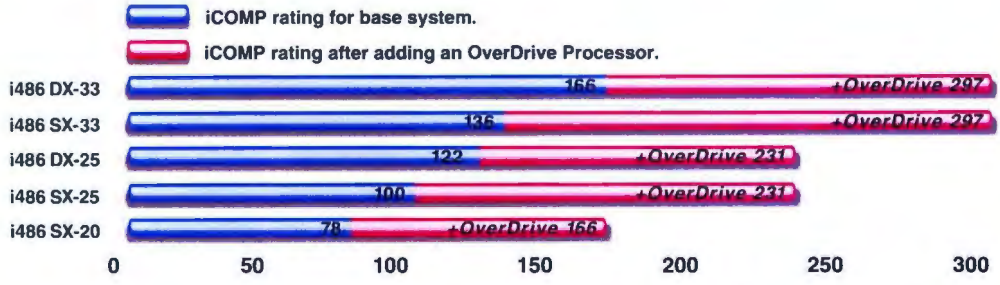
INTEL486 DX2 OVERDRIVE PROCESSOR SPEEDS UP APPLICATIONS.

THIS CHART REPRESENTS THE INCREASE IN PERFORMANCE WITH SOME POPULAR SOFTWARE APPLICATIONS.



Source: Intel OverDrive Processor Performance Brief.

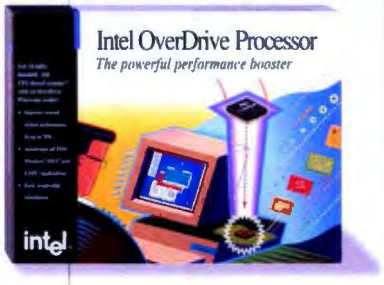
THE INTEL iCOMP™ RATING INDEX:*



*The iCOMP index is an Intel microprocessor "horsepower" rating. It is a composite of selected performance measurements from SPEC 92, ZD Bench, and Whetstone. Source: iCOMP™, A Simplified Measure of Relative Intel Microprocessor Performance, Intel Corp., 1992.

HOW DO I GET THIS TECHNOLOGY?

Almost all Intel486 SX systems and most Intel486 DX systems can be upgraded with an Intel486 DX2 OverDrive Processor. For more information on how to upgrade your system, see your authorized Intel dealer. You'll find they have a ready supply of OverDrive Processors, as well as answers. Just look for the box below. And give your PC a mid-life kicker with an Intel OverDrive Processor.

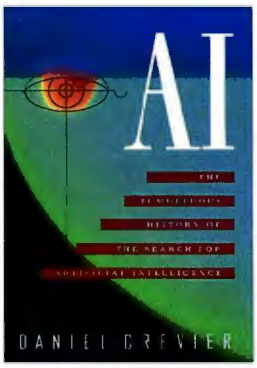


FOR MORE INFORMATION ON UPGRADABILITY, CALL 1-800-955-5599.

We're ready to supply you with all the additional information you need on OverDrive Processors: a performance brief, a system compatibility guide, a demo disk, and even a specsheet. Ask for literature package #68. Plus, we'll also be happy to send our first Technology Briefing on the Pentium processor. Remember, the information is free. So is the call.

intel®

Quest for the Silicon Grail



HUGH KENNER

Daniel Crevier's *AI: The Tumultuous History of the Search for Artificial Intelligence* comes from a writer whose reputation doesn't ride on AI's success or lack of it. Not that he'll conceal his fervent belief in its future; but he doesn't believe either that the Weizenbaums and Dreyfuses need sweeping under the rug.

Crevier, a Canadian professor of electrical engineering, is founder of a firm "that uses artificial intelligence to let computers see through TV cameras." That suggests an expert system, and nobody, not even Hubert Dreyfus, denies that they can do useful things right now. Whether or not their lookup-table facility equates with intelligence remains a different question.

Crevier is also qualified enough in Techspeak to interview a Minsky, a Simon, or a Moravec and understand what's being said, and his narrative that starts in the age of von Neumann proceeds with easy clarity through the bold visions of the sixties, through the setbacks of the seventies, and all the way to three possible futures for The Computer.

(Those scenarios? 1. Wholly bad: Machines will take charge altogether, like *2001*'s HAL, and in the scariest version they'll take charge of our weaponry. 2. Still ungood: They'll take charge of those of us who already get shortchanged and eavesdropped on, thus making present imbalances still worse. 3. Music, please!: They'll open the heavenly gates.)

True, heavenly gates seem at present out of reach. As of now, "The world chess champion is still a human being," and "A hundred-thousand-dollar prize for the discovery of a new mathematical theory by a computer remains unclaimed." So two 1957 forecasts of Herbert Simon's are still unfulfilled.

No denying that progress has been slow by those long-ago standards. Crevier is right to dwell on the slow and tight hardware of three decades ago: the punch-card access to a torpid CPU and a few kilobytes of RAM. He's right too in conceding to the Dreyfuses that conceptual difficulties were always underrated. (Can a lifetime's experience, acquired in many contexts, really be simulated by dumping encyclopedias down a funnel in the genie's head?) He's still optimistic.

Quick Bits

Enough already, you're saying, of books about the hacker underworld. Yes, I know; but here's a really fresh one: *Approaching Zero* by Paul Mungo and Bryan Clough. You may want to save their case histories till next winter's crackling fires. "The Bulgarian Threat" is an especially fine chapter. "The Illuminati Conspiracy" is another.

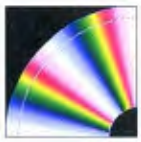
And from page after fervent page of *The Green PC*, we may glean that 9.3 million trees are cut down annually to feed computer printers, or that there are more floppy disks in the world than people. There's also much advice, such as how to refill ink-jet printer cartridges cheaply. You get a hypodermic syringe and find "the tiny pinhole at the top of the cartridge" and inject "fresh ink from a bottle of standard Shaeffer or Scripto." I've no idea whether this is sound advice or not. You might ask Al Gore. ■

AI: THE TUMULTUOUS HISTORY OF THE SEARCH FOR ARTIFICIAL INTELLIGENCE
Daniel Crevier, Basic Books, ISBN 0-465-02997-3, $27.50

APPROACHING ZERO
Paul Mungo and Bryan Clough, Random House, ISBN 679-409-386, $22

THE GREEN PC: MAKING CHOICES THAT MAKE A DIFFERENCE
Steven Anzovin, Windcrest/McGraw-Hill, ISBN 0-8306-4311-7, $9.95

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. You can contact him on BIX as "hkenner."



ARTISTIC INFLUENCE

Electronic Library of Art

Ebook, Inc., 32970 Alvarado-Niles Rd., Suite 704, Union City, CA 94587, (510) 429-1331, fax (510) 429-1394, $99.95 per volume

With its Electronic Library of Art series, Ebook envisions an impressive set of CDs covering "the history of art, from primitive cave paintings to the most influential works of the twentieth century." The first five installments of the library for Windows, Mac, and VIS (Video Information System) platforms, and a sixth CD scheduled for release later this year, represent a solid foundation for this panoramic goal.

The latest release in the series, Impressionism and Its Sources, covers the Impressionism movement of the late nineteenth century. It shares the same simple Windows interface as earlier entries in the series. A scrollable window displays a thumbnail of each work. Double-clicking on an image enlarges it and enables more options, such as reading the author's biography or—in some cases—viewing the image in greater detail. You can search by artist, title, medium, date, school, or object type (e.g., painting or sculpture). For added atmosphere, you can peruse the paintings while listening to classical music of the era.

An introductory essay relates the spirit of rebellion shared by the seminal Impressionists who banded together and defied the art establishment of the day. Short biographies cover the major artists' life and work. But the images themselves best tell the story. The paintings reflect the revolutionary style of the Impressionists as they used light and color in new ways and imbued common people with a romantic aura formerly reserved for sacred images. The important artists are well represented in over 1000 images.

Ebook has done a masterful job compiling this series. The next CD will include art depicting Greek and Roman mythology. The Electronic Library of Art is an excellent reference work and a great way to spend an evening.

—Stanford Diehl

THE INCREDIBLE SHRINKING IMAGE

FRACTAL IMAGE COMPRESSION by Michael Barnsley and Lyman Hurd AK Peters, ISBN 1-56881-000-8, $49.95

Occasionally a technology appears that's so new, different, and conceptually odd that it is difficult to grasp the idea. For me, fractal image compression is one current example. At one level, I understand that the basic idea of naturally repeating fractals lends itself to data compression. At the same time, however, I admit to having no idea how this idea is reduced to practice.

Fractal Image Compression by Michael Barnsley and Lyman Hurd provides more information about this technology than the casually interested will care to know. This is no light overview, but a serious discussion of the mathematical foundations beneath fractal compression.

You'll spend a long time working through the mathematics in this book, but not all the discussion is left for the mathematicians. Barnsley and Hurd reduce each algorithm to strictly functional examples written in C. All the expository code is quite small (typically a page or two). I'd like to see an accompanying code disk, but the examples are not too large to be entered manually.

Other compression methodologies, such as Huffman and arithmetic encoding, are also presented as mathematical discussions with expository C code. So too is a detailed investigation of transformations: scaling, rotating, moving, and stretching in two and three dimensions.

Fractal Image Compression is an excellent treatise on the leading edge of compression technology by the people who created it. There's one catch: The actual fractal-compression algorithm included in the book is protected by a patent. If you're going to do more than play with it, you'll need a license from Iterated Systems.

—Raymond GA Côté

DO-IT-YOURSELF CD-ROM

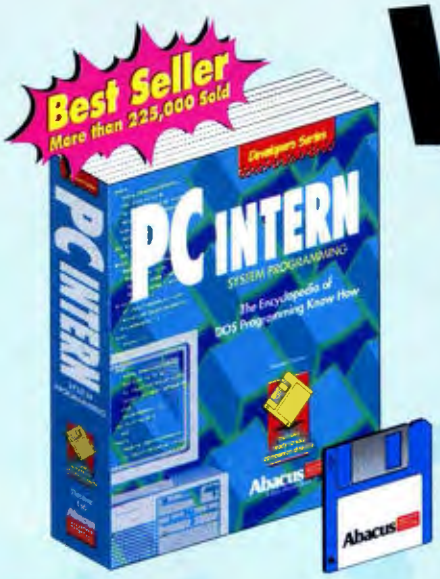
PUBLISH YOURSELF ON CD-ROM (WINDOWS, MAC, OR UNIX) by Fabrizio Caffarelli and Deirdre Straughan Random House Electronic Publishing, ISBN 0-679-74297-2, $50

Publish Yourself on CD-ROM is based on the assumption that inexpensive and easy-to-use CD-recordable technology will free the repressed publisher in all of us. Apparently, Caffarelli and Straughan run with a richer, smarter crowd than most of us. CD-recordable technology has certainly made rolling your own CD-ROMs easier and more affordable, but the entry fee can easily run over $8000, and the task requires more knowledge of file formats, device drivers, and publishing principles than the typical novice possesses.

The authors' missionary zeal, however, does not diminish what is actually a good introductory guide to self-publishing on CD-ROM. To help you get started, it even includes image-formatting software, called EasyCD, for

We Deliver

Computing Know How



PC Intern

A *literal* encyclopedia of DOS knowledge. This book is a completely revised edition of our bestselling *PC System Programming* book which has been read by over 225,000 programmers worldwide. Whether you want to program in Assembly Language, C, Pascal or BASIC, you'll find dozens of practical working examples in each of these languages.

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Reviews Books & CD-ROMs

Windows, DOS, Mac, and Unix on CD-ROM. This bundled software explains the book's relatively high price. EasyCD is no match for professional premastering software such as Dataware Technologies' CD Prepare, but it serves well as a beginner's tool.

The authors cover all the basics of standards, hardware, and media in a complete, easy-to-understand manner. The book goes an extra mile with its advice on setting up your application, complete with multimedia files, for publication. It explains how to assemble the tools and possible licenses you need, and how to estimate production costs. A hypertext version is on the bundled CD-ROM.

The book has two weaknesses, if you ignore its early hyperbole. First, it provides almost no examples. Caffarelli and Straughan could have created a sample application to produce on CD-ROM and used it throughout the book. Second, after exhorting their readers to dive right into the world of CD publishing, the authors shrug off what is arguably the most vital information they could have provided: how to sell your completed product. Instead, they sagely tell you that you need help in this area and list four distributors.

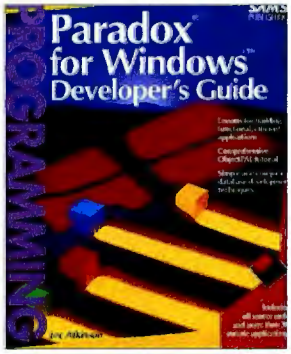
If CD-recordable technology has stirred the publisher in you, *Publish Yourself on CD-ROM*, with the EasyCD software, is a relatively painless way to experiment. If you decide to take the next step, however, you will need to find better sources of information on selling and promoting your products.

—Michael Nadeau

PARADOX BY EXAMPLE

PARADOX FOR WINDOWS DEVELOPER'S GUIDE by Lee Atkinson, Tom Hovis, and Randy Magruder Sams, ISBN 0-672-30105-9, $44.95

Great beginnings are not the strong suit of *Paradox for Windows Developer's Guide*. There's a great deal of fat here—in both its wide-margin layout and its content. The authors waste space explaining that they're about to explain something, and the book would have been just fine without their gushing over Borland's database strategies. Several appendixes are equally worthless. Nonetheless, the authors put plenty of beef into the examples that form the core of the book. And examples are what anyone tackling Paradox for Windows will be looking for.



An enclosed disk contains over 6.3 MB of compressed sample databases, programs, scripts, bit maps, and other miscellanea. You'll even find C programs that illuminate the fine art of attaching DLL support routines to ObjectPAL programs. Working through the examples reveals the real worth of the book. Having the live screens on your computer's display is essential, because some of the screen shots don't reproduce well in the book.

As a developer's reference, this book falls short of the mark. As a cookbook of programming examples, however, it's worth perusing. ■

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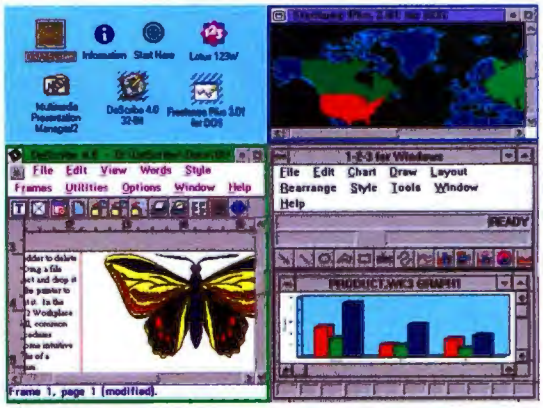

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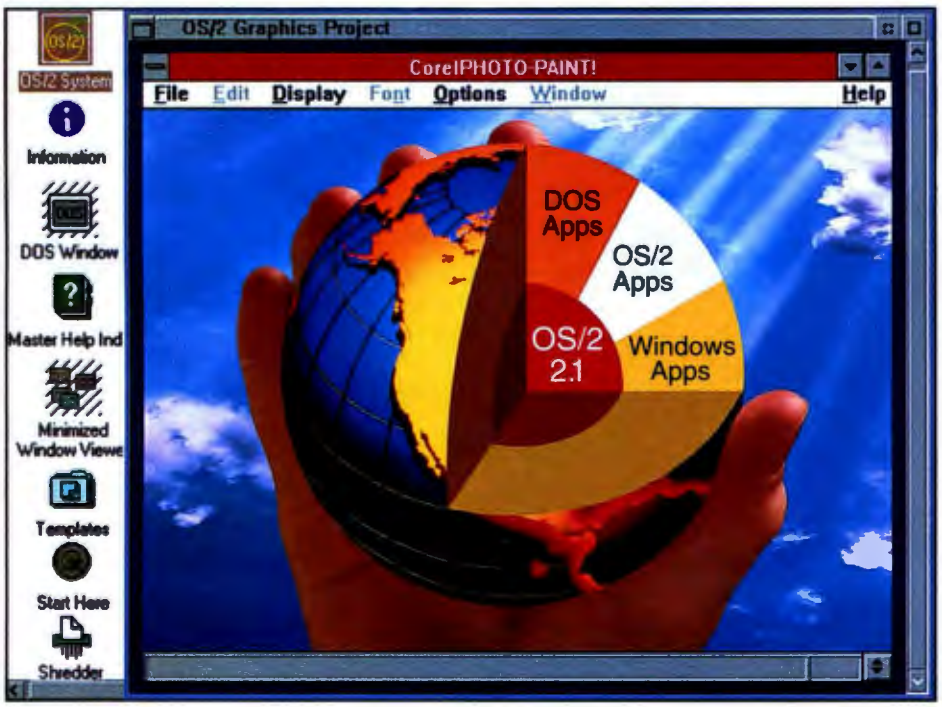

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Cluster PCs for Power

MICHAEL J. GUTMANN

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Every day, more and more MIS managers are downsizing their mainframe and minicomputer applications to client/server architecture. However, big-iron applications sometimes require more processing power than your server can deliver. And applications such as image processing and full-motion video require more network bandwidth than Ethernet or token-ring networks can currently provide. To overcome the barriers to using such applications, you can try a relatively inexpensive network design approach called a PC cluster.

A PC cluster uses a small, high-bandwidth network to group together high-end computers or workstations to serve as a high-capacity extension of your existing network. While an Ethernet or token-ring network typically provides you with file- and resource-sharing capabilities, a PC cluster is used for problem-solving applications, making it more of a distributed system than a computer network.

Do you need more processing power? How about more network bandwidth? You can turn your existing network into a PC cluster.

Physically, a PC cluster resembles a standard network, but instead of 10-Mbps Ethernet or token-ring topologies, you use a 100-Mbps network to loosely couple your high-end workstations. The combined processing power of the clustered computers and the high-bandwidth interconnection creates a large server capable of processing applications that were once beyond the scope of your server and network. The novelty of a PC cluster is that it lets you exploit intermachine connections for special-purpose, multiprocessor, and network-intensive applications, such as image processing and full-motion video.

Since you build a PC cluster around the computers that you already have, your existing software runs on it without modification, and your program development team has a familiar platform with which to write new applications. It also saves you money. For example, rather than replacing your low-bandwidth network, you can continue to use it for client systems and such operations as database processing and E-mail. The PC cluster connects to the low-bandwidth client network through standard network interfaces on cluster machines, allowing the systems on the client network to obtain access to cluster data.

Three key components are necessary for building a PC cluster. The first is any type of network that is capable of a sustained 100-Mbps data transfer rate, such as a fiber-optic network. Second, you need a computer that has sufficient bus bandwidth to handle distributed CPU processing and to drive the network. Finally, you must have software to control network and PC-cluster data transfers. A 33-MHz 486-based computer augmented with an IEEE 1296 bus would satisfy the computer criterion, but the PC-cluster concept is applicable to a variety of microcomputer platforms

WHAT'S A PC CLUSTER?

A PC CLUSTER IS a network design that creates a large server by linking workstations through a high-bandwidth network.

A PC CLUSTER IS a way for you to downsize complex applications that were once too huge for your server to handle.

A PC CLUSTER IS built with the computers you already have, giving you a familiar development platform that runs your existing software.

A PC CLUSTER IS a development platform for multiprocessor applications that take advantage of high-speed networking.

A PC CLUSTER IS a high-powered, high-speed extension of your existing network that specializes in problem-solving applications.

operating in the client-server environment.

Bus Bursts Data

The IEEE 1296 bus, also called the Multibus II, is well suited for building a PC cluster. The Multibus II is a 32-bit synchronous bus with parity and designed with stringent electrical and mechanical specifications, making it highly reliable. Because it is so reliable, you can load it with processors and peripheral controllers and not have to be concerned with unwanted interactions resulting from electrical interference.

The Multibus II features backplane message passing, which, due to its efficiency, lets you build a high-speed, compact network. Configuring a system around the Multibus II is simple, because the message-passing interface decouples CPUs from data transfer overhead, resulting in a 320-Mbps data transfer rate without any intervention by the central processing unit. As a result, its overall speed is sufficient to drive the PC cluster's high-bandwidth interconnection as close as possible to its physical limits while also avoiding excessive CPU overhead, which would slow down system performance.

Transport Protocols

FEATURE	BENEFIT
Transfers small control and interrupt messages	Keeps intermachine communications efficient by sending status signals rapidly
Transfers data messages as small as 20 bytes and as large as 16 MB	Moves data at high speeds without software overhead or CPU fragmentation, preventing network-performance slowdowns
Connectionless mode and low-overhead transaction management; supports out-of-order responses	Makes it easy to write applications and disk drivers; applications can be partitioned over cluster CPUs
Asynchronous interfaces with nonspecific and specific buffer preposting	Gives you a NetBIOS-like interface and flexible buffering; eliminates copying data blocks

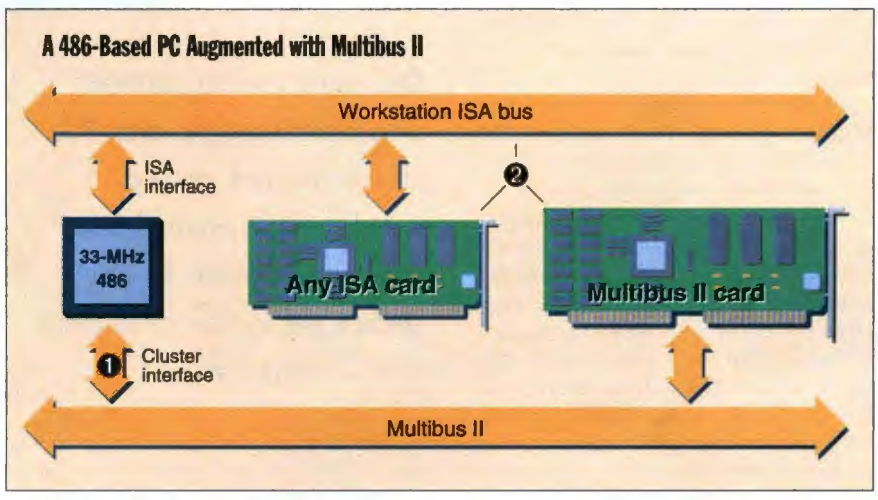
The Multibus II backplane can support up to 21 processor cards, so you can tailor it for specific applications. Because of the decoupled, packet-switching nature of its message-passing protocol, concurrent I/O transfers at the local cards' maximum bandwidth are possible. This makes for an attractive I/O environment. You could, for example, load up the Multibus II with serial communications cards and build an enormous modem server at a cost of about $200 per communications port.

A computer built in compliance with the IEEE 1296 format enables you to construct compact PC clusters. For example, you can fit 16 such computers into an enclosure no larger in volume than one or two tower computer cases. Further, if you incorporate a workstation computer into the backplane chassis, you can use it as a front end to other chassis cards, such as the CPU and I/O modules, without additional external cabling and packaging.

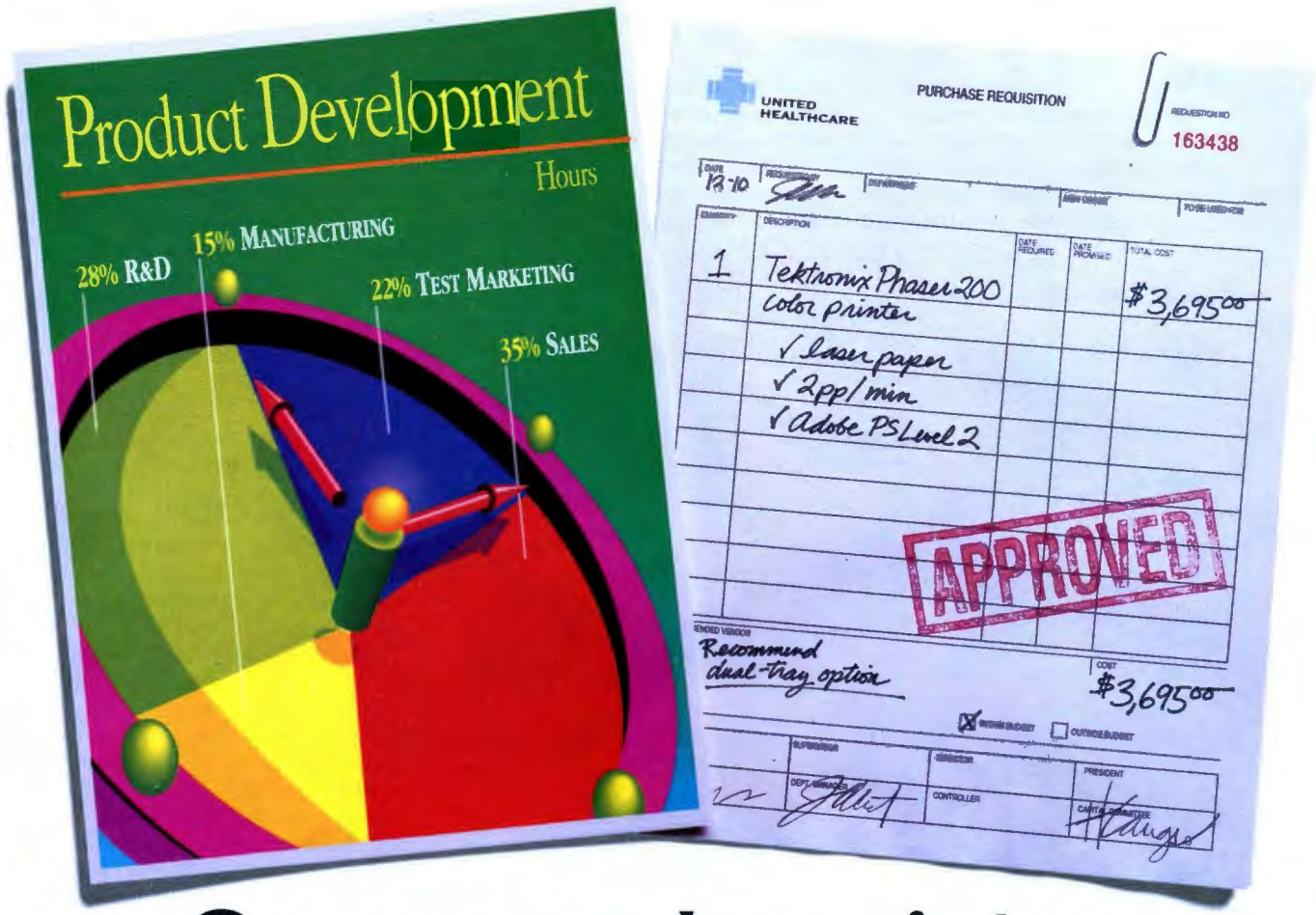
Communication Controls

To ensure that the computers in your PC cluster are able to use their high-speed interconnection effectively, your PC-cluster intermachine software must use a data transfer protocol based on the bus backplane message passing. Such a protocol is said to be "lightweight," meaning it's not CPU-intensive or laden down with transfer management functions.

The transfer protocol will let you transfer both small-block (i.e., blocks as big as 20 bytes) and large-block (i.e., blocks as



PC-cluster interface software ❶ *decouples the CPU from transfer overhead and uses a backplane message-passing protocol, enabling concurrent I/O data transfers at maximum bandwidths.* ❷ *A workstation's ISA bus doesn't have sufficient bandwidth to push data fast enough for I/O-intensive operations. But under applications-software control, a 320-Mbps Multibus II bus can assume I/O-intensive operations. Routine system tasks are left to the ISA bus.*



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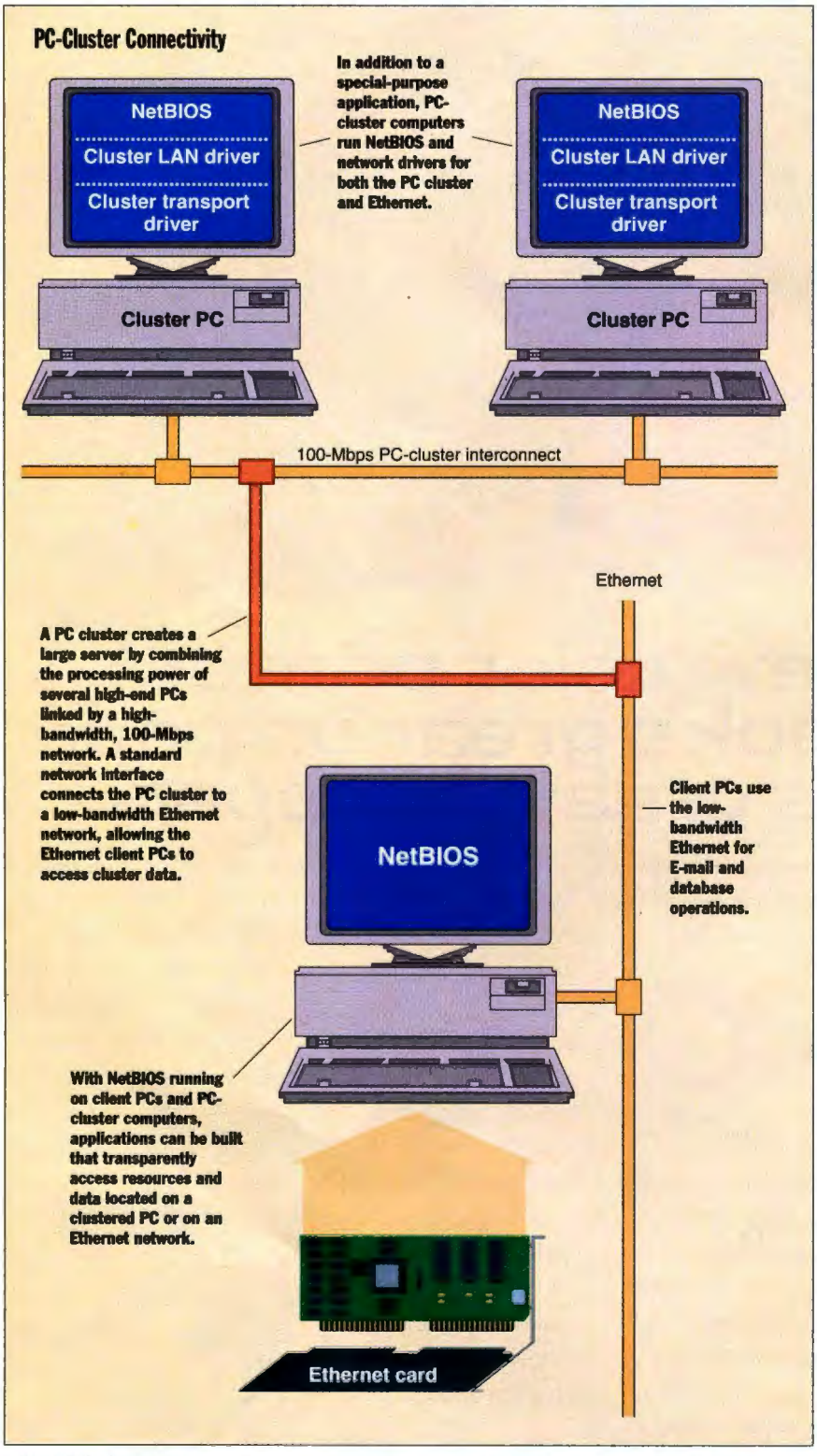
big as 16 MB) data messages directly to or from the transport-application buffers. It must do so without CPU intervention and at the 320-Mbps Multibus II backplane data transfer rate. Its transaction mechanism must support out-of-order responses and asynchronous interfaces with nonspecific (i.e., a pool of buffers) and specific (i.e., a designated buffer) preposting capability.

When designed in this manner, the transport protocol lets you build applications that are partitioned over your cluster CPUs. This means that you can use the transport protocol for those parts of an application that require high-bandwidth communications, leaving routine network operations to be handled by NetBIOS.



A NetBIOS interface *permits applications to transparently access a computer in the PC cluster or a computer residing on an external network.*

For example, you can design an OCR scanning application in which only the large-block images are transmitted over the PC cluster and the rest of the data is sent via Ethernet. A typical Ethernet network fragments data into small blocks before shipping them across the network. The larger the OCR application's image, the more data Ethernet has to chop into blocks, and the more blocks it has to ship. These operations degrade performance, because they monopolize your CPU and choke your network bandwidth. But a PC cluster can send the OCR application's images in one large block over the high-speed connection, freeing the CPUs and Ethernet for other jobs.

Using a PC-cluster design, you could build the OCR image-processing system using as few as nine 486-based PCs to process, compress, and store scanned images, and you could use one PC to act as a file server (assuming that an uncompressed 600-KB image requires approximately 3 seconds to compress on a 486-based computer and that three images must be processed every second to keep up with the scanned image input). The large-block transfers to the file server's SCSI disk array and across the PC-cluster interconnection would free up enough bandwidth so that the file server could feed the systems executing the compression algorithms at a pace that would satisfy the application's requirements.

Furthermore, you could build a network video server capable of serving eight clients simultaneously. Your base would be a 486 computer equipped with up to four SCSI connections, multimedia technology (e.g., DVI) to decompress video files, and up to 60 GB of storage for a 1000-clip video database (1 MB gives you 5 seconds of playback). Exploiting the cluster's large-block transfers, uninterrupted 200-Kbps (which is the minimum for high quality) video streams are possible.

A scalable video server can be built with a cluster of individual computers with one or more Ethernet and SCSI controllers. The 100-Mbps interconnection would satisfy client requests to the video database. The maximum bandwidth of the SCSI or cluster interconnection determines the number of simultaneous clients (an expected situation in, say, educational applications). The cluster lets your video server scale at both the client and video-storage interfaces. Adding a PC to the

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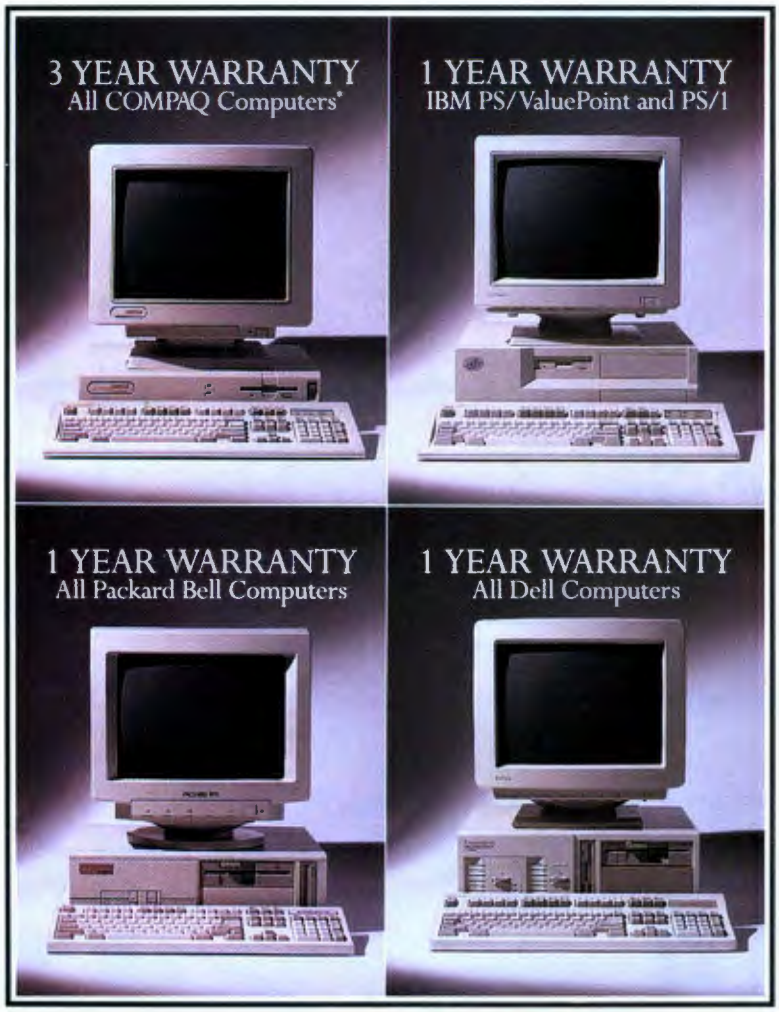

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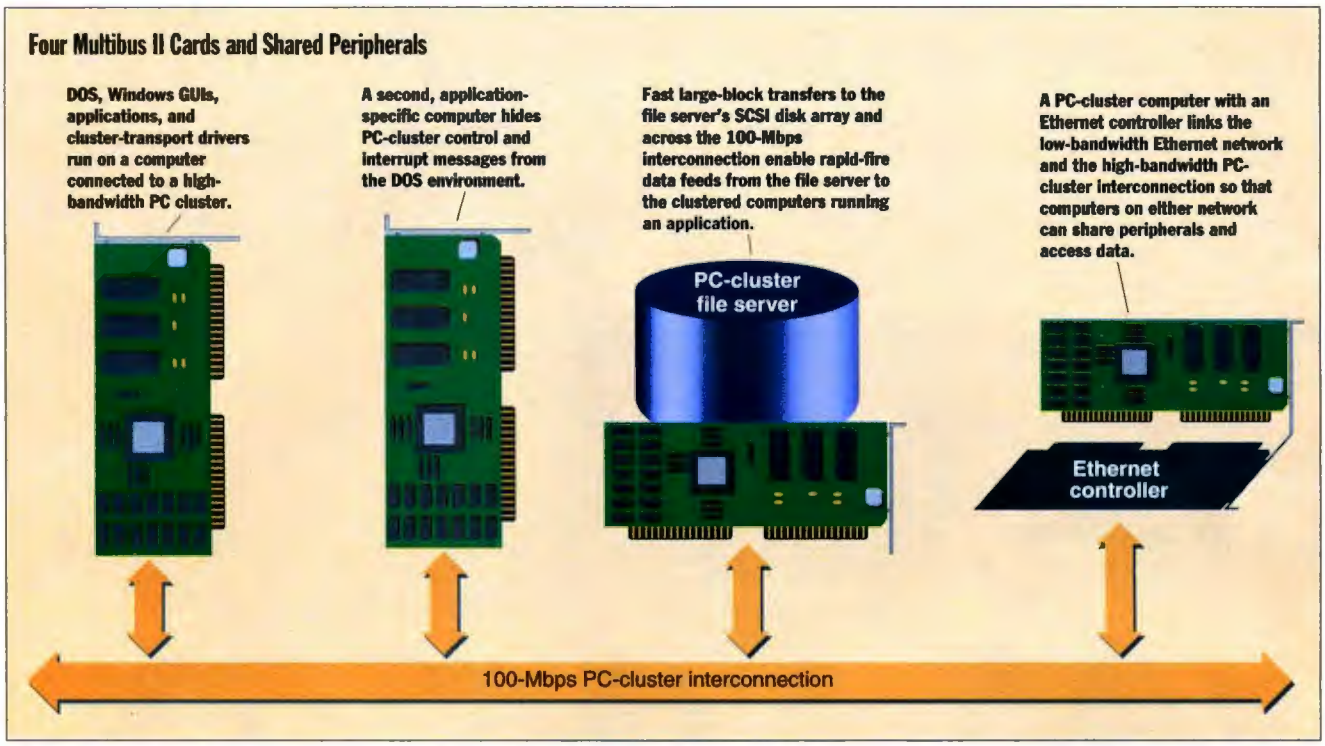

On a PC cluster. *PCs can share bus peripherals. Cluster NetBIOS support redirects hard disk accesses to the cluster PC that runs the file server.*

cluster gives you more Ethernet segments or disk capacity.

Standard Network Support

As mentioned earlier, your existing network must interface with the PC cluster without modification. Thus, your PC-

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cluster DOS software needs a NetBIOS interface to ensure that your applications can communicate across the PC-cluster backplane just as they do over a standard PC network. A NetBIOS interface also permits applications to transparently access another computer in the PC cluster or one residing on an external network.

Intel offers OEMs PC-cluster DOS software with a control-block interface that's similar to the NetBIOS NCB (network control block). Its MPCB (message-passing control block) is passed via a software interrupt to the message-passing driver, and the MPCB uses the NCB's asynchronous notification-routine technique to return completion status and to deliver newly received messages. If you're familiar with the NCB interface, you'll be able to work with the MPCB interface easily.

A Windows/NetBIOS interface allows you to use Windows DDE protocols between computers in the PC cluster. You can extend the Windows environment with a Windows process to field DDE messages and route them over the network as needed. Because the DDE router is a NetBIOS application, it runs across any network that supports the NetBIOS interface.

A PC-cluster NetBIOS interface also allows DDE-capable Windows applications to run across a PC cluster. This application environment lets one or more computers in the PC cluster perform an application-specific function and pass user-interface data to another system that executes the GUI. If the front-end computer is part of the PC cluster, you can create embedded applications that do not require external cabling or packaging of the operator's system.

Sharing Cluster Resources

A PC cluster can share a single keyboard, monitor, and drive, a plus in terms of cost and ease of use. Cluster PCs can also share a single backplane Ethernet controller or a serial communications controller. A diskless DOS-boot capability lets you boot up diskless PCs across the backplane.

Your PC-cluster software should support the sharing of Multibus II disk and LAN controllers and bus peripherals. Use NetBIOS support to redirect hard disk accesses to the computer in the PC cluster that functions as the file server.

A keyboard and monitor redirector can also be included in the cluster software. The redirector would use the PC-cluster transport to carry out its operations.

Future Applications

Currently, Intel's PC-cluster software supports DOS text-mode graphics programs. But given the bandwidth of the PC-cluster interconnection, it should be possible to support bit-mapped graphics across the backplane as well. This could change your concept of console monitoring and control. Bit-mapped graphics would let you observe activities on other Windows-based systems linked to your backplane. Further, you could manipulate those machines through Windows on your machine. Thus, instead of Windows-based virtual machine multitasking, you would have true multimachine multitasking capabilities.

Since the PC cluster's design is based directly on existing CPU cores, you'll be able to adapt your PC-cluster hardware and software to evolving industry trends. Additionally, the size and scope of the applications that you can develop for use with your PC cluster will also follow those trends. ■

Michael J. Gutmann is a software engineer with Intel Corp. (Hillsboro, OR). You can contact him on the Internet at Mike_Gutmann@ccm.hf.intel.com.

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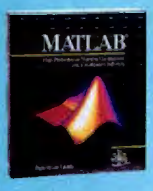

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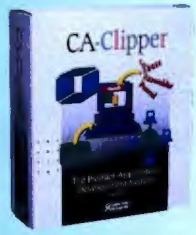

Yes, the newly released CA-Clipper version 5.2 is being offered to Xbase language product owners at the low retail price of $199. This competitive upgrade is available for a short term only! What a great opportunity to get the power of CA-Clipper, at a super price! And now when you buy, get your choice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

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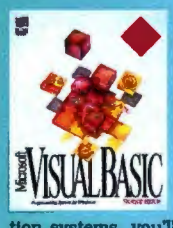

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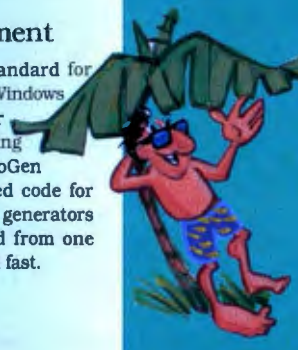

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Data from the Depths

BEN SMITH

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Acquiring data from the ocean reveals a trend: programmable devices that operate independently of personal computers

Data acquisition in a controlled environment is a challenge all its own, but when the sensors are 400 meters below the surface of the ocean and towed by a research ship off the Azores, a new set of challenges arises. Even though the data acquisition methods used by WHOI (Woods Hole Oceanographic Institution) are distinctive, they are applicable to several other data acquisition problems and reflect a new trend in data acquisition systems. A number of sites are relying on small, programmable data acquisition systems that operate independently of computers.

Ocean Currents

This case study covers a small part of the large and complex Subduction Experiment sponsored by the Office of Naval Research. As the Gulf Stream crosses the Atlantic, it bends clockwise—a phenomenon caused by the Coriolis force (i.e., the whirl in fluids resulting from the earth's rotation)—and generates strong oceanic currents. The Subduction Experiment, a three-year study of these currents and their effect on the weather, covers both oceanographic and meteorological data collection in an area covering more than 1 million square kilometers. It involves a number of other research institutions besides WHOI.

Subduction is the process of one earth plate sliding beneath another. In much the same way, one ocean current layer can slide beneath other layers. By understanding where and how subduction occurs in ocean currents, researchers can develop a better understanding of the currents and the weather in general.

The Subduction Experiment incorporates three studies. The first study is of the large-scale structure of wind and thermal forces, as well as the upper ocean responses to these. The second study is of the mesoscale structure of the velocities and directions of mixing currents and the currents' vortices. The third study is of the currents and thermal front that occur off the Azores.

There are three primary instruments to the Subduction Experiment. The third is the focus of this case study:

- Moored instrument buoys—these record meteorological and surface conditions and collect information from the water that flows past them at different depths.
- Free-moving buoys—some record their position as they drift with the current at a depth of 300 m; others float near the surface, and a satellite tracks them; and some regularly come to the surface to transmit data to a satellite and then dive to various depths to collect more data.
- The Seasoar (manufactured by Chelsea Instruments, Surrey, U.K.)—this towed vessel has on-board sensors that collect a vertical cross section of CTD (conductivity, temperature, and depth)

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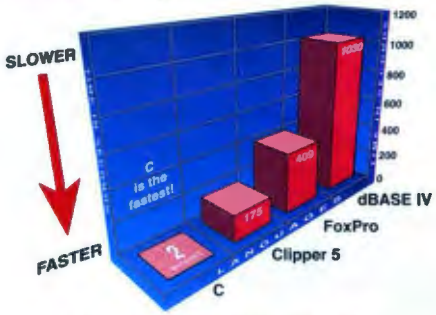

"Sieve of Erastothenes"
Benchmark for Prime Number Generation
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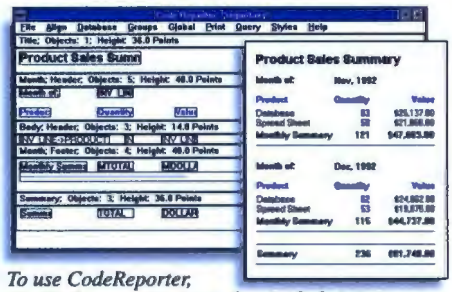

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data and the data of the Seasoar itself. For its sensors to collect data in this way, the Seasoar oscillates between a depth of 400 m and the surface as it is pulled behind a 170-foot research ship at 8 knots. Because the movement of the currents at a thermal front includes a vertical component as well as a horizontal component, the Seasoar is necessary to gather data for the study of this complex, 3-D activity. Without a continuously collecting vessel like the Seasoar, a ship would have to make frequent stops and lower a sensor to collect the data at different points and depths along the grid. The data collected with the Seasoar, combined with the data from an Acoustic Doppler Current Profiler (on-board the ship) and from monitoring the diffusion of a short-lived tracer (radon-222), provides a clear, multisensory picture of what the currents are doing in the complex region of the Azorean front.

Rough Seas

The Seasoar consists of a hydrodynamic case, roughly 0.4 m in diameter by 1 m in length. Its overall length is approximately 2.5 m. It includes a towing bridle at the bow, an impeller and stabilizer fins at the stern, and wings on either side of the instrument case. Its sensors and electronics are in pressure-tight tubes inside the instrument case.

PAUL "LUIGI" FUCILE

handled the details of devising a data acquisition module for the Seasoar. He designed the solution around an off-the-shelf, self-powered, data-logging board, the Tattletale 4A.

TOM KLEINDINST / WHOI © 1993

Fortunately, the CTD data acquisition system in the Seasoar uses standardized oceanographic sensors. Unfortunately, there is a problem obtaining the operations and engineering data used for monitoring the operation of the Seasoar itself and determining its exact location at all times.

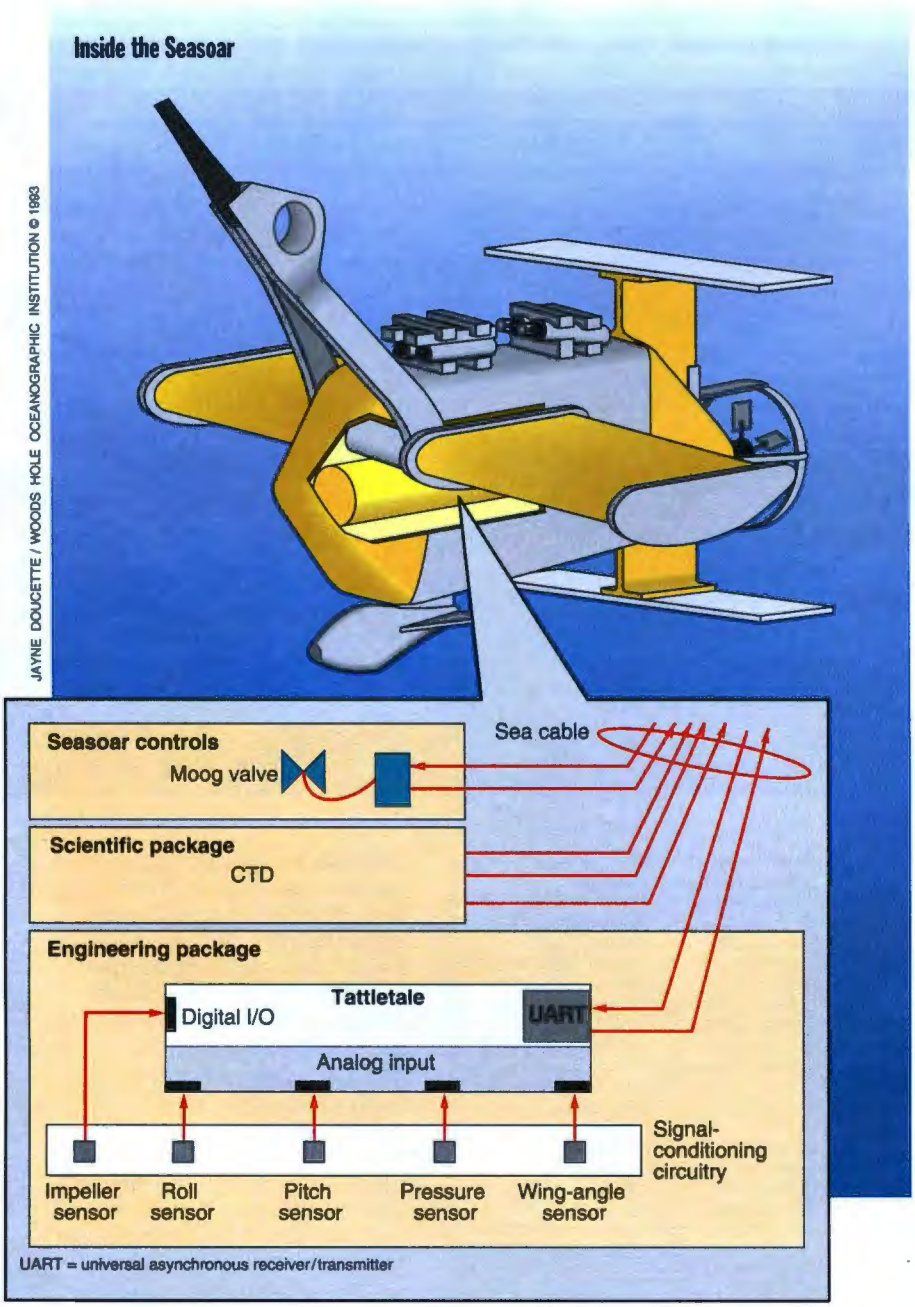
The Seasoar determines its depth by adjusting the angle of attack of its wings. An impeller-driven pump at the back of the unit hydraulically powers the wing rotation. An electronic valve (i.e., the Moog servo valve), which is part of an on-board analog-depth-sensor feedback loop, controls the hydraulics. A panel on the deck of the ship controls the depth and frequency of the Seasoar's dives.

The exact orientation of the Seasoar is actually unknown. At times, the Seasoar had problems in performance when it was near the surface and at the bottom of its dive. Only two weeks before the Seasoar was due to leave port, the WHOI project team decided to add a second data acquisition system to the Seasoar, to better control its performance. This was a problem for the design team.

The Design Team

The success of a project depends on the planning that goes into it. WHOI excels at planning and engineering. It has support engineers as well as oceanographic scientists, and all specialize in oceanography. The support engineers must also perform tasks that relate to fields ranging from fluid dynamics to computer design. It takes a seaworthy party of scientists to run an oceanographic cruise, and a multidisciplinary team to solve problems before the cruise.

The first member of the design team is Jerry Dean, a research specialist and a



JAYNE DOUCETTE / WOODS HOLE OCEANOGRAPHIC INSTITUTION © 1993

The Seasoar *contains a control module and two data acquisition components: the scientific package for logging CTD data and the engineering package for determining the Seasoar's status.*

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that adapts to multiple environments.

pike. More operating systems? No problem. As your network system continues to evolve, the capabilities of this printer are no longer just impressive. They're indispensable.

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HEWLETT PACKARD

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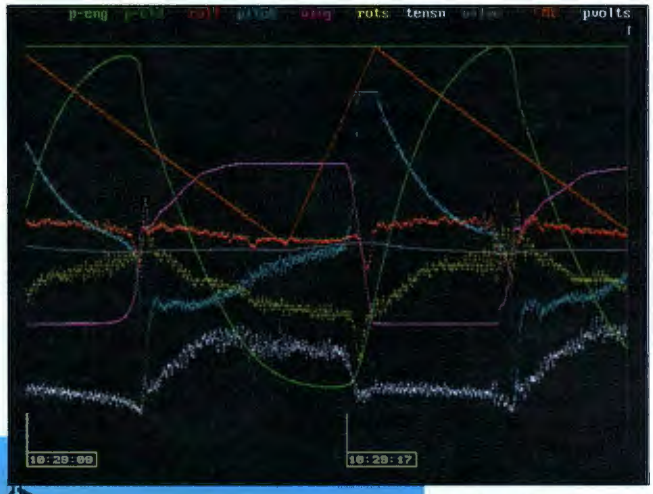
WHOI engineer on the Seasoar project. He focuses his work on oceanic and marine meteorological sensors for moorings and buoys and on the free-drifting, acoustically tracked ocean-current meters that are part of the Subduction Experiment. Dean knew that with specific information on the Seasoar's roll and pitch, wing angle, and depth pressure, and the rotation rate of its impeller-driven pump, he could determine the Seasoar's exact position. In addition, the information could determine the cause of the performance problems.

Constraints were formidable. Electronics and a power source had to fit in the small, pressure-tight instrument tube inside the Seasoar. The budget for collecting data for Seasoar control was small. The design team had to find an inexpensive solution quickly. The problem of working out the details was handed to Paul "Luigi" Fucile, Dean's circuits expert. Fucile's solution was simple and inexpensive, and it fit in the Seasoar's constrained space. Dean called this new data acquisition system "the engineering package."



A QuickBasic program *on the shipside personal computer displays the engineering data as it is sent up from the Tattletale 4A inside the Seasoar. Some of the data comes from the shipside Seasoar control, and some may come from the scientific sensors. Note the delay between the voltage sent to the Seasoar Moog valve (CMD) and the actual depth as shown by pressure (p-ctd or p-eng).*

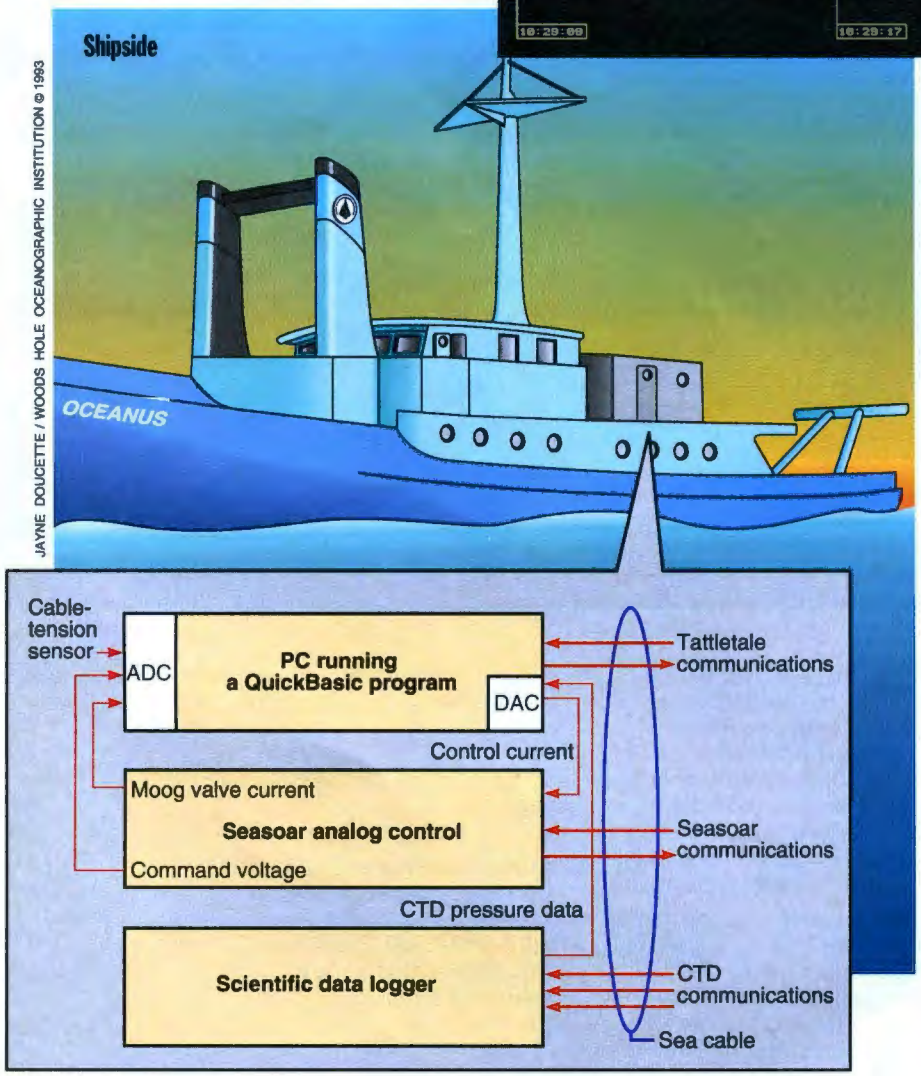
Calmer Waters

The engineering package was designed around an off-the-shelf, self-powered data-logging board (see "Small, Portable Data Acquisition Systems"). This design approach represents a trend in data acquisition: taking the data-collection component off large computer systems and placing it directly on a measuring device. In this case, Fucile used a Tattletale 4A from Onset Computer. The Tattletale offers eight 12-bit A/D channels, 18 programmable digital I/O ports, and a three-wire asynchronous serial port for communications and control. It measures 5.7 by 9.46 centimeters and consumes 2 to 15 milliamperes at 5 V in active mode, and only 30 microamperes in sleep mode. The Tattletale's data acquisition and control functions are programmed in TTBASIC (Tattletale BASIC) through a serial port with a terminal or a serial-communications program. It also has 32 KB of RAM, backed by a lithium battery. TTBASIC resides in 16 KB of ROM.

Fucile used only four A/D ports and one digital I/O port for his data channels. He built the signal-conditioning electronics using wire-wrapped components on a board (supplied by Onset) that plugs directly into the Tattletale's piggyback connectors.

The pitch and roll sensors are electrolytic fluid inclinometers. The pressure is measured with a load cell that incorporates its own amplifier. The wing angle is measured with a linear potentiometer and voltage divider. A magnetodiode sensor determines rotation speed by tracking tiny magnets that are cemented to the impeller blades. The data coming from the sensor is a digital signal; therefore, it doesn't need an A/D channel.

The BASIC program on the Tattletale controls the power to the sensors, measures and keeps a running average of the



A personal computer on-board the research ship *takes the ASCII data coming into the serial port and plots it as five separate curves representing the five elements of data. In addition, the program sends pressure data out through an A/D converter to the shipside Seasoar controller, thereby eliminating the need for the Seasoar depth sensor.*

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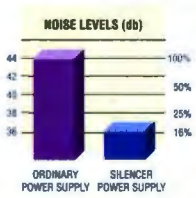

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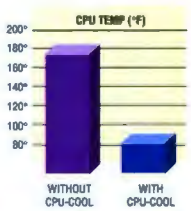

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Feature

Small, Portable Data Acquisition Systems

HOWARD EGLOWSTEIN

One trouble with data is that the interesting stuff never seems to be near a laboratory bench. Your network is having difficulty with packet collisions from time to time; what's the network load as collisions reach their worst? Or say you raise dairy cattle and want to monitor each animal by tagging it with coded markers and weighing it as it passes through a gate.

You could design specialized hardware for these tasks, or you could run power to the remote site and use a standard personal computer. A better option might be a low-power dedicated controller or data logger. These critters are inexpensive and come ready to run with data acquisition and control hardware built in. You can put them anywhere, program them to do just about anything, and then connect them to a standard personal computer to extract the logged data for analysis. The following text describes my experience with two of them—Blue Earth Research's Micro 440 and Onset Computer's Tattletale 5LCD.

Blue Earth Research's Micro 440 (left) features a 12-MHz processor, eight 8-bit A/D channels, two serial ports, 32 KB of battery-backed RAM, a real-time clock, and 14 digital status and control lines. A customized version of BASIC runs the show. The Tattletale 5LCD runs off a Hitachi 6303 processor and comes with a serial port, digital I/O lines, EEPROM for storing program configurations, and a customized BASIC interpreter. As with the Micro 440, you connect the Tattletale to your personal computer and write your control program in BASIC or assembly language.

Micro 440

Blue Earth Research's Micro 440 is smaller than a radar detector and weighs only a few ounces. Under the hood, you'll find a 12-MHz processor, eight 8-bit A/D channels, two serial ports, 32 KB of battery-backed RAM (good for 10 years), an RTC (real-time clock), and 14 status and control lines. A version of BASIC runs the system.

The Micro 440 runs from a single power supply of 7 to 16 V at 75 milliamperes. Connectors at either end of the case provide connections for power, serial lines, data lines, and external memory or other peripherals. For simple analog data acquisition solutions, you merely provide the Micro 440 with power and your signal. For control applications, you'll need to add appropriate interface hardware to the TTL-compatible data outputs.

The processor in the Micro 440 is an Intel 83C51B, an enhanced 8051. Blue Earth's BASIC is an unusual dialect of BASIC, with extensions for the Micro 440's hardware and easy access to assembly language.

The Micro 440 connects to your development environment through one of its two serial ports. You run the BASIC interpreter and enter your program directly into Micro 440 RAM. For assembly language programming, the resident monitor/debugger provides an assembler and debugger. Talking to the RTC, ADC (A/D converter), or I/O hardware requires memory-mapped I/O.

Our Micro 440 came with the Application Module (with a speaker, a potentiometer attached to one A/D channel, and a seven-segment display) and the ST-I/O module (with all analog and digital ports brought out to convenient screw connectors). I used the ST-I/O module and the Micro 440's built-in

frequency of pulses coming from the magnetodiode sensor, converts all the data to ASCII character strings, and sends the data up to the ship through the Tattletale's RS-232 port. Serial communication with the ship uses just three conductors on the cable running from the Seasoar to the ship.

On the receiving end, a personal computer running a QuickBasic program (written by Jim Luyten, the head of the Physical Oceanography department) takes the ASCII data coming in through the serial port and plots it as five separate curves representing the five elements of data. The program also sends raw data to a disk file and sends the pressure data out through an ADC (A/D converter) to the shipside Seasoar controller, thereby eliminating the need for a preexisting Seasoar depth sensor.

All that's needed to test or modify the Tattletale's program is a personal computer with a simple communications program, such as Procomm Plus. Modifications of the program can take place while the Seasoar is 400 m below the ship.

The Tattletale uses far less power than do the sensors connected to it. It can store the data in its battery-backed RAM rather than send it back to the ship; however, since scientists use the data to monitor and control the activity of the Seasoar (and hence must collect it in real time), the Tattletale hasn't needed to use its on-board data storage.

Design Evaluation

Although the design used only a small subset of the features of the Tattletale 4A, its simplicity and flexibility and the speed of its development far outweighed the parts-cost saving of not having to build a 6805/ROM-based system (an architecture with which Fucile has substantial experience).

Several data acquisition engineers may wonder why certain elements turned out the way they did. For example, Fucile and Dean could have beefed up the RS-232 communications by using higher output circuits than those on the Tattletale or using the RS-485 instead of the RS-232, but this approach would have required more hardware. Instead, they opted to use parts on hand, including parts salvaged from earlier projects. In many places, they could have used a more suitable part, but they chose not to order a new part if they had something on the shelf that could do the job.

PWM (pulse-width modulated) command to try a simple feedback/control solution.

I started with a one-tenth-scale radio-controlled electric car, an Associated RC10. The servos commonly used in these cars require a pulse train to position the motor. A single pulse of varying width sets the motor position; this pulse repeats every 16 milliseconds. I disconnected the steering servo from the car's radio and connected it through a buffer to a single output pin from the Micro 440. The Micro 440's BASIC command PWM provides easy, precise control over the pulse output while the ONTIME statement provides accurate interrupt-driven time control from within BASIC. Three or four BASIC statements were enough to generate a stable pulse train as a background process. To this, I added a control loop.

Three photocells mounted to the front of the car watched the ground. I put one in the center of the car and the other two by each of the front wheels. Each of these connected through a voltage divider to one of the Micro 440's A/D channels.

I placed the car over a white stripe painted on the ground. A BASIC program monitored the relative brightness of the stripe and the surrounding pavement and adjusted the pulse width to keep the car centered over the stripe as it moved. The whole project took just a few hours, thanks to the excellent documentation and easy access to the I/O ports.

Tattletale 5LCD

The Tattletale 5LCD from Onset Computer is one of a family of data-logging computers. The Tattletale 5LCD runs off a Hitachi 6303 processor and comes with a serial port, eight digital I/O lines, eight 12-bit analog input lines, EEPROM for storing programs and configurations, and a customized BASIC interpreter. As with the Micro 440, you connect the Tattletale 5LCD to your personal computer and write your control program in BASIC or assembly language, or both. When you're ready to go to the field, you store the program in the Tattletale 5LCD's permanent program storage (i.e., EEPROM on the Tattletale 5LCD; hard drive versions are also available).

The Tattletale 5LCD I reviewed included eight 12-bit A/D channels, 512 KB of data storage, an LCD, and three front-panel buttons. Unlike the Micro 440 and the Tattletale 4A that the Woods Hole Oceanographic Institution uses, the Tattletale 5LCD doesn't have a lithium battery for data retention, although you can load your program into the EEPROM. Onset targets the Tattletale 5LCD for unattended data-logging applications. The Tattletale 5LCD's A/D channels have better resolution than the Micro 440's and more RAM to store the logged data. The Tattletale 5LCD needs only 20 mA to run and a mere 3.5 mA to retain its memory in sleep mode.

Onset's BASIC in the Tattletale 5LCD comes in two flavors. The first (TTBASIC) is a conventional integer BASIC with limited variable naming, no arrays, and a requirement for line numbers. I found TTBASIC to be adequate for simple tasks but tedious for developing longer programs. If you're using an IBM PC or a Mac for development, the tokenized version (TXBASIC) uses your desktop PC to pretokenize the program before downloading it to the Tattletale 5LCD. With more resources free to handle your code, TXBASIC gives you arrays, floating-point, and free-form structure using labels instead of line numbers. In addition, you get a primitive multitasking capability for background processing.

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"These designs are intentionally simple," notes Dean. WHOI is more interested in whether a design works in the field than if it is using the most modern technology. The simpler the design, the more likely it is to work in the field. The fewer parts, the more reliable the device. The less complex the software, the more likely there will be someone on-board who can fix or modify it in an emergency. Dean puts it this way: "If it works for us, we stop."

WHOI originally built Seasoar's engineering data acquisition package as a "one-time-use" instrument—to try to answer some questions about the Seasoar's performance problems. But, as is so often the case, WHOI liked having all the data and wanted to use the package all the time. Now it hopes to incorporate an entire control system into the shipside personal computer, making the computer responsive to information from the engineering package.

Dean and Fucile's design cost them less than $500 (not including sensor hardware). It took just a few hours to sketch out and required less than a week to build and program.

Tattletale Applications

The fixed buoy used in the Subduction Experiment is another Tattletale-based system. Tattletales reside in several of the test and calibration systems used in free-moving buoys. In fact, of the 14 major microprocessor-based projects that Fucile has worked on in the last seven years, eight involved Tattletales, including the following:

- Antarctic Lake ice ablation sensor—a sensor that sits in an 8-inch-diameter hole in the ice and measures the change in ice thickness. It is capable of running off its own batteries to record data for two years without maintenance.
- Low-power RS-485-based network—a multidrop/multipoint communications standard used in data acquisition and instrument-control networks. It was used to interface many existing oceanographic instruments without requiring any new (i.e., expensive) electronics.
- Buoy dynamics recorder—an instrument that uses a high-end Tattletale with a hard drive that spins up when needed.
- Automatic geocompass—a device attached to the deep-diving submarine Alvin (the submarine used to explore the wreck

Data Acquisition in the Mainstream

The factory and processing plant, the research environment, and the hospital all use instruments to detect and record temperature, pressure, conductivity, pH, flow, pollutants, and many different variables and values of the physical world. Today, this data collection is done automatically by electronic circuits and computers in place of direct observation and record keeping, thermographs, barographs, seismographs, and other mechanical graphs. Data acquisition is the element of electronics and computing that deals with this automated process.

Subjects related to data acquisition include data analysis, data visualization, and control. At times, the three fields are so closely integrated that they exist in a single appliance. Consider an electronic digital thermostat for your home. It has a sensor (a thermistor), an ADC (A/D converter), a digital clock, and some buttons for you to set the temperature range and associated times. In addition, the thermostat has the circuitry for taking all this data and deciding whether your furnace or air conditioner should be on or off. The data acquisition part of the electronic thermostat consists only of the sensor and the A/D circuits.

In data acquisition systems, the sensors are specific to the application. Often, the sensors are also the most expensive element of the system. You can get a simple thermistor at Radio Shack for less than a dollar, but a high-precision electronic strain sensor can cost hundreds or even thousands of dollars.

Sensors are categorized as either active (i.e., they produce a current or voltage) or passive (i.e., they change in resistance or capacitance). Signal-conditioning circuitry converts any device's output to a voltage that is within the range of sensitivity of the ADC (usually between 0 and 5 V). Conditioning circuits often use voltage dividers or operational amplifiers to do their work. Some A/D boards have adjustable gain amplifiers built in.

The resolution of a data acquisition system is determined by the number of bits that its ADC provides. For example, an 8-bit ADC can give you only the nearest degree of temperature ranging from +128 to -127, but a 12-bit ADC can give better than the nearest tenth of a degree.

of the Titanic). When the arm touches a face of the underwater geological formation, the geocompass records the *strike* (i.e., the geographical orientation) and *dip* (i.e., the angle) of the feature.

Designs vary according to application; in some, the data is sent out the serial port, while in others, it's stored on the system. Most of WHOI's exotic instruments are placed in hostile environments, where it's impractical to have a full-size computer processing the data. In these situations, the data is stored in the instrument, at least until it is beamed up to a satellite. Sometimes the data-storage requirements are on the order of tens of megabytes; for these situations, the designs use Tattletales equipped with hard drives or optical drives that only spin up for a data dump from memory.

Oceanographic instruments are certainly not the only application for autonomous data loggers. By using inexpensive remote data acquisition systems that can communicate with the host computer via a simple asynchronous serial link, you have tremendous flexibility in where you place the data acquisition equipment. You can easily deploy large-area data collection by putting the inexpensive data acquisition systems in a box with a modem and telephone line. A central computer can then poll each data acquisition node once a day or less, upload the data, and reset the node's memory. These little boards have been tucked into the engine compartment of race cars, built into patients' wheelchairs, and used extensively on farms and in production plants. The CIA has even purchased thousands of the devices—although for reasons known only to itself.

Endless Possibilities

Because WHOI gathers most of its research away from land, power consumption is a major design criterion for its research instruments. Fucile has looked at two other single-board data-logging and acquisition systems, but the power requirements of the others made them less desirable. Fucile's summary: "When it came to designing a data-logging engine, Lon Hocker [of Onset] knew exactly what was required: low power, simple I/O, and an operating system that is easy to understand."

The idea of an autonomous intelligent data-logging computer is not new, but it is a growing trend now that these systems are inexpensive. Dozens of manufacturers produce a wide spectrum of data loggers. The price of some of the more elaborate systems can be in the tens of thousands of dollars, but the low-end devices will suffice for most mainstream applications.

Many data acquisition applications are far more complex than the Seasoar. For instance, your application may require higher data-sampling rates and dozens of channels. For the next step up from the Tattletale, Fucile says he would go to a low-power single-chip personal computer. One of many bases for this design is a single-chip personal computer and a PC-104 bus. PC-104 cards measure 9.65 by 9.14 cm and run at 5 or 10 V. Gespac's (Mesa, AZ) PC Light, a typical CPU board, consumes 1 W—compared to an AT's 15 W or more. Still, 1 W is 10 times the power consumption of a Tattletale. With PC-104, additional boards (e.g., a modem) stack above the baseboard, one on top of another, to maintain the 9.65- by 9.14-cm form factor. Six boards stack only 10.16 cm high. At least a dozen data acquisition boards are available for PC-104. But the added functionality of a general-purpose PC-on-a-chip demands far greater complexity and cost, as well as a greater source of power.

No matter what your needs are, the goal for data acquisition has always been the same: Make it accurate. With autonomous data loggers, you can also make it convenient, simple to build and modify, durable, and inexpensive. ■

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Cover Story

PENTIUM

CHANGES IN THE PC

PAUL AVIS © 1993

ANDY REINHARDT

The first Pentium systems are here, but you might not want to buy one yet. None are fully optimized for Intel's new chip. This scenario is likely to change with the next-generation Pentium PCs as more vendors make use of high-speed buses, enhanced bidirectional I/O ports, and fast SCSI-based disk subsystems.

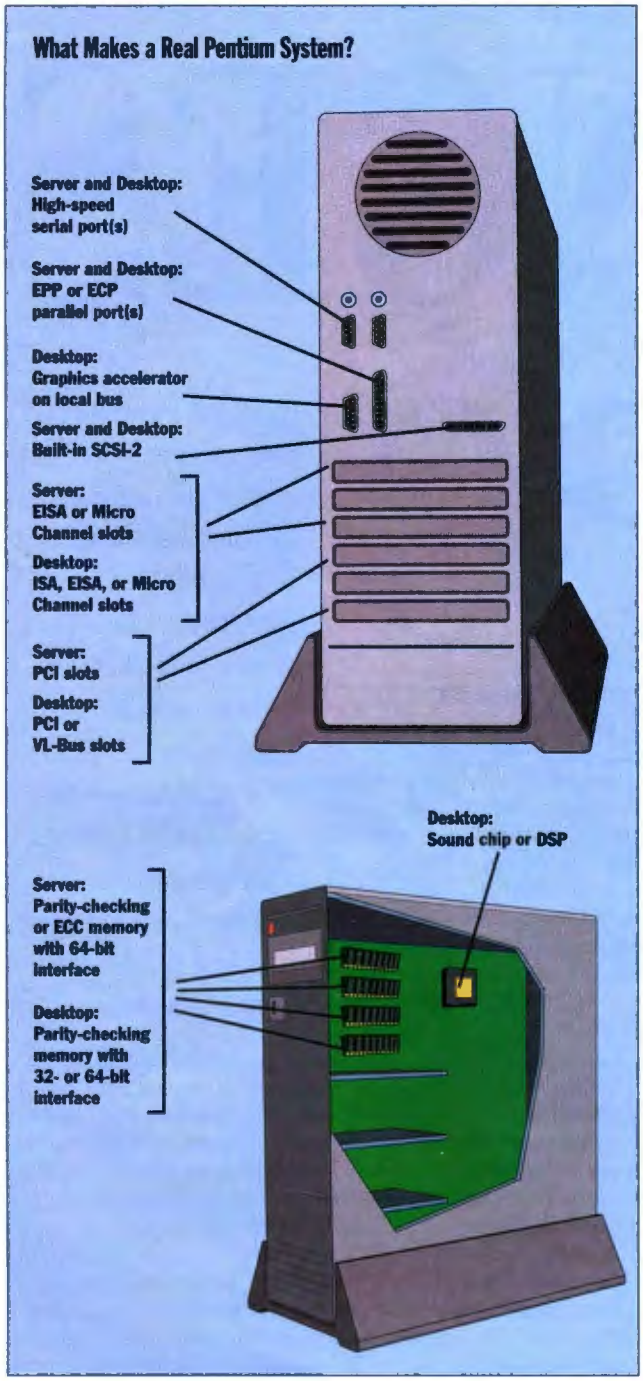
Dropping a 66-MHz superscalar processor into an architecture originally designed around the 8086/8088 chip and an 8-bit I/O bus is like putting a Ferrari engine into a Model-T chassis: The machine moves forward, but it doesn't exactly purr. "Pentium raises the ante for all subsystems," says Larry Shintaku, an R&D project manager for Hewlett-Packard in Sunnyvale, California. To complicate matters, the software environment is poised for change: A half-dozen 32-bit operating systems are set to compete on Intel-based systems, and downsizing from host systems is pushing microcomputers into new and more demanding roles. By borrowing design concepts from mainframes, minicomputers, and workstations—and by pioneering some entirely new ones—vendors are devising next-generation PC compatibles that are significantly advancing the state of the art of microcomputers.

Nowhere is this more evident than in servers. The Pentium is so powerful that it outruns some mainframes in raw compute speed, yet if it's strapped into a conventional PC design, the resulting system won't provide the performance or robustness needed for it to be the center of an enterprise network. To boost critical I/O speed, engineers are using new bus designs and storage subsystems. Equally important, they are harnessing techniques such as redundancy, error correction, and predictive diagnostics to give 80x86 systems the reliability and manageability typical of hosts.

The first Pentium systems don't take full advantage of the new CPU. As with the transition from 386 to 486 systems, old designs are being adapted for use with the faster processor. But in the next year, a growing number of "true" Pentium systems will appear.

The New High End

Initial Pentium systems will be richly configured because vendors assume that the first, most eager buyers are less cost sensitive. According to Tony Tong, product marketing manager for motherboard producer Elitegroup Computer Systems (Fremont, CA), Intel's reference design for Pentium machines "uses higher-performance, higher-cost components and reinforces



an attitude that these will be sexy, no-holds-barred systems."

For example, Pentium systems may offer VRAM-based (video RAM) graphics accelerators, built-in SCSI-2 connectors, CD-ROM drives, or multimedia support via DSPs (digital signal processors) or dedicated audio/video chips. In fact, the arrival of Pentium systems could herald a new baseline for how the market views a "standard" PC, because vendors will pack the systems with fancy features.

Whether these deluxe capabilities will migrate down to the mass market as Pentium systems become more common is open to question. Neal Margulis of video chip manufacturer S3 (Santa Clara, CA) says that by putting such features into systems now, vendors push up volumes and make the features less expensive. "Not much of this stuff will get stripped out once it appears to be standard in Pentium systems," he says. "Customers will no longer want to buy systems without it." Others argue that given the price sensitivity of commodity PCs today, stripped-down Pentium machines are bound to be marketed in the future.

It is commonly assumed that the Pentium will find its strongest initial acceptance as a server platform, but this may be only partly true. "In servers, the Pentium will be overkill for some time," says Mark Garver, vice president of corporate strategy at Tricord Systems (Plymouth, MN), which nevertheless plans to use the Pentium in its ES5000 PowerFrame server. Garver says that Pentium servers will boost network throughput only if there are matching improvements in I/O performance.

On the other hand, database and other application servers used in client/server environments can benefit now from a faster CPU and memory subsystem. "The Pentium is going to mean a lot more to my customers running SQL Server and Notes and Oracle on OS/2 than to my customers running NetWare," says Davis Fields, vice president of marketing for Parallan Computer (Mountain View, CA). Parallan, which is partly owned by IBM, designed the superservers that are sold as the PS/2 Models 195 and 295.

Most of the initial Pentium systems are based on upgradable designs in which the processor/memory complex may be optimized for the Pentium, but the balance of the system is generic to 386 or 486 implementations. "The first generation of 486 systems were patched solutions—a 486 CPU slapped into a box optimized for the 386," says Jim Mathios, an R&D project manager for HP. "The same thing will happen with the Pentium: Right now, everybody is gluing together less-than-optimal systems based on 486 designs." By the end of 1993 or early 1994, however, customers will start to see what Mathios calls "proper" Pentium systems—machines designed from the ground up around the Pentium.

Real Pentium Systems

How to define a "real" Pentium system is far from obvious. One criterion might be a completely 64-bit design, but this is implausible for technical and economic reasons; for example, there's no rationale for a 64-bit version of the ISA/EISA bus. Why add the complexity and cost if some common add-in devices—modems, for instance—can't take advantage of it?

Instead, the Pentium standard will likely combine multiple buses, fast interfaces, and a higher degree of integration on the motherboard than 486 systems. Desktop systems will include accelerated graphics, stereo audio, and other multimedia features. Servers will likely offer high-reliability features, diagnostics, and system management.

One element that may set Pentium systems apart from their predecessors is their memory subsystem. The chip's 64-bit memory interface now operates at 60 and 66 MHz. At these speeds, today's DRAMs require an external cache to keep the processor fed with code and data. Most systems will use caches of 256 KB or larger—probably built from synchronous SRAM (static RAM) chips—to ensure hit rates above 90 percent (see "New Memory Architectures to Boost Performance" on page 86).

With a cache hit rate this high, the path from cache to main memory may not need to be wider than 32 bits; HP estimates that the incremental performance from using 64-bit DRAM could be as little as 5 percent, because the wider bus will help only when there is a cache miss. Given that 64-bit memory can be configured and expanded only in multiples of 8 MB, a 5 percent performance gain may not justify the reduction in RAM flexibility.

But Tom Benoit, business development manager for motherboard maker Micronics

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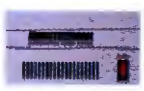

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(Fremont, CA), takes a different view. "Anything with a 32-bit memory interface isn't a real Pentium system," he says. Micronics has implemented 64-bit memory on its Pentium motherboards because it adds no incremental cost, Benoit says, adding that even a 5 percent performance delta can make a big difference to high-end users.

As for emerging RAM architectures, vendors are taking a wait-and-see attitude. For now, traditional hierarchical cache designs can bridge the processor/memory bandwidth gap and cost less to implement. But systems will eventually need faster DRAM to accommodate cache misses.

Hierarchical Buses

Another defining element of real Pentium systems will be the use of a *local* or *mezzanine* bus. A local bus is a direct extension of the processor's lines and operates on the same clock, like the VESA (Video Electronics Standards Association) local bus with the 486. A mezzanine bus is conceptually between a local bus and an I/O bus: Its lines are buffered from the processor's, and its clock can be proportional to the CPU's (i.e., one-half or one-third the speed). "A faster bus is implicit in any system sold today, 486 or above," says Elitegroup's Tong. "The benefits are obvious: For almost no incremental cost, you get much better performance."

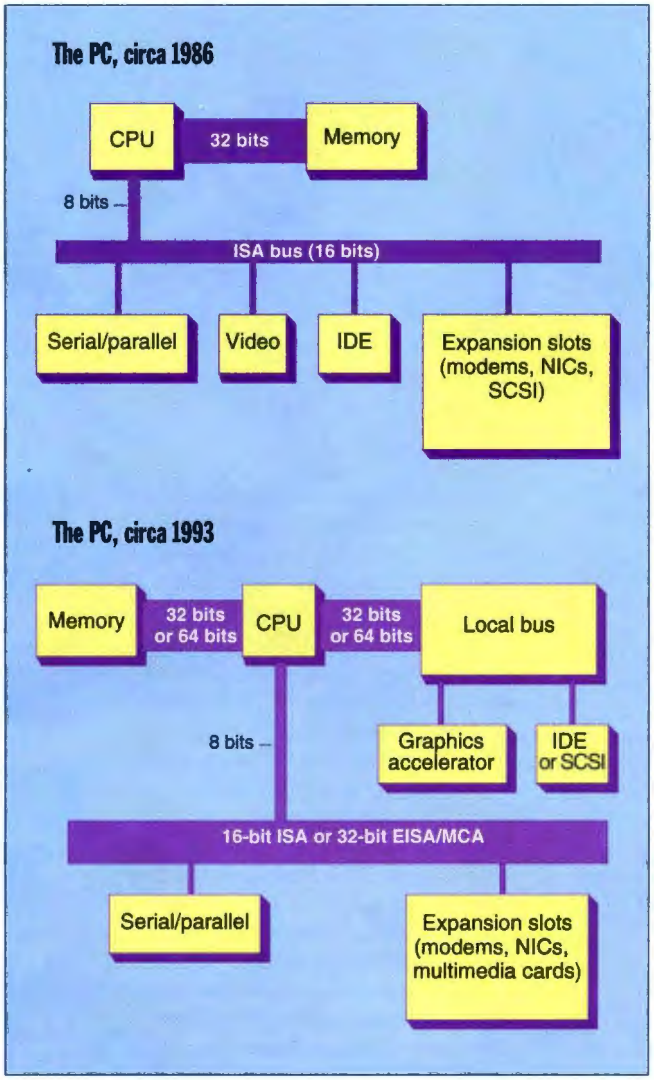
Intel is pushing vendors to adopt its PCI (Peripheral Component Interconnect) specification and chip set for a mezzanine bus in Pentium systems, and most vendors believe the two will become tightly linked. PCI is now specified at 32 bits and operates at half the speed of the Pentium's external clock. The new PCI 2.0 revision adds support for 64-bit addressing and 3.3-V implementations, as well as the first definition of a PCI connector slot for add-in cards. Use of PCI among system makers will get a boost late this year when VLSI Technology becomes a second source for a Pentium-PCI chip set.

However, unless PCI also becomes a factor in the 486 market, it could become, as one wag put it, "the next EISA: a server architecture with limited penetration." In other words, if PCI is too closely associated with the Pentium, and if Pentium volumes stay small compared to the 486's, the market for PCI add-ins won't be large enough to attract third-party developers. Vendors say that another supplier besides Intel needs to deliver PCI support for the 486, but none has yet committed.

The alternative to PCI is VESA's VL-Bus, which has gained wide use in the 486 world. Opti (Santa Clara, CA) has a chip set that supports the Pentium and VL-Bus, and it may prove to be a lower-cost solution than PCI because of the large number of inexpensive VL-Bus controllers already available.

Like PCI, VL-Bus is currently specified at 32 bits, but the pending 1.1 specification will provide support for 64 bits. Waqas Khan, senior product marketing manager for Opti, says that the company started with VL-Bus support for Pentium "because there are controllers available, so people could get machines right now." By comparison, he says, there is an "extreme shortage" of controllers and add-ins for PCI, although many are scheduled for introduction in upcoming months.

The major criticism of VL-Bus is that it is not as robust as PCI and may run out of gas above 50 MHz because its timing was designed for 40 MHz or below. "PCI has done a better job of addressing what a local bus needs to be," says a senior design engineer at a leading system maker. Since VL-Bus is so closely tied to the 486, glue logic is needed to implement it as a mezzanine bus for the Pentium.



The trend in PC design *is to move functions off the general-purpose ISA bus and onto wider, specialized buses tied to the speed of the CPU. ISA's 8-bit interface and 8-MHz clock create a bottleneck for all peripheral functions. By contrast, today's systems have 32- or 64-bit paths from CPU to memory and 32- or 64-bit local buses for speedy subsystems such as video and storage. Today's systems also use ISA for slower I/O and to maintain backward compatibility.*

Only two of the systems that were tested by the BYTE Lab use the VL-Bus. Some use a proprietary local bus for video and none use PCI. Some, including Compaq and NCR, say they are committed to eventually implementing PCI.

However, for low-speed functions, such as serial I/O with mice and modems, you don't need anything more than the low-cost ISA bus. Ahmet Houssein, director of engineering for the networks and servers product group at Zenith Data Systems (Buffalo Grove, IL), notes that ISA offers a larger choice of option cards than newer buses. On the other hand, designers might be able to eliminate an ISA bus entirely by using only VL-Bus or PCI and attaching one of the emerging serial I/O schemes to it for use with slower devices. The PCI 2.0 specification also includes a shared slot that allows you to install either an ISA or a PCI card.

EISA is a different story. Micronics' Benoit believes that Pentium servers will typically include EISA slots. "Servers need eight or more slots, and you can't put that many on VL or PCI," he says, adding that while customers have balked at the price of EISA in the past, it's relatively less expensive in a Pentium system.

Others are less sure. Carl Amdahl, chairman and chief technical officer for superserver maker NetFrame Systems (Milpitas,

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New Memory Architectures to Boost Performance

TOM R. HALFHILL

One of the system bottlenecks exposed by high-speed processors like the Pentium is the interface to main memory. This interface is the most crucial pathway in the entire computer, because it's responsible for carrying a constant flow of program instructions and data between memory chips and the CPU. If memory or the pathway fails to keep pace with the CPU's insistent requests, the CPU stalls in a wait state and valuable processing time is lost.

Today's DRAM chips—variously known as asynchronous, page-mode, or generic DRAMs—are constrained by both their internal architecture and their interface to the CPU's memory bus. DRAM architecture hasn't changed significantly since 1974; neither has the memory interface in desktop PCs, except that memory buses have grown wider—from 8 bits on the 8088 to 64 bits on the Pentium. Although wider buses have increased the available raw bandwidth, throughput still lags behind the spiraling demands of faster microprocessors.

More and more PCs now bridge the gap by using high-speed SRAM (static RAM) chips to cache traffic between the CPU and DRAMs. A typical 486 or Pentium system might have 256 KB of SRAM cache. But SRAM is much costlier than DRAM, and boosting cache beyond 256 KB yields a diminishing rate of return.

To get around these limitations, several new technologies have been developed. Most of these technologies require new types of DRAMs, but two of them attack the memory interface problem. It's not clear at this point which will become the new DRAM standard. All of them cost about 15 percent more than generic DRAM, but even so, they can reduce the overall cost of a system by eliminating the SRAM cache and associated controller chips. This can also result in a smaller motherboard that consumes less power. These are important considerations for portable systems.

Enhanced DRAM. EDRAM, the brainchild of Ramtron (Colorado Springs, CO), is the only new DRAM that is now shipping in volume. It takes an evolutionary approach by integrating a small SRAM cache with a fast core of otherwise generic DRAM. Each EDRAM chip has 2 Kb of 15-nanosecond SRAM and 4 Mb of 35-ns DRAM.

Ramtron's benchmarks show an EDRAM-equipped machine outperforming a comparable system with generic DRAM and an SRAM cache, unless the application program fits completely inside the cache. In that case, EDRAM delivers about the same performance as the other system. Ramtron says it already has 44 EDRAM customers and that EDRAMs are going into everything from desktop PCs and workstations to laser printers and copiers. However, none of the first Pentium systems use EDRAM.

Rivals criticize EDRAM for being single-sourced. Ramtron says it is seeking second sources. Without the price competition and redundant supply fostered by multiple sources, some vendors are reluctant to adopt EDRAM.

Cache DRAM. CDRAM, invented by Mitsubishi, is similar to EDRAM. It integrates an SRAM cache with either 4 Mb or 16 Mb of DRAM. Although CDRAM's on-board cache is larger (16 Kb versus 2 Kb), the DRAM is slower (70 ns versus 35 ns). But CDRAM's on-board SRAM can be used as either a cache or a buffer, depending on whether the application requires serial or random access to the data.

When retrieving data serially—for example, to refresh a bit-mapped screen—CDRAM can prefetch the data from its DRAM core into the SRAM buffer and thus improve performance. In fact, Mitsubishi claims that CDRAM, which is single-ported, is faster for such applications than dual-ported VRAM (video RAM) is. The company says a CDRAM-based PC will run as fast as a comparable machine with DRAM and a 256-KB secondary SRAM cache.

Mitsubishi is the sole source for CDRAM, which is now being ramped up to volume production. However, Mitsubishi says chips will also be available from NEC and perhaps another company.

Synchronous DRAM. SDRAM is another evolutionary alternative, and it is attracting the widest support among semiconductor manufacturers. SDRAM chips are coming later this year or in 1994 from Mitsubishi, NEC, Samsung, Texas Instruments, and nearly every other major DRAM player. To ensure that SDRAM chips are interchangeable, a standard is being developed by the JEDEC (Joint Electronic Device Engineering Council).

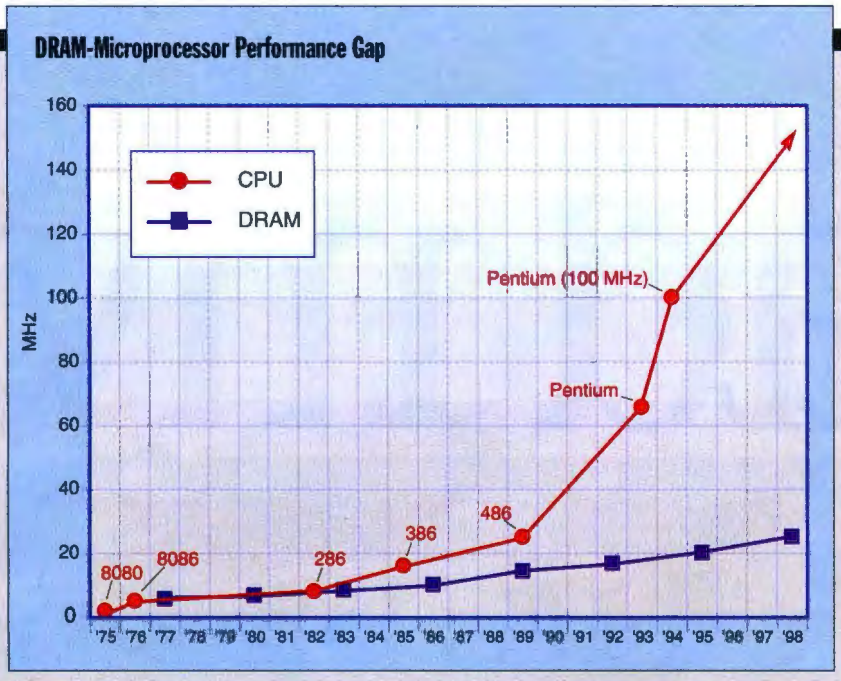
Unlike today's asynchronous DRAMs, SDRAMs exchange data with the CPU in sync to an external clock signal and are designed to run at the full speed of the CPU/memory bus without imposing wait states. For instance, TI's 16-Mb SDRAM, which the company will be sampling late this year, is rated for speeds of up to 100 MHz. That's fast enough for the 66-MHz Pentium, with enough headroom to accommodate even faster processors.

SDRAM performs best when transferring data serially. TI says it's ideal for applications like word processing, spreadsheets, and multimedia. But for programs that depend heavily on random access (e.g., databases), a cache-type memory like CDRAM or EDRAM will probably outperform SDRAM.

Rambus DRAM. RDRAM, developed by Rambus (Mountain View, CA), takes a more revolutionary approach to the

CA), says EISA is "not appropriate" for mission-critical servers, citing its lack of both scalability and support for parity checking. By contrast, he says, NetFrame can use an unlimited number of its parity-checking, 25-MBps MPSA (Multiprocessor Parallel Server Architecture) buses in a single system.

Tricord Systems shares Amdahl's critique, using its own bus design to optimize performance and reliability: CPU, memory, and disks are on a separate high-speed interconnection, while off-the-shelf cards such as network interfaces plug into EISA slots. Similarly, Parallan uses a high-speed



Comparing the relative speeds *of microprocessors and memory chips necessarily requires some apples-and-oranges compromises, but no matter how these curves are plotted, the results are similar: CPU performance is rapidly outstripping DRAM performance. While the CPU curve climbs steeply, the DRAM curve remains almost flat.*

memory-bandwidth problem. In addition to introducing a new type of memory chip, Rambus has reinvented the interface to the CPU.

RDRAM chips are vertically packaged, with all pins on one side. They exchange data with the CPU over 28 wires that are no more than 12 centimeters long. The bus can address up to 320 RDRAM chips and is rated at 500 MBps, although 400 to 450 MBps is more realistic. That compares to about 33 MBps for asynchronous DRAM.

RDRAM chips have no on-board SRAM, but pages are cached by reading the sense amplifiers. The controller employs a new type of I/O cell, and the bus requires no extra glue logic. The chips can be manufactured in the same plants that make generic DRAMs.

Rambus is now sampling 4-Mb RDRAMs to major system vendors and is planning for volume production this fall. A 16-Mb RDRAM is also in the works. Rambus has licensed its technology to Fujitsu, Hitachi, NEC, and Toshiba.

RamLink. This technology is the most revolutionary of all, but it is destined for use further in the future than the others. It concentrates on the CPU/memory interface rather than the internal architecture of the memory chips. RamLink originates from the IEEE, but many firms are involved in its development, including Apple, Hewlett-Packard, TI, and all the major DRAM makers.

The technology is an offshoot of a recently adopted IEEE standard known as SCI (Scalable Coherent Interface), which defines a system architecture that encompasses anywhere from one to 64,000 microprocessors. RamLink is a memory interface with point-to-point connections arranged in a ring, like a network. Traffic on the ring is managed by a memory controller that sends messages to the DRAM chips, which act as nodes. Other nodes can be ROM chips, flash ROMs, drives, or even additional RamLink rings.

Hans Wiggers of HP Labs, who is chairman of the IEEE RamLink committee, says that RamLink could run as fast as 500 MHz or even 1 GHz. But RamLink is still years from reality. "Everybody says, 'Oh, this is very interesting,' but nobody has committed any designs to it yet," Wiggers says.

Even if you disregard RamLink and focus on the near-term contenders, it's unclear whether EDRAM, CDRAM, SDRAM, or RDRAM will become the new memory standard. "I wouldn't even touch predicting which of these will be the long-term winner," says Sherry Garber, an analyst at In-Stat (Scottsdale, AZ). "These things just haven't been out long enough. It takes a lot of momentum to replace a known product."

System makers are reluctant to adopt any of these alternatives until an obvious leader emerges. Nobody wants to build a computer with RAM that's not in wide production and that users can't readily find when they want to expand memory. "It's really hard for a clone maker to go out on a limb," notes Steven Przybylski, a consultant in San Jose, California, who specializes in system architectures.

Przybylski says that although the new DRAMs all command about the same 15 percent premium over existing DRAMs, prices could swing radically as production ramps up. "Volume is everything," he says. "What makes them so expensive is that no one is buying them."

The new DRAMs may filter slowly into the market by filling niches. They offer clear advantages for certain embedded applications and may replace VRAM on video cards. As volumes rise and prices fall, they could move gradually into main memory.

Another possibility is that an evolutionary design such as SDRAM will fill near-term needs for faster memory in Pentium-class systems. Later in the decade, as processor speeds approach 1 GHz, a revolutionary approach such as RDRAM or RamLink might rescue users from yet another memory bottleneck.

It's also possible that no single solution will prevail. In-Stat's Garber notes that the worldwide DRAM market was worth $8.5 billion last year. "That's big enough to support more than one DRAM architecture," she says.

Tom R. Halfhill is a BYTE senior news editor. You can reach him on BIX as "thalfhill."

internal bus for CPU, memory, and SCSI-attached disks and offers dual Micro Channel slots for network interfaces, WAN (wide-area network) connections, fax modems, and tape drives.

Motherboard Integration

Pentium systems will have an even higher level of motherboard integration than 486 machines now have. "The more integration, the lower the price and the higher the reliability," says Tom Mays, senior vice president of NCR's general-purpose product group in Dayton, Ohio.

Mays projects that within about 12 to 18 months, users will see single-board

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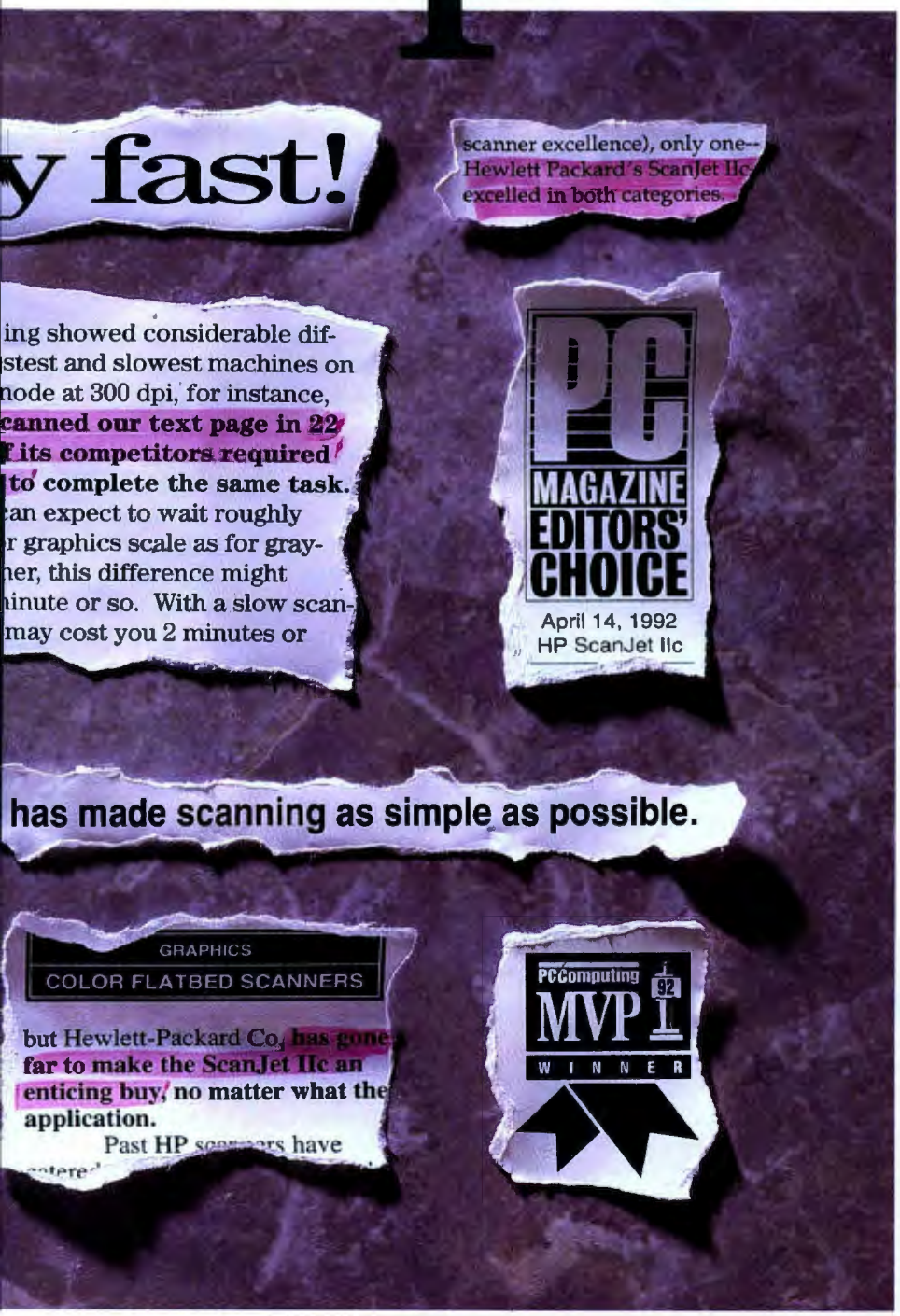

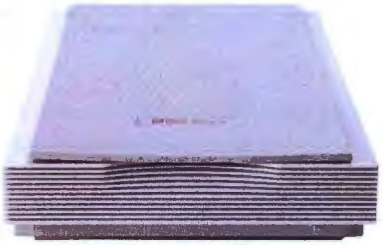

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Revisiting the Lowly I/O Ports

Your system has a sizzling processor and an architecture enhanced to match its horsepower. But when you print a document, the data is squeezed through a parallel port at a measly 150 KBps. Clearly, something is wrong with this picture.

With the arrival of the Pentium, system makers are taking a hard look at serial and parallel I/O. These ports are now seeing increased use—for attaching not only printers but also devices ranging from tape drives to network interfaces—and are quickly becoming a performance bottleneck.

Many vendors are now adopting port technologies that dramatically boost I/O port speed. The new ports are also smarter, opening up new avenues of capability and easing the burden of configuration. Some of these ports will begin appearing in systems this year.

Faster Parallel

Improvements to the standard parallel port began a few years ago when Xircom, a maker of parallel-port network interfaces, helped Intel define a faster specification. The Enhanced Parallel Port, or EPP, was supported in Intel's 386SL chip set and became common in notebook computers. It raised throughput from 150 KBps to 2 MBps.

Hewlett-Packard was also interested in raising parallel-port speed to boost LaserJet performance, and it devised a technology called Zippy that runs between 2 and 5 MBps. Zippy is bidirectional, which means the printer can talk back to the PC to report job status or error conditions. After Microsoft joined forces with HP, the technology was renamed Extended Capabilities Port, or ECP. Now an IEEE committee considering parallel-port enhancements has decided to roll EPP and ECP together into a standard called 1284.

Support for IEEE 1284 parallel ports is forthcoming from chip-set and BIOS vendors, as well as from HP and other printer and scanner makers. The impact on system cost is expected to be negligible. Microsoft will add support for bidirectionality in the next version of Windows; for example, improved Print Manager dialog boxes might inform you that a printer is out of paper or low on toner.

Serial Upside

Engineers see even more opportunity in serial I/O than in parallel I/O: It uses less physical space; presents fewer electrical problems, such as cross talk; and scales up more easily to optical media. Two technologies may gain wide use in the next few years: Access.bus from Philips Semiconductor and Serial Bus from the IEEE.

Access.bus is like ADB (Apple Desktop Bus), "only much better," says Denis Pavillard, an engineer at Logitech. It's faster than ADB and supports more devices. The technology, originally developed by Signetics, lets you connect more than 100 serial devices, such as keyboards, mice, trackballs, and digitizers, to a single 100-Kbps port, eliminating the need for multiple connectors on the back of the system. Devices identify themselves and can be "hot-plugged" (i.e., connected while the system is running). DEC is already using Access.bus in its Maxine workstation, and Logitech has delivered a compliant mouse.

Higher up on the performance scale is Serial Bus, also known as IEEE P1394. Serial Bus is rated now for 100 Mbps, but someday it might scale up to 400 Mbps; with speeds like that, it's clearly intended to be more than a mouse port. In fact, Serial Bus is meant to be a general-purpose interface that can replace a range of I/O types, including ADB, RS-232, RS-422, parallel, and SCSI. According to Michael Teener, a plumbing architect for Apple and former chairman of the P1394 committee, "It will be the standard I/O interconnect of the future, beyond Apple and even beyond computers."

Like Access.bus, Serial Bus will require only a single inexpensive connector on the back of a system; attached devices need no DIP switches or jumpers, and they will identify and configure themselves dynamically. Unlike with SCSI, a chain of Serial Bus devices won't need addresses or terminators, yet the performance is high enough to match that of SCSI-2.

Members of the IEEE P1394 group include Apple, IBM, and NCR; Apple has reportedly already developed Serial Bus controller chips that it will license to other companies. Teener confirms that hardware and software prototypes are now up and running and promises that "real" hardware will ship in 1994. Pentium and PowerPC systems are ideal candidates for a Serial Bus port.

computers based on either the 486 or the Pentium with SCSI-2, DSPs, video codecs, and LAN interfaces on-board. Some of these components will show up even sooner in early Pentium systems.

SCSI is a given. "It's clear that SCSI-2 has completely won for any kind of high-performance systems," says Amdahl. "The notion of using IDE just isn't right in these [systems]." IDE is closely tied to the ISA bus and suited for a small number of local devices, whereas SCSI supports more devices at greater distances and with more flexibility. In servers, and perhaps even in some desktops, single- and dual-SCSI controllers will be tied to the local bus for the highest possible throughput. Slower devices, such as tape drives and CD-ROMs, might be hung off yet another SCSI port on the EISA bus or Micro Channel.

Networking is less certain, because standards are in flux. Zenith's Houssein believes that integrating a network interface makes sense in a desktop or portable system but not in a server; since the vendor doesn't know how the server will be networked, open slots are provided instead. But even on-board Ethernet, which has steadily gained in popularity, may become too limiting as new networking schemes, such as Fast Ethernet and FDDI over copper, come on-line.

One of the best opportunities for integration in high-priced Pentium systems is multimedia. Intel is actively promoting the incorporation into Pentium systems of an Analog Devices AD1848 sound chip, the same device used in Compaq's Business Audio and Microsoft's Sound System. The AD 1848 offers a basic interface between real-world analog signals and the computer's digital format (i.e., 16-bit A/D and D/A conversion at rates of up to CD-quality 44.1 kHz). However, user functions such as voice annotation of documents or

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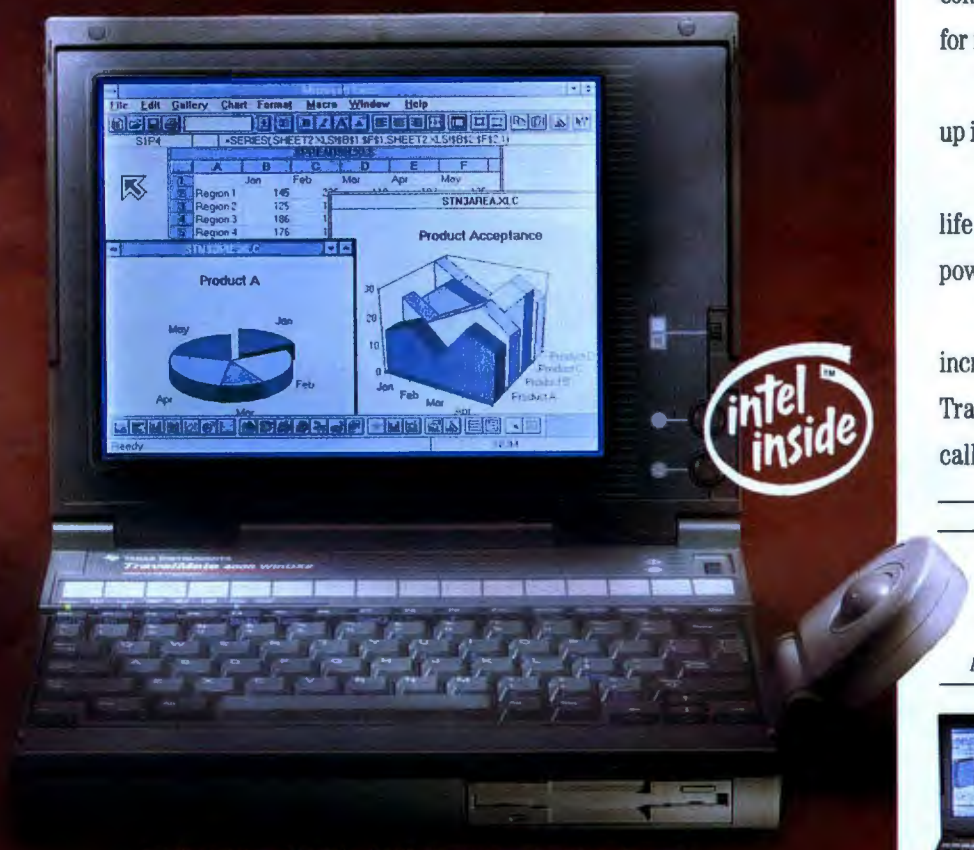

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TEXAS INSTRUMENTS

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spoken attachments to E-mail messages must be provided through software, and adding music functions requires additional hardware—either a dedicated synthesizer chip or a programmable DSP.

Micronics' Benoit isn't ready to take the plunge into multimedia. "We are reluctant to put anything on the motherboard that will be obsolete within a year," he says. "Sound and video are still going through too many changes right now to integrate on the motherboard." While basic parts such as the AD1848 won't be made obsolete, the functions wrapped around them are indeed in evolution. For example, dissatisfaction with the quality of FM synthesis music is leading quickly to the adoption of wave-table audio, and video-compression standards are in flux. In the long run, these functions will likely be provided by a DSP coupled with software tailored to specific multimedia tasks, and makers of commodity systems don't yet see a strong-enough market demand to warrant the added cost of a DSP.

Graphics accelerators are also likely to be integrated, but only in desktop systems where imaging, desktop publishing, CAD, and other graphics-intensive applications need the extra horsepower. Intelligent graphics controllers (e.g., bit blitters) are likely to be attached to the local bus, as they are now in many 486s. S3's Margulis says that because early Pentium adopters "won't be price-sensitive," he expects a typical graphics subsystem to include 2 to 4 MB of high-performance VRAM, not less expensive DRAM. With 4 MB of display memory, a system can achieve 1024 by 768 resolution in 24-bit full color.

The Next Big Thing

Held back for years by a lack of standards and software support, SMP (symmetric multiprocessing) is one of those technologies that are often described as the Next Big Thing. With the arrival of the Pentium, Microsoft Windows NT, and SunSoft's Solaris 2.0, the era of SMP may have finally dawned.

George White, president of Corollary (Irvine, CA) and a longtime promoter of multiprocessing, says that the Pentium will cause "RISC bigots" to take a fresh look at Intel. "We expect multiprocessing to get a big boost from people looking for higher performance and losing their bias against Intel," he says. Siemens Nixdorf has committed to using Corollary's C-Bus II, a 400-MBps backplane that can support up to 10 Pentium CPUs. Four or five companies are expected to demonstrate C-Bus II systems at Fall Comdex this year.

Some people consider Corollary's approach too proprietary, arguing that SMP won't become commonplace until it's supported by major chip-set vendors. Yet the multiprocessing architectures used by superservers, from the Compaq Systempro to systems from Parallan and Tricord, are also homegrown and, in many cases, not really symmetrical. Corollary's licensable designs, C-Bus II chips, and support for them in Windows NT could expand the use of SMP into a broader market.

However, Intel has also complicated the picture with its rumored P54C, a kind of "overdrive" Pentium that, instead of disabling the existing chip (as does the 486 OverDrive), would work alongside it in a multiprocessing fashion. Intel will position this solution as a quick and easy way to boost performance on the desktop, rather than as a scalable multiprocessing architecture.

"The concern among MP people is that this could give multiprocessing with Intel CPUs a bad name," says White. While the P54C requires system makers to simply add a socket, it won't boost performance

except for multithreaded programs in environments such as NT or OS/2. It isn't a real SMP solution, because the chips share the same bus and external cache.

Another kind of multiprocessing may be redundant designs for improved fault tolerance. Says Opti's Khan: "People have understood this technology for years, but with the extreme price competition, they haven't implemented it in PCs. The Pentium will be the platform of choice for doing things like dual-processor multiprocessing for reliability."

Brian Croxon, vice president of Zenith's network and server products group, predicts that Pentium systems will be designed to absorb host functions previously unknown in PCs. "You are going to see the ability to do remote diagnostics, automatic dial-out, and system-level network management capability," he says.

HP's Mathios agrees. "Customers are looking for high availability. This leads to things like redundancy, ECC [error checking and correction] memory, disk arrays, and predictive diagnostics," he says. "And these things start driving the system architecture."

Leading the charge in this arena are the superserver companies. For instance, Parallan now delivers ECC memory and parity on all buses, and it offers a sophisticated monitoring and diagnostics capability. "Our system maintenance is actually better than what's available for mainframes, because it uses a GUI front end," says Parallan's Fields. The next release of the system management software will support the SNMP protocol, which will allow Parallan servers to operate in heterogeneous network management systems. Tricord and NetFrame servers provide similar levels of data integrity and diagnostics.

The Pentium itself will also help in this regard, because it incorporates several new diagnostic capabilities. On-chip performance-monitoring registers maintain statistical information on cache hits, bus transactions, and average processor waits. In compliance with the Joint Testability and Automation Group standard, internal Pentium registers can be read directly, which should help in debugging and testing systems. And the Pentium's FRC (functional redundancy-checking) mode lets two chips run side-by-side and compare their results in real time. Unfortunately, FRC mode doesn't indicate a resolution in case of an error, so it serves to flag—but not solve—data integrity failures.

Investing in Pentium

The first generation of Pentium PCs does not yet take full advantage of the new CPU. If you must buy a Pentium-based system today, protect your investment by seeking out one with a PCI or VL-Bus for video or disk I/O. A 64-bit memory interface and a 32-bit I/O bus are nice bonuses.

However, it's probably worth waiting until the rest of the architecture catches up with the chip and until the operating systems that take full advantage of the Pentium are available and robust. And if you're not sure of your needs but are planning to buy a 486 system anyway, consider one with a P24T socket on-board (to accommodate Intel's unannounced Pentium "overdrive" processor), with the understanding that when the chip that plugs into it is delivered, it won't give you the same performance levels as a native 64-bit Pentium system. ■

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Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on BIX as "areinhardt."

Pentium PCs: Power to Burn

RAYMOND GA CÔTÉ
AND BARRY NANCE

The first afternoon I spent with a roomful of new Pentium systems took me back 10 to 15 years—roaring fans, special cooling hardware, and sturdy tank-like cases that *must* be kept closed or the electronics inside will surely melt. It is difficult to view the first round of Pentium-based systems as microcomputers. They blur the already indistinct line between microcomputers, supermicrocomputers, and minicomputers.

BYTE ran preliminary tests on nine servers and two desktop systems. Most of the units were based on existing designs. All the vendors had been privy to the Pentium specifications for some time. This allowed them to build flexibility into their latest 486 designs to accommodate the Pentium. To move their systems up to the Pentium, vendors employed either a daughtercard or a processor card approach. The designs of these cards vary; they can contain the processor, cache, DMA, and memory with a 64-bit interface, or they can provide simply the processor and some support circuitry with a 32-bit interface.

The ALR Evolution V-Q was the only machine we looked at that implements the Pentium on the motherboard. It and the NCR System 3360 are the only two machines that feature completely new system designs to support the Pentium.

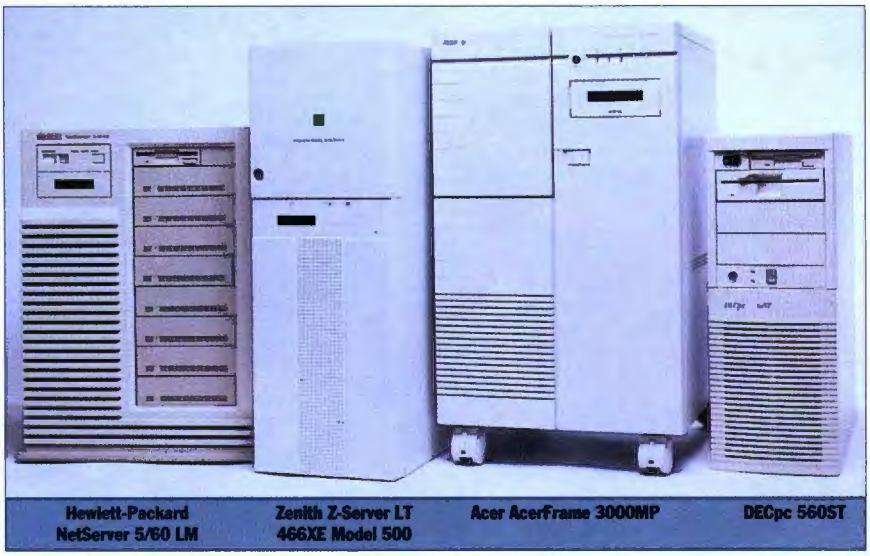
The first Pentium systems offer significant performance gains over the 486, but they could do better

All these machines are hot, in a very real physical sense. A 66-MHz Pentium requires about 15 W just to keep itself running—never mind the high-speed supporting electronics immediately surrounding it. The Pentium may not be the first chip to have its own private fan mounted directly to it, but it is the first such chip to reach the mass market.

All the Pentium systems BYTE examined use at least a heat sink, as Intel recommends. Some, including the Compaq and Zenith offerings, use both a heat sink and a fan mounted directly to the IC. Newly designed systems such as the multiprocessor NCR System 3360 incorporate separate air channels and pathways that guarantee processor cooling. Between these two extremes are systems such as the Acer AcerFrame 3000MP, which uses a large conductive cooling plate, and the IBM Model 95 66-MHz Pentium Server, which has a row of squirrel-cage fans mounted near the processor.

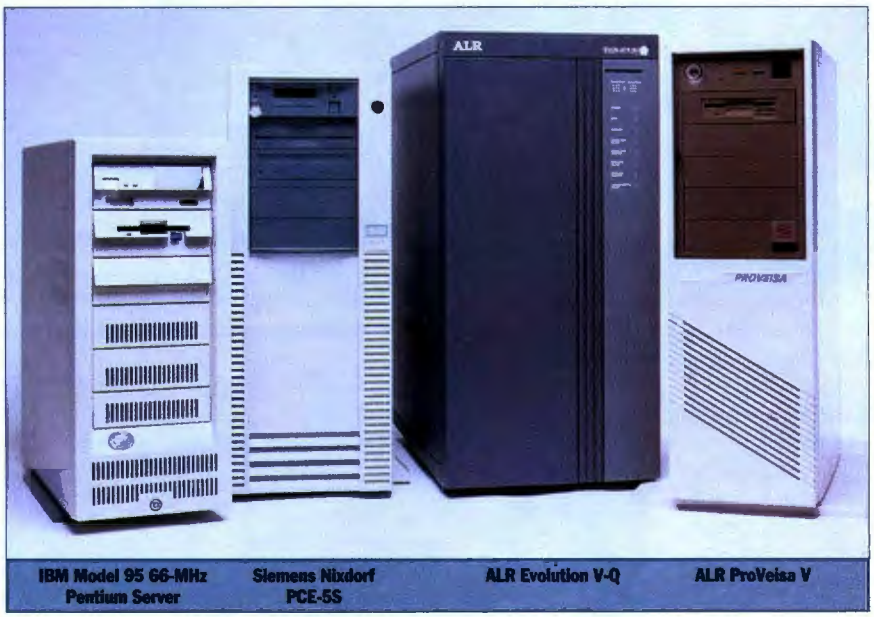
As processor speed and complexity increase, so too does the need for raw electrical power. Pentium systems tend to have large power supplies—400 W or more is not uncommon. The power supply itself produces its own heat problems, but most vendors have already dealt with this problem in their fastest 486 designs by separating the power supply and its cooling fan from the rest of the system.

All the systems we looked at adequately isolate the power supply's cooling airflow. However, heat is likely to become more of a problem as the Pentium becomes readily available and clone manufacturers place this year's electronics in last year's cases.



Hewlett-Packard NetServer 5/60 LM | Zenith Z-Server LT 466XE Model 500 | Acer AcerFrame 3000MP | DECpc 560ST

Look for designs that allow adequate airflow through the system; Intel recommends a minimum of 400 feet per minute.



IBM Model 95 66-MHz Pentium Server | Siemens Nixdorf PCE-5S | ALR Evolution V-Q | ALR ProVeisa V

On the Server Side

We ran the Novell file I/O server benchmarks under various network loads. Although there are significant differences among the systems in the group, most of their results were within shouting distance of one another. Cost becomes an obvious determinant when evaluating these machines. Based on pricing available at press time, expect to pay at least $8500 for a base-model Pentium server.

We ran the random and sequential file I/O tests five times for each server. The benchmark activity was the only LAN traffic during each test. The network connections consisted of two Thomas-Conrad 4045 token-ring cards, each containing 128 KB of on-board memory. The IBM Model 95 66-MHz Pentium Server used two Micro Channel token-ring cards and was the only server that didn't use Thomas-Conrad adapters.

The token-ring speed was 16 Mbps. The LAN was split into two ring segments, each with 50 workstations. For the tests involving an odd number of workstations (25 and 75), one ring segment had one more workstation active than the other. One of the more tedious aspects of the test was assigning workstations. We had to ensure that each ring participating in the test had an equal number of clients. The actual tests consist of sequential and random workstation I/O. Each file I/O test is run on 10 2-MB files, reading and writing 512 bytes at a time.

What is most interesting about these tests is what they reveal about the need to balance total system performance with the Pentium processor. The BYTE benchmarks allow you to configure a "processor load," which attempts to keep the server's processor busy while the clients perform the timing tests. Running the benchmarks on each server with and without processor loading produced negligible changes in the throughput results. This indicates that our tests were exercising the hard drive subsystem more than the actual Pentium chip. That's no real surprise, but it's a point to be remembered when determining if you need a Pentium system.

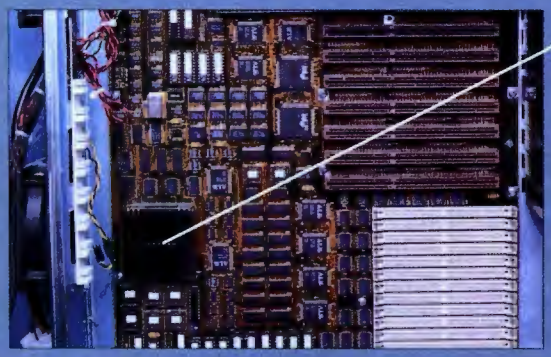
Even more telling were the results of the Pentium-based systems compared to those of the Zenith Z-Server LT 466XE Model 500 with a 50-MHz 486. (The Zenith Pentium module was delivered too late to be included in the network tests.) The 486-based Zenith outperformed the DECpc 560ST and IBM Model 95, and it didn't do that poorly against the other systems, either. Again, this points out that overall performance is much more important than simply the performance of a single component.

These systems would have undoubtedly exhibited completely different rankings if they had been tested with a more compute-intensive environment such as SQL Server under OS/2. However, for a strict file server, our numbers indicate you can do just as well without a Pentium as you can with one.

Compaq Deskpro 5/66M | Unisys PW² Advantage Plus 5606

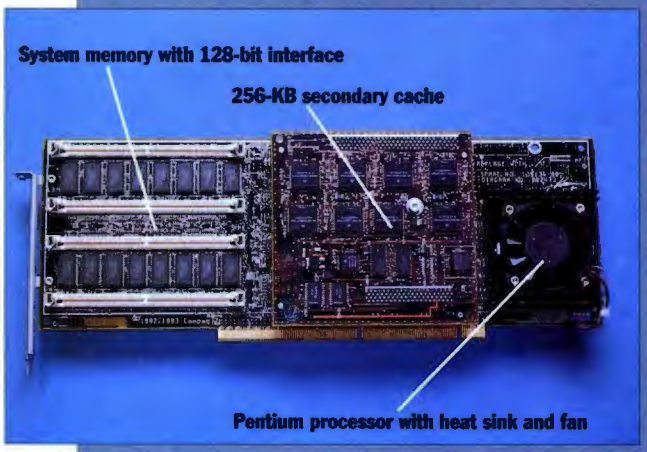
Desktop Power

Two of the first Pentium systems we evaluated—the Unisys and the Compaq—are



The ALR Evolution V-Q was the only system among the 11 that BYTE examined that had the Pentium mounted on the motherboard.

Acer took a unique approach to dissipating the heat generated by the Pentium in the AcerFrame 3000MP. A metal plate acts as a heat sink; it's thin enough to allow normal spacing of the expansion slots.

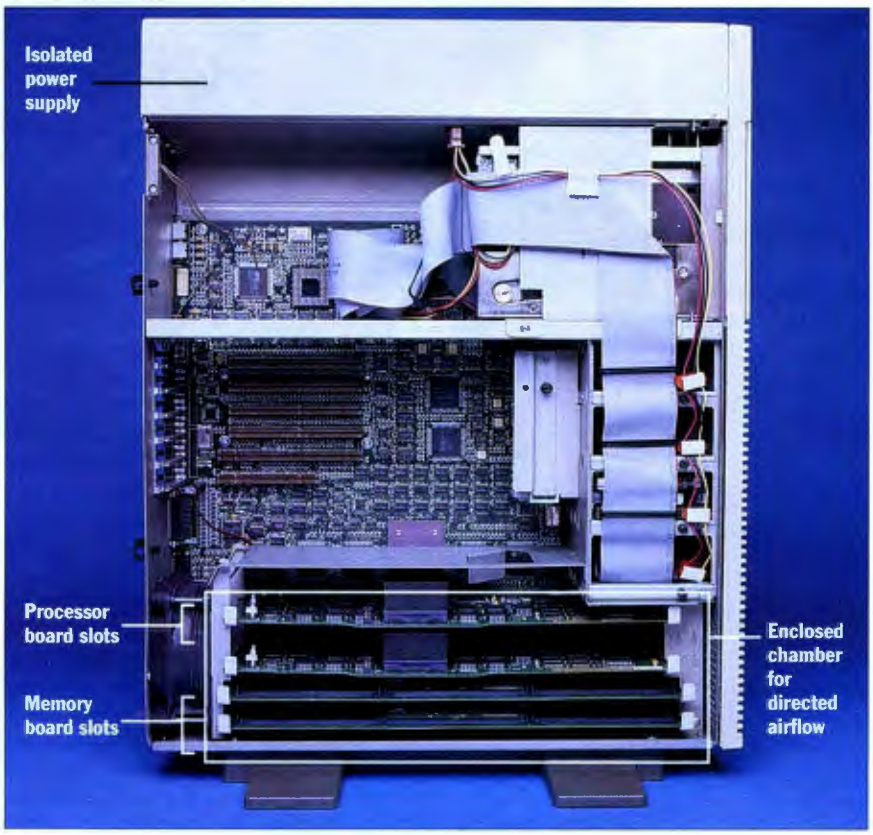


Compaq's TriFlex architecture allows its existing Deskpro system design to accept this Pentium processor card. It places all the timing-critical components, such as cache and DMA, on the card.

being marketed as desktop machines, so we tested them with the BYTE low-level DOS and Windows benchmarks. The DOS CPU benchmarks show the Pentium systems running at speeds of up to 13 times the throughput of a Compaq Deskpro 386/33. However, overall system configuration will drastically affect the performance of an actual application. The Unisys PW^2 Advantage Plus 5606 system performed exceptionally well on the file I/O tests, but it was outclassed by the Compaq Deskpro 5/66M system in raw CPU throughput and video.

The Windows benchmarks show even more confusing results. The Unisys, which uses a special pixel-caching video adapter, outstrips the Compaq for drawing individual pixels, and it maintains this advantage for bit-block transfers. However, drawing real-world items such as lines, ellipses, and polygons is nowhere near as speedy. Likewise, the Unisys system is 63 percent quicker than the Compaq at sequential file I/O tasks but nearly 31 percent slower at the random test.

Many of the discrepancies that these tests show arise due to the number of different caches throughout the system. First, the CPU and FPU tests show the speed of the system only while it's operating from within the processor cache on the system processor board. All the current BYTE



The NCR System 3360 *was designed as a multiprocessing Pentium system. The processor cards and memory reside in their own compartment, at one end of which is a large fan that generates enough airflow to keep the two processors cool.*

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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?"

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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."

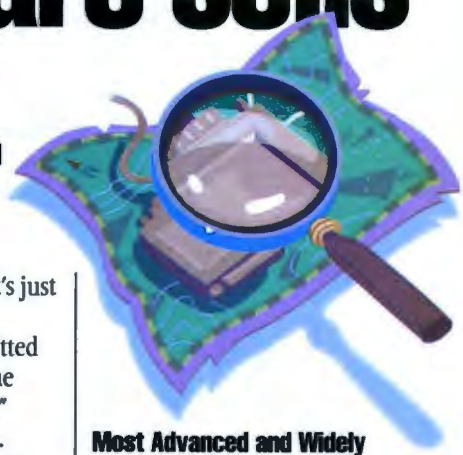
"That's why I committed myself to solving the piracy problem," explained Don. Simon's eyes lit up. "The dongle!" he shouted. Don corrected him, "Not just any dongle — the dongle that paved the road to success for over 10,000 developers worldwide — Sentinel."

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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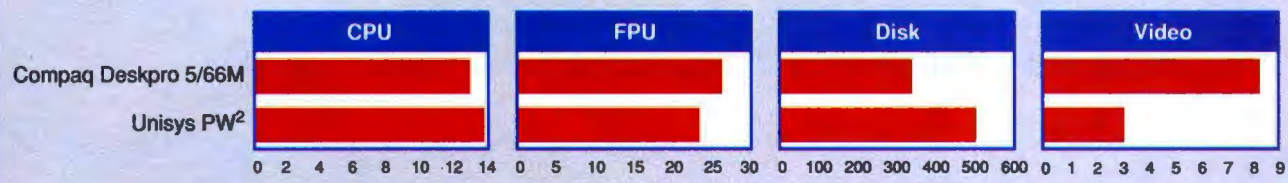
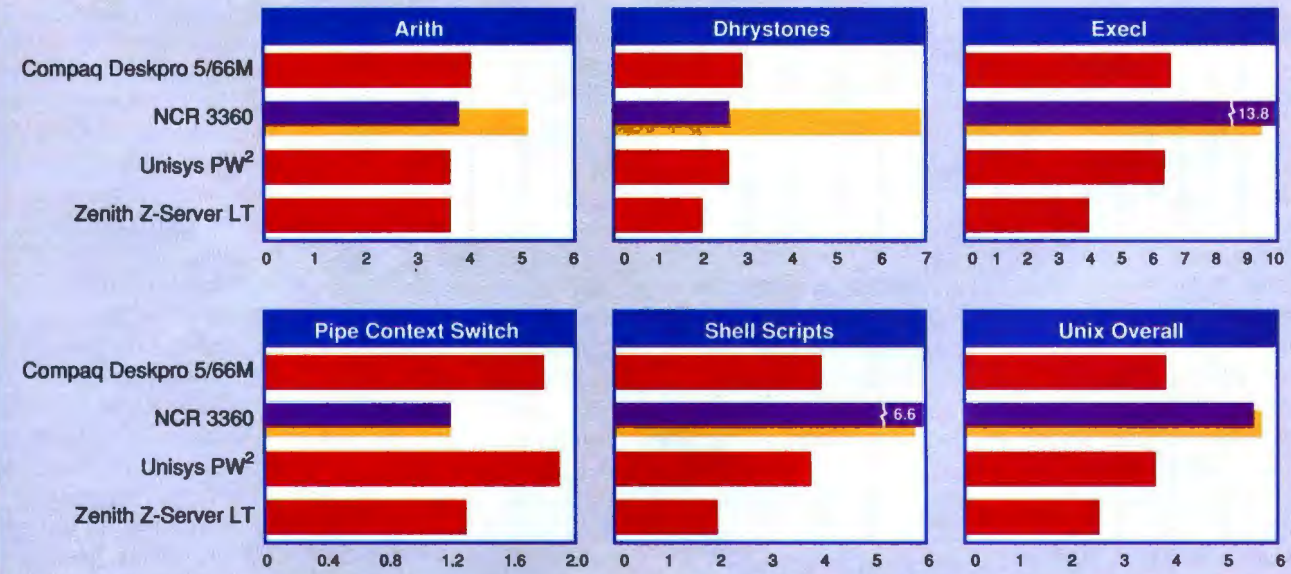
DOS Benchmarks



All results are indexed, and higher numbers indicate better performance. For each index in the DOS tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 = 1.

The overall index is the average index of the individual tests. The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you to identify the relative performance of a given subsystem and to determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.4, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

Unix Benchmarks



All results are indexed, and higher numbers indicate better performance. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

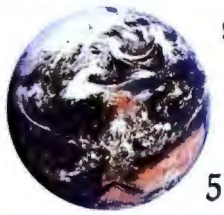
Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, in the listings area on BIX, or on disk.

Windows Benchmarks

All results are indexed, and higher numbers indicate better performance. For each index in the Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.1 = 1. The overall index is the average index of the individual tests.

BYTE's Windows test suite measures system performance running Windows. It is divided into three categories: Graphics, which includes calls to GDI drawing routines; Memory, which measures the speed of memory access under Windows; and File I/O, which measures performance of the file system on disk.

HALF HEIGHT FULL POWER



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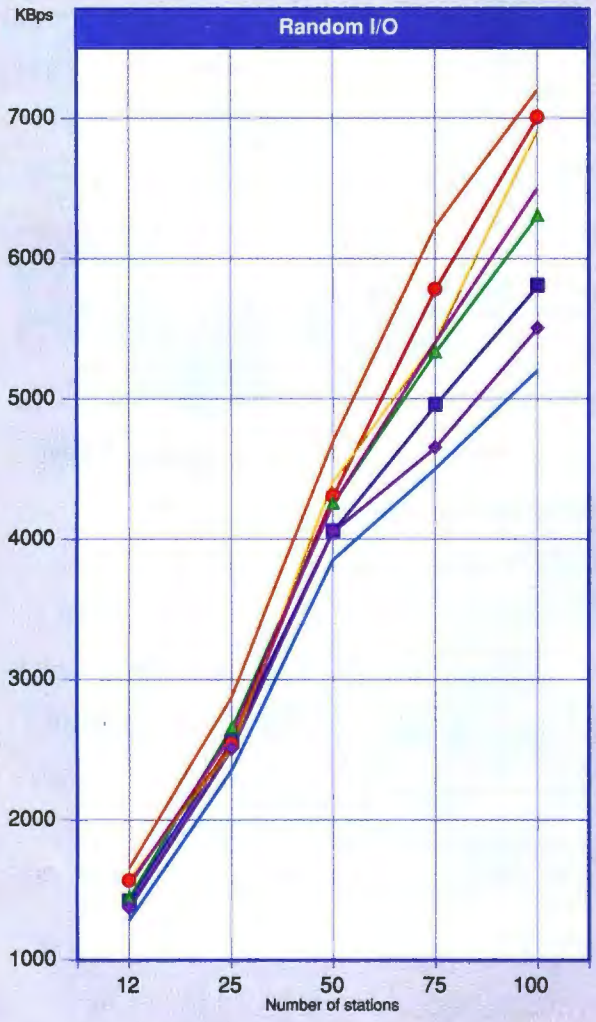
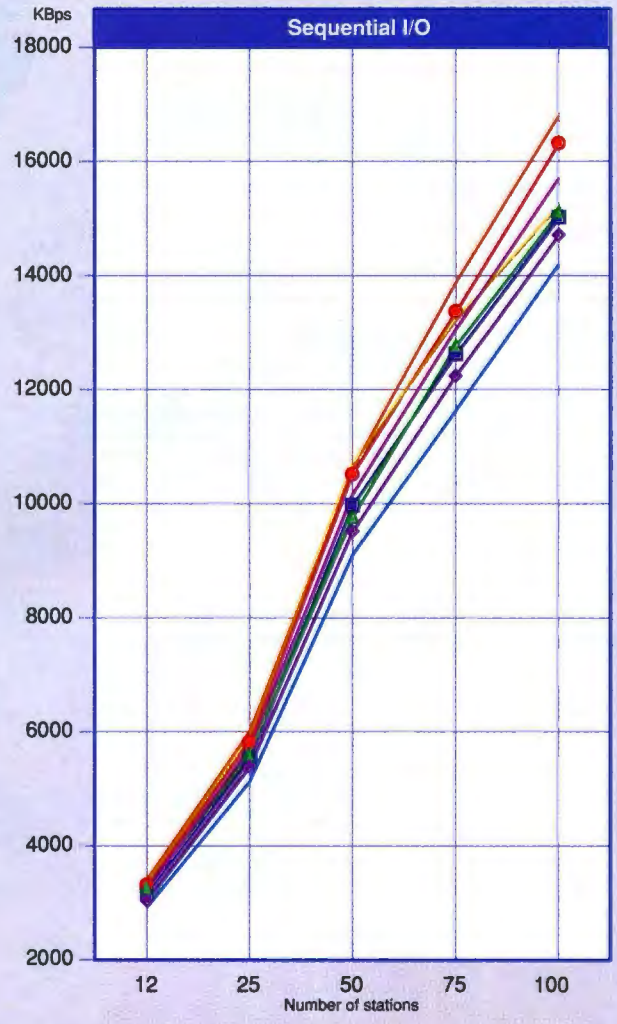
NetWare Benchmarks





AcerFrame 3000MP
DECpc 560ST
ALR Evolution V-Q
HP NetServer 5/60 LM
IBM Model 95
ALR ProVeisa V
Siemens Nixdorf PCE-5S
Z-Server LT*

* Zenith server tests run on 486/50 CPU.

On the network file I/O tests, workstations open, read, and write files on the server using either sequential or random-access patterns. The file I/O tests measure true server throughput; disk I/O speed is the most important factor, but processing speed and network I/O performance also contribute.

All servers are tested under NetWare 3.11. The figure shows the aggregate throughput for each server for each test. Note that the figure shows *total* throughput on the network—that is, the sum of the throughput seen by each client on the network.

benchmarks don't require hits in main memory. Conversely, the file I/O tests highlight differences in approaches to on-board disk caches as well as to the interface.

The More, the Merrier

Beyond the promise of simply more speed lies the ability to gang Pentium processors into multiprocessing systems. We received two such systems for review: The Acer AcerFrame 3000MP and the NCR System 3360. We were unable to pit these two systems against each other, since the AcerFrame arrived with only one processor board.

The NCR 3360 we received had two Pentium processor boards. NCR claims it will deliver systems that support up to 16 processors. This is a ground-up redesign that NCR configures for either desktop or server use. It includes custom memory management chips, a custom local bus for video access, and the ability to provide multiple processor access to shared video memory. This means that the video is not tied to a particular processor—whichever processor board is free can update the display. This also leads to the potential, with still unrealized software, of allowing different processors to write to specific windows on the display.

NCR's use of a nonstandard local-bus definition for the video means you'll be limited in your choice of video cards for this machine. For server use, this is not much of a concern, and NCR claims it is seriously considering PCI (Peripheral Component Interconnect) 2.0 for future iterations of the 3360.

The 3360 points out the difference that a good compiler can make to performance.

continued

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PENTIUM SYSTEM CONFIGURATIONS

These are the most important differences among the first Pentium systems. Pricing will be critical, with early models expected to cost from $5000 to $20,000. All these systems will eventually ship in 66-MHz versions. (P=parity; EDAC=error detection and correction; MC=Micro Channel; N/A=not available.)

SYSTEM TESTED	PROCESSOR SPEED (MHZ)	PROCESSOR-TO-MEMORY BANDWIDTH	MEMORY TYPE	CACHE (AS TESTED)	EXPANSION-BUS TYPE	SCSI-2	CONFIGURATION AS TESTED (RAM, STORAGE, VIDEO, MONITOR)	PRICE AS TESTED
AcerFrame 3000MP	60	32-bit	ECC	256 KB	EISA, ISA	None	16 MB, 5 520-MB SCSI, 640×480, no monitor[2]	$23,995[3]
ALR ProVelsa V	60	32-bit	P	512 KB	EISA, ISA	None	32 MB, 4 540-MB SCSI array, 1024×768, 14"	$12,989
ALR Evolution V-Q	60	128-bit	P	512 KB	EISA, VL	None	32 MB, 4 540-MB SCSI array, 1024×768, 14"	$13,320
Compaq Deskpro 5/66M	66	128-bit	P	256 KB	EISA	None	16 MB, 510-MB IDE, 1280×1024, 20"	$9399[3]
DECpc 560ST	60	32-bit	P	256 KB	EISA	Option card[1]	16 MB, 1-GB SCSI, 1024×768, 14"	$8500[3]
Hewlett-Packard NetServer 5/60 LM	60	32-bit	P	256 KB	EISA	Integrated[1]	16 MB, 4- GB SCSI, 640×480, 14"	$12,899
IBM Model 95 66-MHz Pentium Server	66	64-bit	ECC	256 KB	MC	Option card[1]	16 MB, 2 540-MB SCSI, 1024×768, 14"	N/A
NCR System 3360	60	128-bit	EDAC or P	256 KB	MC	Integrated	64 MB, 1-GB SCSI, 1280×1024, 19"	$19,000[3]
Siemens Nixdorf PCE-5S	60	64-bit	EDAC	256 KB	EISA, ISA, VL	Integrated[1]	16 MB, 510-MB SCSI, 1024×768, no monitor	N/A
Unisys PW² Advantage Plus 5606	60	32-bit	P	256 KB	EISA	Integrated	16 MB, 1.2-GB SCSI, 1024×768, 14"	$10,000
Z-Server LT 466XE Model 500	66	64-bit	P	256 KB	EISA	Integrated[1]	16 MB, 3 500-MB SCSI, 1024×768, 17"	$8915

[1] Fast SCSI. [2] Includes 525-MB QIC tape drive. [3] Estimated price.

The BYTE Unix benchmarks are compiled using the standard SCO Unix compiler. We ran these standard binaries and a version of the benchmark compiled with the native NCR Metaware C compiler.

In some cases, the Metaware compiler shows a 2.5 percent increase over the standard SCO speeds. It was interesting to see that some tests, such as spawning other tasks, were actually quicker when the SCO compiler was used. With the Metaware compiler, the 3360 ranks between the Silicon Graphics Indigo and the IBM RS/6000 in speed. This speed increase is seen without using a Pentium-specific compiler.

The AcerFrame has been around since late last year in 486 form. It supports up to four Pentium processors. Memory is shared and accessible by all CPUs and EISA-based subsystems. The processor-to-memory interface, which Acer calls the FrameBus, boasts a claimed bandwidth of 264 MBps.

Best Is Yet to Come

We expect few Pentium systems to land on desktops in the immediate future. The 486 is still more than adequate for the average user. It's likely that most Pentium systems will be sold for use with server applications, such as database and multiuser Unix environments, where the processing power can make a difference.

Our early tests of Pentium systems are hardly the last word. Most of the units we've seen are not yet finished, particularly in terms of software drivers and BIOS code. All the systems discussed in this article will eventually ship with 66-MHz processors, too, although many arrived at BYTE with 60-MHz parts. Furthermore, we've yet to see what these systems can really do with applications written using compilers designed specifically for the Pentium architecture.

For now, these systems are merely good, fast implementations of 486-class machines. We won't know what their full potential is until Pentium-specific applications appear. ■

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New Knowledge Tools

Combining knowledge-based systems with neural networks, genetic algorithms, case-based reasoning, and other emerging technologies produces new types of tools. They'll help you come to grips with tasks that will dominate the workplace in the coming years.

SARA HEDBERG

A new generation of applications is helping companies work smarter by letting them take advantage of their collective experience. The applications, called KBSes (knowledge-based systems), are also playing a growing role in rightsizing companies by reducing costs and improving workers' performance.

KBSes capture a company's intellectual capital—its expertise and experience—and distribute it throughout the enterprise over a network. For example, American Express (New York, NY) placed corporate policies and procedures in its KBS to assist its credit authorizers to rapidly handle transactions.

New intelligent systems combine KBSes with other emerging technologies, such as neural networks, CBR (case-based reasoning), genetic algorithms, virtual reality, and multimedia (see the glossary). Potential new applications of these hybrid technologies include coordinating all the functions and departments of a corporation, improving customer service at reduced cost, and developing better software more quickly.

Smarter Tools

KBS technology evolved from expert systems, which were designed to encode an expert's knowledge into a computer program in the form of IF...THEN rules. The expert systems of the early 1980s proved to be difficult to build because of the challenge of capturing all of an expert's knowledge. They were also difficult to maintain, because their large rule bases had little organization. Most expert systems were stand-alone applications on dedicated workstations.

In the mid-1980s, researchers married rule-based expert systems with powerful, frame-based, object-oriented representation. This combination helped represent complex data structures, their constraints, and their relationships. The pairing produced a new generation of software development tools and applications, called KBSes.

With their ability to represent, manage, and analyze complex knowledge and processes, KBS software development tools offer powerful advanced programming techniques that are highly productive. "KBS technology is really a superset of object technology," says Dennis Yablonsky, president of the Carnegie Group (Pittsburgh, PA), a consulting firm specializing in intelligent-software technologies for manufacturing.

The Next Generation

Researchers and software developers are combining KBS tools with other emerging software technologies. Although the hybrid systems are still largely experimental, preliminary results indicate that such coupling can enable more complex problem-solving techniques than have been available to programmers in the past.

For example, if you combine multimedia and virtual reality with KBS technology, you create a powerful user interface for the KBS. Programmers can use KBS technology to manage and retrieve multimedia data sources and to create intelligent agents and objects in virtual reality. As a result, computer interfaces come alive (see "See, Hear, Learn" on page 119).

When a system combines a KBS and CBR, it can intelligently process a wider variety of information than could be handled by either of the technologies it comprises. Because it can access, organize, and analyze unstructured information that cannot be captured in databases (e.g., free-text data), CBR allows the hybrid system to handle people's experiences, or cases. It also enables the system to perform broad, shallow reasoning across these cases by matching new cases with existing ones in the case base (see "Roll Your Own Hybrids" on page 113).

Customer service is one area where companies are implementing systems that combine KBS and CBR technology. For instance, Compaq Computer (Houston, TX) is using this approach to automate such customer service functions as answering questions and troubleshooting (see the text box "Help Is on the Way").

Coordinated Engineering

Hybrid systems composed of KBS and CBR technology are also proving fruitful in managing product life cycles (i.e., coordinating the design, marketing, and parts inventory of a product). With its rich representation capabilities, a KBS allows a company to store and intelligently retrieve product decisions and trade-offs that can guide future decision-making. DEC, Boeing, and General Motors are a few of the companies that use KBSes to coordinate such tasks.

One of the most prominent research efforts in product-engineering coordination going on today is ARPA's DICE (Defense Initiative for Concurrent Engineering).

continued

A KBS QUICK PRIMER

A KBS (knowledge-based system) is an application that can store, retrieve, and analyze vast stores of knowledge and data. KBSes are extensions of the old AI notion of an expert in a box. As a new generation of what used to be called expert systems, KBSes came into being about 8 years ago. Today, they are used to accomplish such tasks as diagnosing equipment problems, forecasting stock trends, scheduling production, and designing new products.

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See, Hear, Learn

Combining knowledge systems with multimedia and virtual reality yields intriguing results 119

Glossary

CBR (case-based reasoning) Programming by example in which knowledge is stored in the form of experiences, or cases.

expert system Technology designed to encode an expert's knowledge into a computer program in the form of IF...THEN rules.

frame-based representation A technique enabling more elaborate data definition of the facets of an object (e.g., constraints and multiple inheritance) than can be achieved with pure object-oriented technology.

genetic algorithm A technique based on natural selection. Generations of bit strings are created, combined, and evaluated using genetic-like operations to find near-optimal solutions.

KBS (knowledge-based system) An application for representing knowledge that offers the ability to analyze this knowledge using IF...THEN rules.

multimedia The presentation of information on a computer using audio, video, text, animation, and graphics.

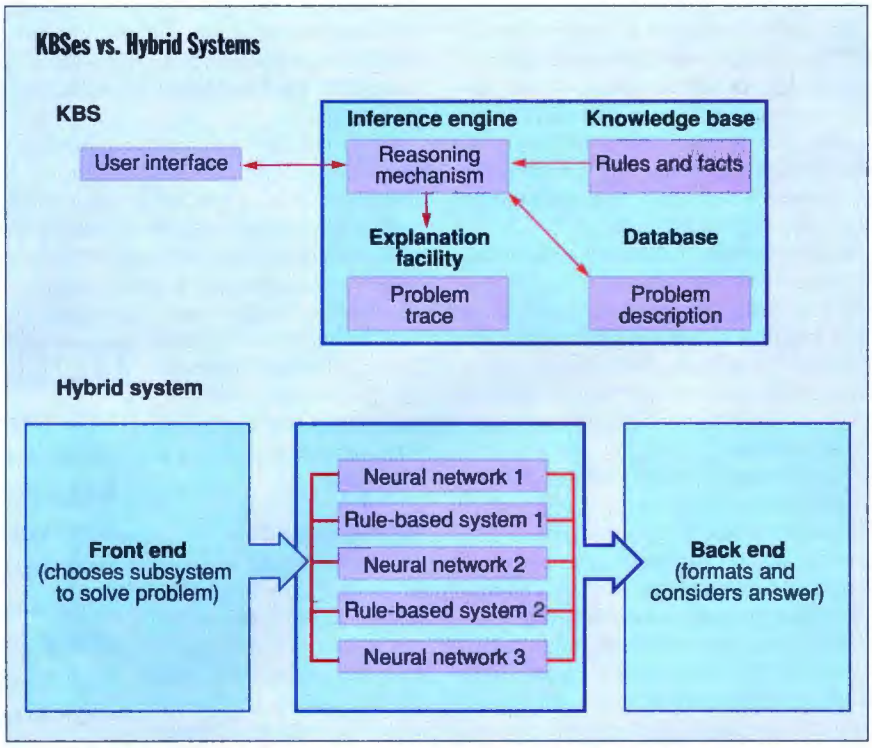
neural network A system that emulates the human nervous system and brain to process information. Neural networks are used for such things as sensor and signal processing and pattern recognition.

procedure-based system An object-oriented programming technique that enables the attachment of behavior to objects in the form of code. When a message is received by the code, the behavior is executed.

rule A technique for representing human problem-solving and heuristic reasoning using an IF...THEN form.

rule-based systems An approach popularized with expert systems that uses IF...THEN rules and frames to encode expertise in a knowledge base. An inference engine controls how the rules are used during the problem-solving process.

virtual reality A process that uses computers to simulate realistic 3-D audio, visual, and tactile worlds.



A generic KBS (knowledge-based system) *relies on its own database, knowledge base, explanation facility, and inference engine, but a hybrid system can select a subsystem to handle each problem through the front end while the back end formats and consolidates partial answers from each subsystem. (Data courtesy of Silverman, Barry.* Expert Systems, *Addison-Wesley, 1987; Eberhart, Russell C., and Roy W. Dobbins.* Neural Network PC Tools: A Practical Guide, *Academy Press, 1990)*

Under the leadership of the Concurrent Engineering Research Center of West Virginia University (Morgantown, WV), the research focuses on integrating intelligent software tools—including KBS and CBR—to support the coordination of engineering activities.

Another innovative group in this arena is the Knowledge Assisted Design Lab at Carnegie Mellon University (Pittsburgh, PA), under the direction of D. Navin chandra. The lab is mixing KBSes, CBR, and natural-language-query techniques to create a system that captures and makes available to users all the design decisions of the corporation. With this information, employees can avoid repeating mistakes made by others, says Navin chandra.

New Hybrids

Some hybrid systems are commercially available today. For example, Art*Enterprise from Inference (El Segundo, CA) represents a new generation of KBS tools packaged for the complex tasks of coordinating the functions of a corporation. Art*Enterprise combines the usual KBS technologies (i.e., rules, frames, object-oriented programming, and GUIs) with CBR, corporate databases, and multimedia. "The result is a scalable development tool that enables a range of applications in one environment," says Chuck Williams, Inference's vice president of marketing.

Using the same environment, Art* Enterprise allows you to build a conventional query-and-update application merely by pointing and clicking on the program's interface. You also have the option of building custom, complex applications that blend KBS and CBR technology. Other general-purpose KBS software development tools from such vendors as IntelliCorp (Mountain View, CA) and Trinzic (Palo Alto, CA) provide many of the same features as Art*Enterprise, but they do not have built-in CBR or multimedia capabilities.

Some KBS Development Tool Components

- **a rich knowledge-representation language combining frame-based and object-oriented representation schemes**
- **message passing**
- **reasoning through rules**
- **a GUI**
- **the ability to integrate with such systems as databases, sensors, and news feeds**

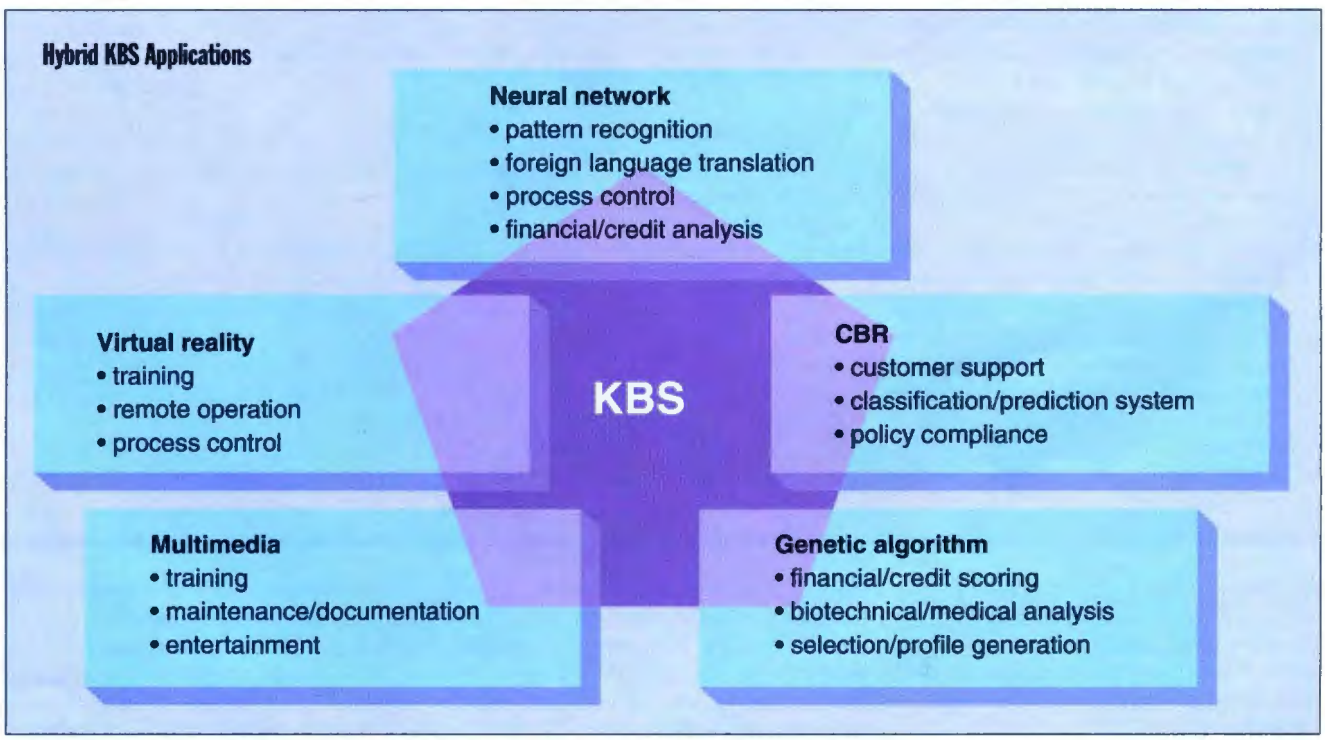
For years, KBS technology has been integrated into process-control systems, monitoring and controlling the workings of such facilities as plastics factories and nuclear power plants. The KBS analyzes all information provided by the control devices and initiates corrective actions. This approach is faster and more cost-effective than traditional mathematical methods. Some large process-control vendors, such as Bailey Controls (Wickliffe, OH), now offer or are currently developing products that combine KBS and controller technologies.

Hybrid Knowledge-Based System Trade-offs

Combine a KBS with:	PROS	CONS
Neural networks	The system learns/trains itself and provides high-response accuracy.	It often requires prolonged training and offers no explanations for its results.
Case-based reasoning	The system is able to store, analyze, and process previous experiences/decisions. Inductive systems explain themselves.	There is no standard underlying the adaptive algorithms. The system has difficulty prioritizing cases.
Genetic algorithms	The system can search an entire domain for a solution, and it breeds on established success paths.	It is developmentally difficult and computationally expensive.
Multimedia	The system integrates graphics, text, sound, and video. It's simple to use and consists of increasingly commonplace technology.	It accesses stored knowledge unintelligently. The system is resource intensive and expensive.
Virtual reality	The system can immerse a user in a 3-D environment and remotely simulate movements and situations.	Its applications are mainly used for entertainment or military purposes. The system requires sophisticated equipment.

* Data courtesy of Cognitive Systems (Stamford, CT) and Symbologic (Redmond, WA)

The dominant KBS player in this market niche is Gensym (Cambridge, MA), which introduced a new product, called NeurOn-Line, that layers neural-network technology onto G2 Real-Time Expert System, Gensym's general-purpose KBS/process-control tool. NeurOn-Line's algorithms allow it to learn while it's monitoring a process. "Now we can have nonlinear adaptive models," explains Gensym's president



Combined with a base KBS (knowledge-based system), *such technologies as CBR (case-based reasoning), neural networks, and virtual reality help create applications suitable for a wide range of tasks.*

Help Is on the Way

STEVEN L. SPERRY

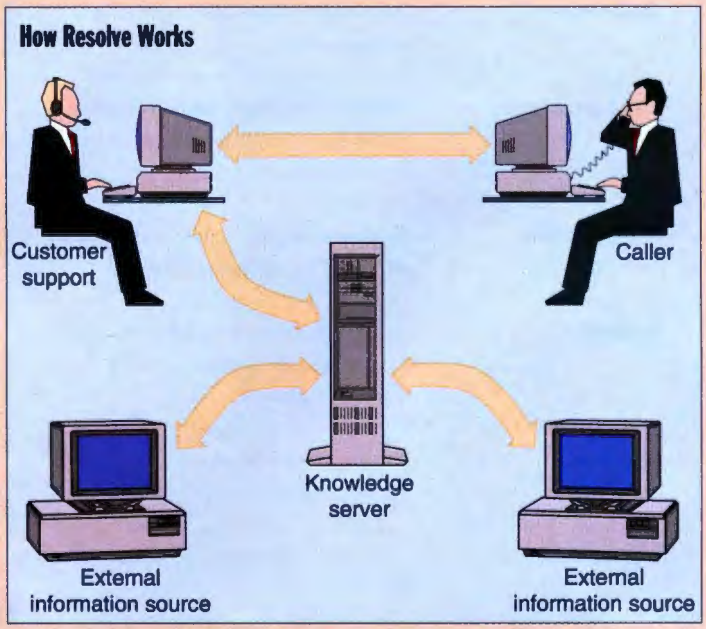
Product support has been called the computer industry's battleground of the 1990s. To help support staffs solve customer problems faster and more accurately, companies are seeking efficient techniques that combine proven knowledge-engineering and information-retrieval technologies with an open, component-based architecture.

No single technology or retrieval algorithm can yield the optimal way of creating a powerful product-support system. But the Customer Support Consortium, an alliance of 20 computer-industry leaders—which includes Banyan Systems, ComputerLand, Intel, IBM, NCR, DEC, Hewlett-Packard, Silicon Graphics, Legent, 3M, and Sybase—has come up with a hybrid product called Resolve that might do the trick. Developed by Symbologic, a software development firm in Seattle, Washington, Resolve combines CBR (case-based reasoning), text retrieval, a relational database, and an expert system and provides a C++, object-oriented front end.

Solving product-support problems is a complex and dynamic task. A firm's knowledge base is constantly shifting and evolving. And with ever-accelerating product releases and shortening life cycles, product knowledge may become obsolete soon after it's acquired, or it may be valid for years.

Problem resolution is further complicated by its multifaceted nature: A person providing support must investigate, analyze, and document each transaction. The person must synthesize all these elements to fully understand the problem.

Resolve is based on a client/server model with a distributed, object-oriented architecture. The system's components can reside on either the client or the server. And the data-storage technology is a persistent, shared-object space that will be provided by an object-oriented DBMS from Object Design (Burlington, MA).



Resolve *aids support personnel in answering customers' questions. A support person enters problem information into Resolve. Because it's a client/server system, Resolve resides on both the desktop component and the knowledge server. Resolve generates queries on the information and submits them to the knowledge server. If the answer isn't there, Resolve sends the query to information servers, which could be databases in other parts of the company. Resolve then filters and returns the results of the queries to the support person.*

The application is designed to acquire knowledge dynamically while the support person resolves the caller's problem. Support staff can use any available information resources to reach a solution, such as databases, E-mail messages, on-line documents, and CBR systems. Each information server, or retrieval tool, accesses on-line information resources, which can be located anywhere within the enterprise.

Smarts Beget Smarts

The main components of the Resolve system are the user interface, problem-resolution facility, knowledge server, object database, and information server. The user interface is the support person's visual workspace, where information returned from searches is rendered as graphical objects. The interface can be embedded in and accessed through a call-tracking system, a combination of telephone and database technology that can handle thousands of calls a day.

The problem-resolution facility translates the support person's understanding

Bob Moore. "Processes are nonlinear. So, this is a breakthrough to allow true optimization of advanced control not previously possible with mathematical models. The neural network's ability to learn allows adaptation."

Some of the latest work in combining KBSes with other technologies has been pioneered by the Carnegie Group, whose products are available through its consulting services. The company recently integrated Testbench, its KBS tool for equipment troubleshooting, with hypertext, neural networks, and CBR.

According to the Carnegie Group's Yablonsky, Testbench detects symptoms, analyzes failures, and recommends repairs. Text and graphics technology have been added so that equipment and troubleshooting documentation can be stored in hypertext. Integrated neural-network capabilities enable the system to learn and adapt in nonlinear situations. Finally, the Carnegie Group included CBR in the system so

of the problem into queries against the external information sources. As part of the system's response to the search, the facility evaluates and ranks the relevance of the results.

The knowledge server manages the object model of the support domain and queries against the knowledge base, where dynamically acquired problem/solution information is stored. The object database provides the persistent, shared-object space for the system. This component manages and synchronizes distributed object storage and access. Information servers generate queries against external information sources (e.g., document and bug databases) and package the query results as objects that can be evaluated by the problem-resolution facility and rendered by the user interface.

Resolve's component-based architecture makes it possible for third-party retrieval products to be incorporated into the support staff's set of tools. When new products and new versions of products become available, a company can quickly augment, change, or merge the elements of its knowledge-base model.

Because customer-support applications are so knowledge intensive, the companies that most efficiently acquire and distribute knowledge will eventually achieve the high ground. Hybrid systems that combine many information technologies provide the means for firms to win the battle of customer support.

Steven L. Sperry is president of Symbologic. He is also executive director of the Customer Support Consortium. You can reach him on BIX c/o "editors."

that unstructured information in cases could be available as another knowledge source to Testbench.

Software Integration

Some of the greatest challenges arising when combining KBSes with other technologies are software integration problems, says Michael DeBellis, a scientist at Andersen Consulting. DeBellis has been struggling with this problem for the past few years in the course of his work on a KBS/CASE research project. In the easiest scenario, both the tools used in the hybrid system are written in C, so communication is straightforward. However, when one tool is written in an object-oriented language (e.g., Smalltalk) and the other is written in a different language (e.g., C), communications become more difficult unless the tools support the same communications protocols.

Another way of integrating different architectures is by working through a central object-oriented programming representation that glues diverse architectures together, says DeBellis. Much of the work involved in combining KBSes with other intelligent technologies uses a hybrid object-oriented frame architecture for this purpose.

However, even using KBS/object-oriented techniques to blend different architectures doesn't solve all the integration problems, because standards are just beginning to emerge in the object-oriented world. Thus, if you are combining two object-based systems, you'll probably still encounter differences between the two that will complicate the conversion of objects.

Making the Right Choice

The new combinations of KBSes and other technologies are giving computers the intelligence to adapt to work environments, access and use vast data banks, and assist in performing tasks intelligently. The challenges lie in appropriately applying these tools to the most pressing business problems.

"What you need to do is examine each problem you want to solve," says Joe Carter, a partner at Andersen Consulting responsible for emerging computing technologies. "Given the nature of the problem that you're confronted with, which of the many techniques available to you is best suited to do the job? Don't try to shoehorn [it] all into one technique. You have a variety of tools now. You can choose the right set of tools and techniques for each application." ■

Sara Hedberg is president of Emergent (Issaquah, WA), a marketing-services firm specializing in emerging software technologies. You can reach her on BIX c/o "editors" or on the Internet at hedberg@halcyon.com.

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ROLL YOUR OWN HYBRIDS

Linking knowledge-based systems with other technologies, such as neural networks, can enhance performance, fault tolerance, and reliability. A hybrid system often gets the job done when a single technology can't. The trick is to come up with the right mix of features for the task you're working on.

JAY LIEBOWITZ

DOLORES FAIRMAN © 1993

Stand-alone expert systems are becoming dinosaurs. They are last-generation technology. Approaches using more reliable KBSes (knowledge-based systems) in combination with CBR (case-based reasoning), neural networks, or genetic algorithms have become this generation's solution to critical problems in the work enviroment.

Hybrid systems take advantage of each technology's best features. For example, CBR's case-based foundation and powerful search capabilities allow you to prototype software rapidly and to create new applications, such as text-retrieval and product-support systems. CBR technology supplements the ability of an intelligent system (i.e., a system with embedded knowledge from human experts or past experience) to store and analyze data. A neural network adds accuracy and fault tolerance to a KBS, and a KBS can explain why a neural network behaves as it does. KBSes gain better search-and-development capabilities when merged with genetic algorithms. And multimedia and virtual reality add sound, animation, and 3-D graphics to intelligent systems.

Linking several technologies creates a knowledge base that can be used to analyze problems in a commonsense manner—much as people do. For example, Doug Lenat, a principal scientist at Microelectronics and Computer Technology (Austin, TX), developed Cyc (an encyclopedic knowledge base), which combines specialized KBS processes (e.g., inferencing procedures and a natural language interface). Cyc leverages knowledge across domains, so knowledge in one field can be applied to decision making in another.

Nowadays many people in the AI world believe that it's critical to integrate intelligent systems with such techniques as

Roll Your Own Hybrids

simulation and optimization, interactive multimedia, neural networks, and genetic algorithms. Experiments have shown that use of these combinations can keep firms competitive by enabling them to bring products to market rapidly and cost-effectively. Also, many hybrid systems allow you to reduce the time it takes to perform routine business operations.

By the mid-1990s, it's highly likely that object-oriented languages, development tools, knowledge-system shells, and current CASE tools will merge into a single product.

—Kevin Murphy
James Martin & Company
(Reston, VA)

Brainy Networks

Used alone, KBSes are powerful, yet they have limitations. They can't always handle large applications. Their reasoning isn't adaptive. And their performance doesn't increase with experience. In addition, they require too much human input and long, expensive development. But for some applications, these hurdles can be overcome by coupling KBSes with complementary approaches, such as neural networks and genetic algorithms.

Neural networks consist of parallel networks, or groups, of simple, highly interconnected processing units. They are well suited for pattern recognition, foreign language translation, process control, and parallel implementations of routine processing tasks.

But neural-network technology is evolving, and there are still shortcomings. For instance, neural networks require the input of large numbers of test cases to obtain accurate results, and even then, the results are difficult to explain. Some of the technology continues to demand that a network undergo extensive training. And the number of neurons in a neural network limits the network's storage capacity.

Even so, the logical, cognitive, and mechanical nature of a KBS complements the numeric, associative, self-learning, and biological nature of neural networks. Larry Medsker, a professor of computer science at American University (Washington, DC), says that combining neural networks and KBSes provides system improvements in many areas, including graceful system degradation, generalization, explicit and implicit reasoning, incremental learning, reliability, and flexibility.

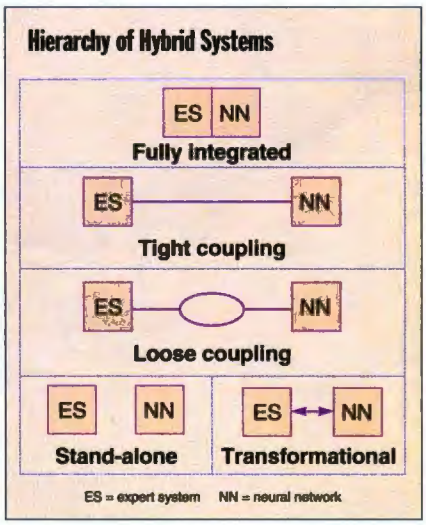
To gain the advantages that these hybrid approaches offer, you need an integration architecture. One such architecture, called the *loose-coupling* model, uses an expert system and a neural network as stand-alone modules that communicate via data files.

Scientists at Computer Sciences (Beltsville, MD), a firm that provides computer programs to NASA, have used this architecture at the Goddard Space Flight Center (Greenbelt, MD). The process uses neural networks to filter out poor-quality data transmitted from satellites. The resultant data is then sent to a KBS for classification.

Another architecture is the *tight-coupling* model. In this approach, an expert system and a neural network are also separate, independent modules, but they communicate via parameter or data passing.

Using the tight-coupling architecture at Loral Aerospace (Houston, TX), Matthew Hanson, manager of software engineering and development, and Robert Brekke, manager of integration, verification, and testing, developed WMES (workload management expert system). The system uses a neural network to determine staffing needs based on such factors as staff availability, workers' skill, and project start dates. An expert system interacts with the neural network to estimate what resources will be required.

A third architecture is the *fully integrated* model, which uses a shared data structure and knowledge representation (i.e., a neural-network node can represent part of a rule). Connectionist systems, or parallel distributed-processing systems, can use this architecture.



At the bottom of the hierarchy, *the stand-alone and transformational models are separate modules of a hybrid system, with no communication passing between them. Higher in the hierarchy, as communication via data files and parameter passing is added, a hybrid system becomes more complex and easier to develop into a more useful system. In the loose-coupling architecture, the ellipse represents files being transferred between the two elements of the system; the straight line indicates direct communication. The fully integrated model is so unified that the distinction between the modules is blurred.*

Coupling neural networks with KBSes has limitations, though. Their development complexity and maintenance require an experienced staff and established guidelines. And even though the market offers good hybrid tools, such as Nuex Shell from Charles River Analytics (Cambridge, MA), there just aren't enough of them. Finally, you need a multiprocessor system to achieve acceptable run-time performance.

CBR to the Rescue

CBR enables a system to store past experiences or situations as cases, analyze and process the data, and suggest ways of responding to a problem. A CBR system has two primary components: a case base and a problem solver.

A case base contains descriptions of previously solved and unsolved problems. A problem solver consists of a case retriever and a case reasoner. The case retriever identifies data (either by using a nearest-neighbor search or by using indexes or other techniques) in the case base that most appropriately fits the situation and presents it to the case reasoner. The case reasoner examines the cases and, with the aid of domain knowledge, performs adaptation, synthesis, or prediction.

Organizations like DEC (Maynard, MA), Compaq Computer (Houston, TX), and Canada's Toronto Stock Exchange are using CBR and intelligent systems together. The applications take the form of field service, software reuse, project costing, product/order configuration, text retrieval, and database mining.

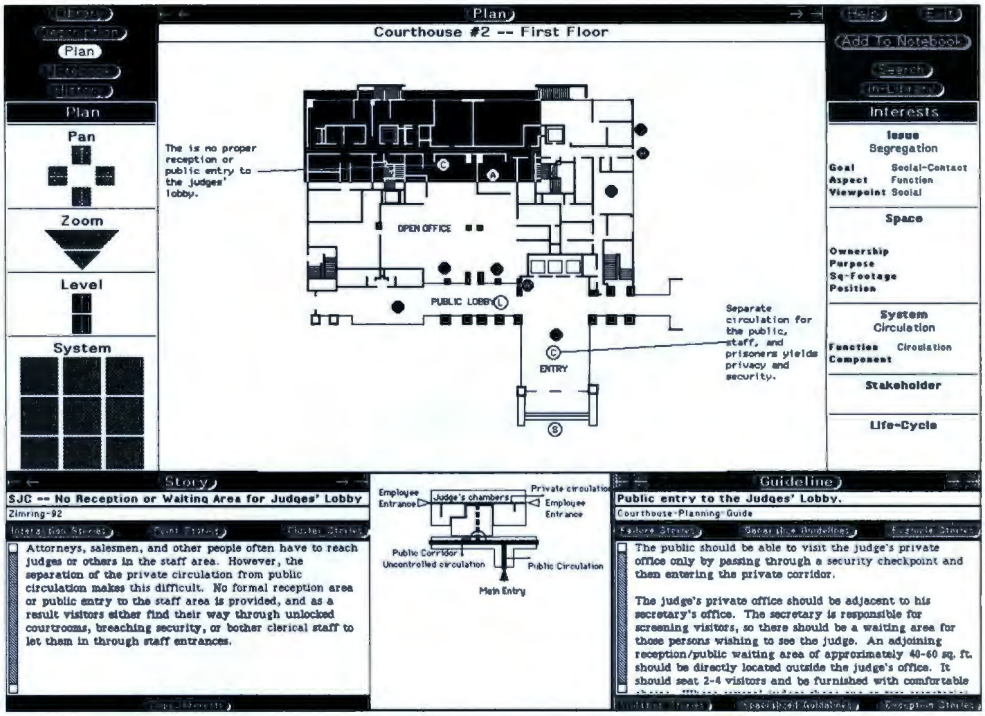
One reason for the increasing interest in developing CBR applications is the increasing availability of CBR tools, says Ralph Barletta, vice president of software technology at Cognitive Systems (Boston, MA), a software development company. One such package is Archie, a CBR tool developed by Janet Kolodner, Ashok Goel,

Roll Your Own Hybrids

Eric Domeshek, and their colleagues at the Georgia Institute of Technology (Atlanta) to help architects handle conceptual design problems. ReMind from Cognitive Systems, CBR Express from Inference (El Segundo, CA), and Esteem from Esteem Software (Indianapolis, IN) are a few other packages that are now available.

CBR and rule-based reasoning complement one another, says Steve Mott, president of Cognitive Systems. Rules handle big chunks of problem domains well, but they are less useful or cost effective in the boundary areas where subtle contexts tend to exist. Cases, on the other hand, can model entire domains if you assemble enough cases to cover every problem area in the domain.

Why build an expansive case base if much of the domain can be covered by rules? A good approach for solving problems is to "model the domain with rules as far as you can, then apply CBR to handle the boundary region exceptions," Barletta says.



Archie *is a tool consisting of KBS and CBR technology that provides architectural design support. Here, the system is responding to a request for previous cases pertaining to secure ways of placing people in a courtroom. The floor plan provides two options; a rule is displayed on the bottom right.*

Survival of the Fittest

Another enabling and emerging AI technology is genetic algorithms. These are adaptive, general-purpose search techniques that are based on the principles of population genetics. A genetic algorithm maintains a list of possible solutions to the problem at hand. Based on whether or not the previous solutions were successful, the fittest solutions not only survive but also exchange information with other candidates to form new solutions.

The U.S. Navy's System Integration Test Station laboratory at Point Mugu Naval Airbase (Point Mugu, CA) has implemented genetic algorithms in scheduling applications. You can also use genetic algorithms to train a neural network. The Navy Center for Applied Research in Artificial Intelligence at the Naval Research Laboratory (Washington, DC) has been using genetic algorithms to help robots develop learning and adaptation capabilities.

You can integrate genetic algorithms with rule-based methods to develop systems that generate new rules. Genetic algorithms are useful for inductive learning, conflict resolution, and classification.

Hybrids Enhance Performance

Pattern recognition and analysis

Neural networks provide pattern-recognition functionality, and KBSes perform analysis.

Interface issues

User-machine interactions are improved when the KBS can explain to users how a neural network arrived at a solution to a problem.

Training neural networks

KBSes can help train neural networks by providing intelligence to create the training sets and test sets.

Knowledge acquisition and engineering

Neural networks develop implicit knowledge that supplements KBSes' explicit rule-based knowledge.

Objectively Speaking

OOP (object-oriented programming) can also play an important role in hybrid systems. Objects are data structures that contain both data and procedures. You can use objects to represent knowledge with class hierarchies, slots, methods, and instances. Objects can also be used to create interfaces and GUIs with windows, icons, images, and dynamic images (e.g., graphics or mouse-sensitive areas).

Pattern-matching rules emanate from the combination of object processing and inferencing. These rules are more efficient and easier to read when the system is processing large amounts of data, says Jan Aikins, vice president of technology at Trinzic (Palo Alto, CA), a firm that provides advanced applications development tools for business automation.

The benefits of combining object processing and inferencing were demonstrated by Aion's Extruder system. This application schedules work orders for producing plastic tubing on machines called extruders. Using an OOP/rule-based hybrid approach, Aion reduces the time required to schedule orders from 11.8 seconds to 3.6 seconds.

What lies ahead for hybrid KBSes? In the next three to five years, knowledge-representation technology will increasingly use rules, objects, cases, genetic algorithms, and neural networks. The integration of two or more of these approaches will be important in a number of environments, such as simulation and process control, where knowledge cannot be fully portrayed by a single representation scheme. ■

ACKNOWLEDGEMENT

My thanks to Larry Medsker for his help with this article.

Jay Liebowitz is a professor of management science at George Washington University. You can reach him on BIX c/o "editors."

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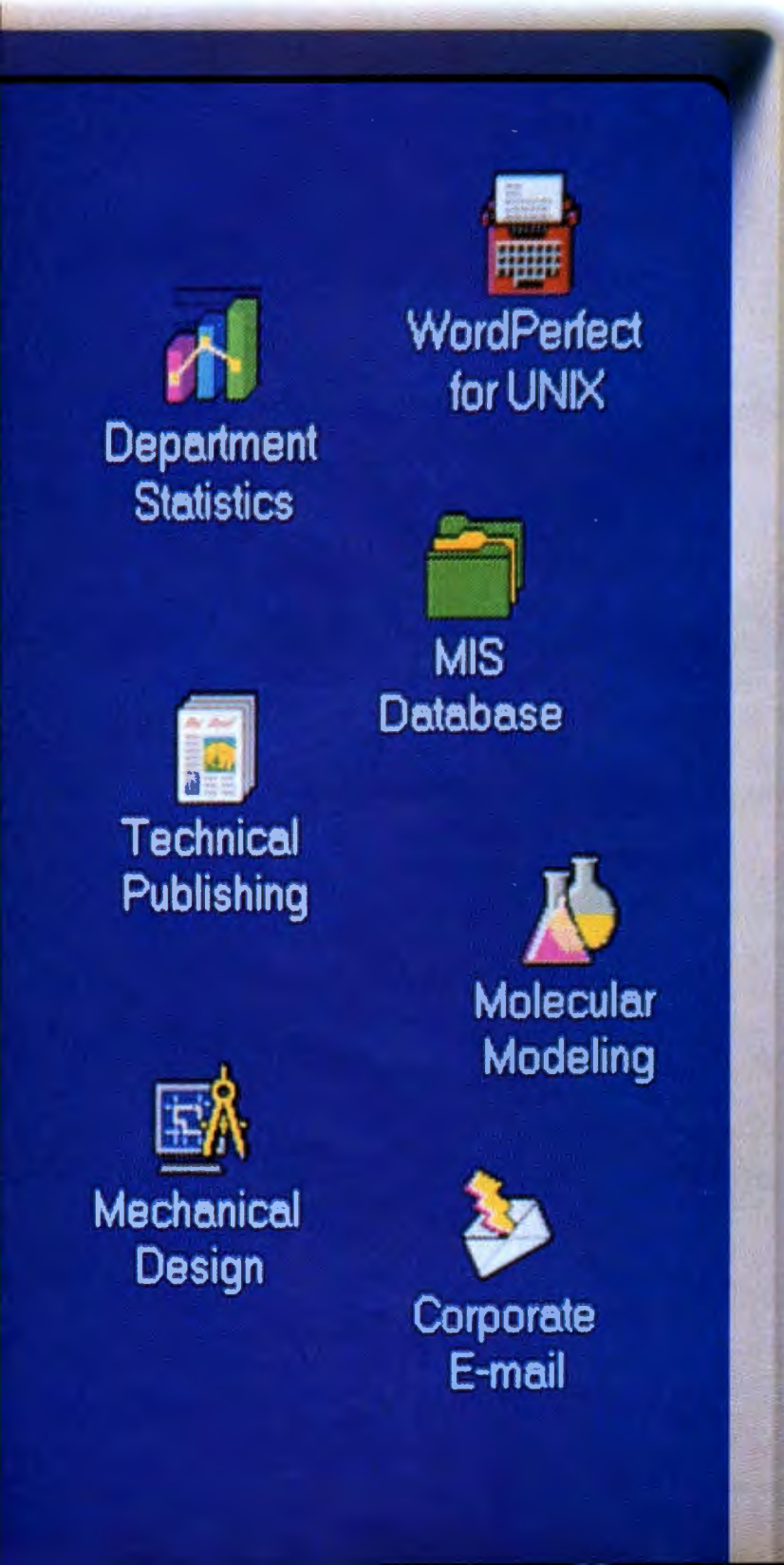

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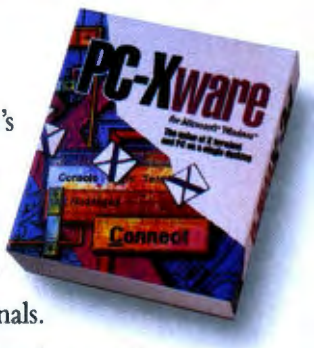

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Combining the audiovisual environments of multimedia and virtual reality with knowledge-based systems will create fascinating applications. This technology could change the way you deal with information.

SARA HEDBERG

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Multimedia and virtual reality are exciting technologies by themselves, but by adding intelligence to them, researchers are creating some intriguing possibilities. These new hybrid KBSes (knowledge-based systems) are still in the experimental stage—most are at least a year away from commercial use—but they will provide the tools that will change the workplace in the years to come.

To multimedia, KBSes bring intelligent storage, indexing, retrieval, and distribution. In the world of virtual reality, a KBS provides the technology to create intelligent agents—virtual Cheshire cats to answer your questions and direct you to shortcuts.

Intelligent Navigation

Imagine the day when you have access to vast libraries of video clips on almost any topic and intelligent assistants that help you retrieve information and explore areas of interest. This is exactly the kind of experimental work under way at Northwestern University's ILS (Institute of the Learning Sciences, Evanston, IL), led by Roger Schank.

Schank's group has developed a "smart" object-oriented/CBR (case-based reasoning)/multimedia navigation tool. Called Ask, it intelligently indexes and retrieves short video clips (i.e., 1 to 2 minutes) and text. Ask creates knowledge bases about the clips and indexes them by content. The user can navigate through the stored videos and retrieve footage interactively through conversational-style queries regarding the context of the clips.

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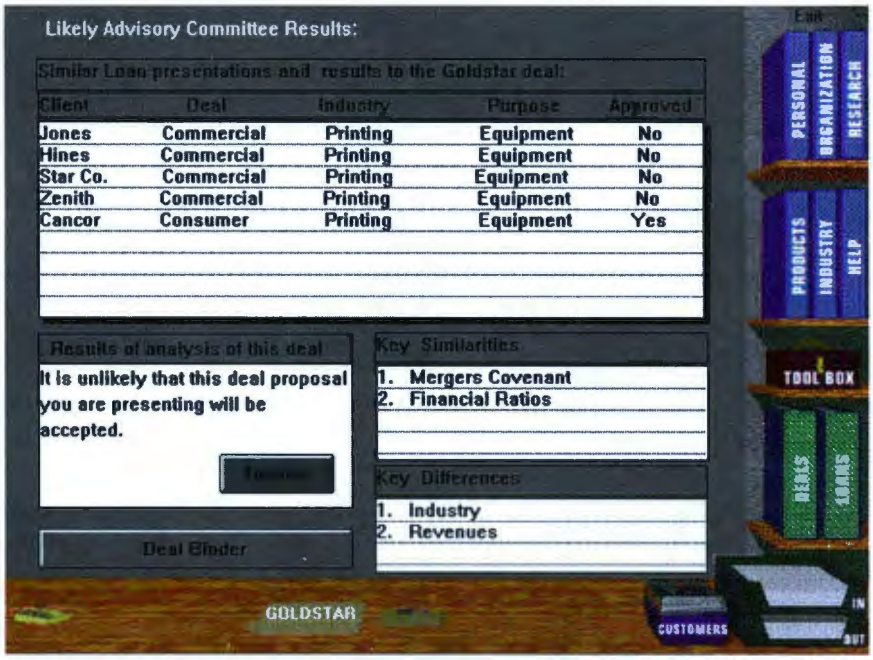

Andersen Consulting's TIM *uses CBR to analyze previous situations that are similar to the loan request being considered. Inference's Art*Enterprise, a knowledge-based development package, provides the case-based analysis.*

by a video clip of the crater or beach of interest. And if you're lured by the beauty of the beach, you can branch off and learn about travel to Bali.

Schank's group worked with the transportation command of Operation Desert Storm to film the experts who managed the monumental task of moving the equipment, troops, and matériel to Saudi Arabia. The expertise gained from the experience is now indexed and available through the Ask system.

The concepts that ILS is pioneering can easily be transferred to other areas of our lives. For the business world, Schank's group has built applications using Ask that range from trust bank consulting and tax accounting services to corporate management.

ILS is also working in a Hispanic area of Chicago on a project called Community Ask, which is intended to enable citizens to ask questions of local officials and professionals via TV. The project presages better things to come. With the establishment of a high-speed, fiber-optic data

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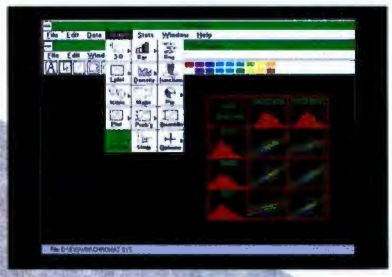

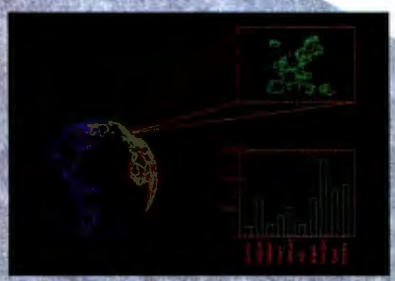

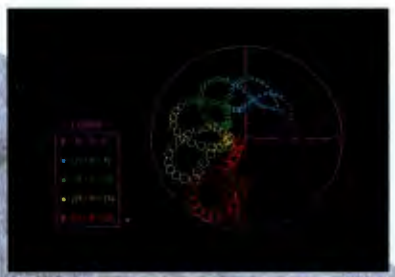

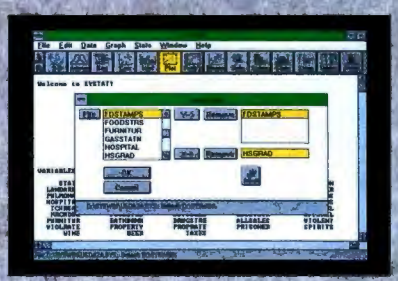

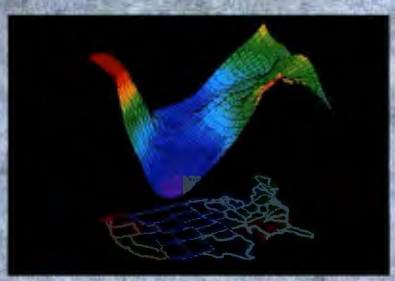

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highway, very much like the one being discussed by the Clinton administration, Schank envisions being able to deliver intelligent multimedia applications right into your home.

Another ILS system, called Creanimate, teaches students biology by allowing them to create their own animals. Creanimate uses intelligently linked videos to teach about the relationship between survival in the wild and the physical attributes of animals.

Experiments applying KBSes to multimedia are springing up elsewhere. For example, a major U.S. manufacturer is investigating KBS-multimedia systems as a form of technical memory and advice. Using such a system, a design engineer could simultaneously bring up an analysis of a competitor's product and the design-for-manufacturability requirements. The company has developed prototypes in this area using industry standards (e.g., personal computer platforms and video peripherals). Such systems might someday be accessed across distributed networks, bringing KBS-multimedia tools to the problems of enterprise coordination.

Metaphor Interfaces

Andersen Consulting (Chicago, IL) has long been an innovator in applying KBS technologies, and it's currently working on a support system that will help commercial loan officers make calls, structure deals, and maintain client relationships. The application, called TIM (Total Information Management), is the focal point for a number of emerging technologies, integrating KBS, CBR, multimedia, and voice synthesis.

At the heart of this hybrid KBS sits Art*Enterprise from Inference (El Segundo, CA). The object-oriented Art*Enterprise makes the integration of KBS and multimedia technologies natural and easy, says Mark Orttung, a manager in Andersen Consulting's hypermedia group.

"We bury multimedia in an object," explains Orttung. "For example, the object is a story from another lender. The attributes of that object would include the features of the story, when the story is relevant, plus a pointer to the actual video." When a message is sent to the video attribute, the film is called and played through MCI (media control interface) control strings, the standard to control multimedia within Microsoft Windows.

TIM's video component resides on a 66-MHz 486 with two special boards: Speech Commander for voice recognition, which is available from Verbex Voice Systems (Edison, NJ), and ActionMedia II for video acceleration and compression, which is sold by both Intel (Santa Clara, CA) and IBM (Armonk,

Applications in the Works

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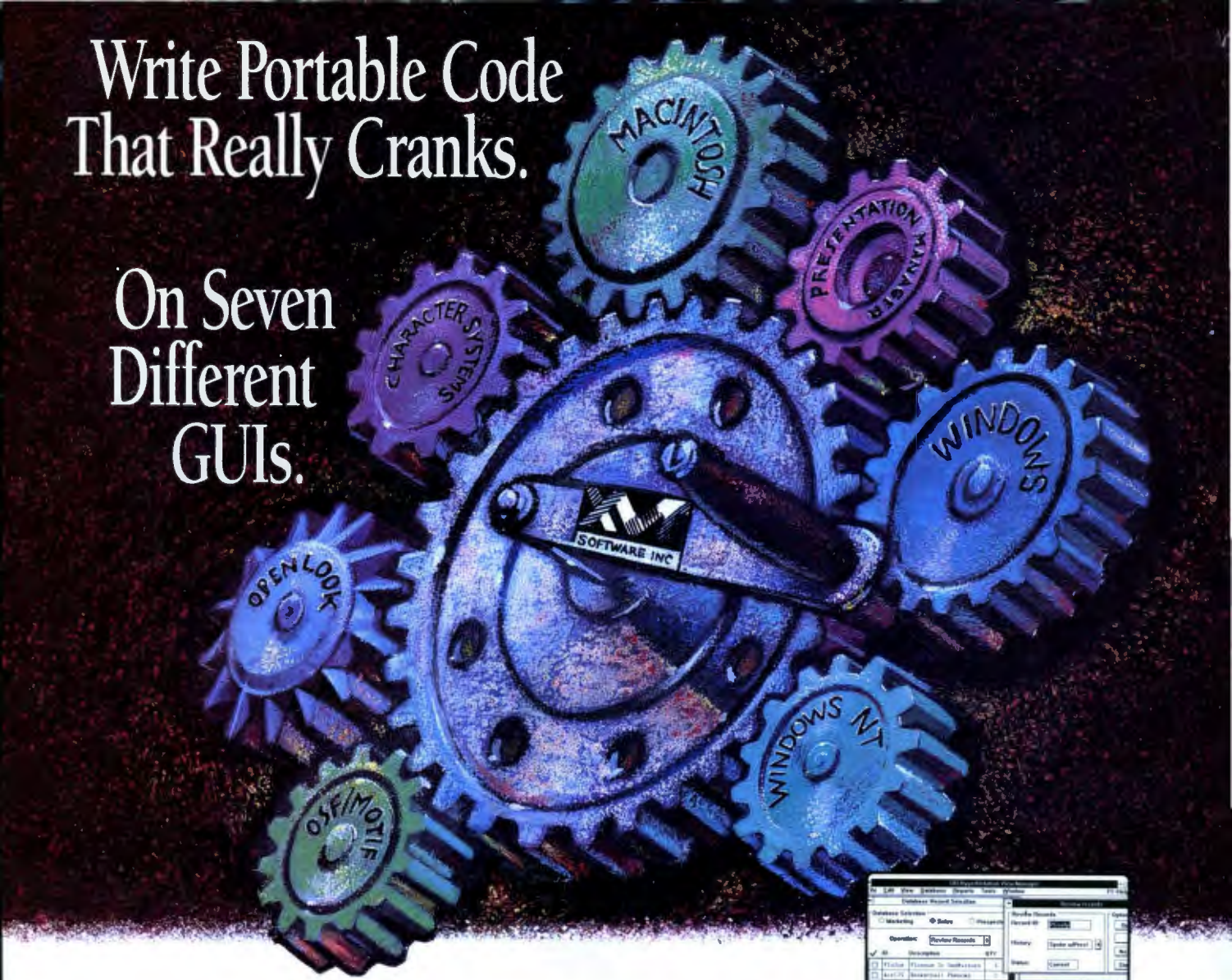

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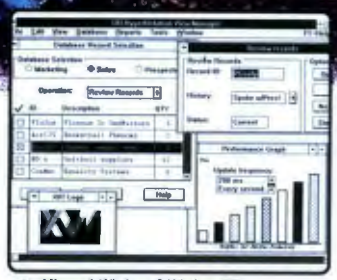

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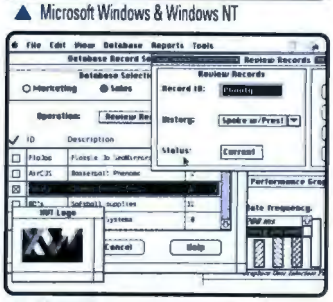

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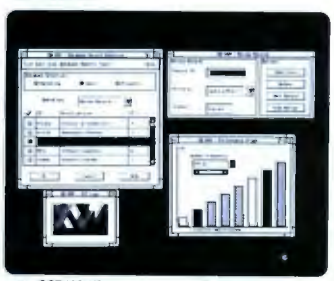

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Shown above are four of the seven GUIs supported by XVT.

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NY). The TIM video is filmed with a camera, digitally captured, and stored directly on a hard disk. Andersen Consulting uses a special tool from Protocomm (Trevose, PA), called Videocomm, to store video on a server and play it on a client.

The KBS component of TIM stores knowledge, automates decision making, and filters news feeds. Various types of advice are available through KBS rules. For example, if a banker must deal with an overdraft, he or she asks TIM to suggest a course of action. Behind the scenes, the KBS is invoked, and TIM presents the banker with three possible solutions, a recommendation on the one most likely to succeed, and an explanation of why it made the recommendation. In addition, instead of taking a rule-based approach, TIM can provide anecdotal information through multimedia.

TIM also uses the CBR techniques integrated into Art*Enterprise. For instance, TIM can compare a customer's needs to the products that are currently available on the market, because these are matching problems well suited to CBR.

We can make a computer look like a magazine, a classroom, a shopping mall, a cockpit—virtually any familiar metaphor. This turns the computer into a chameleon.

— Joe Carter
Andersen Consulting
(Chicago, IL)

"The problem with an application like this," says Joe Carter, Andersen Consulting's partner responsible for emerging technologies, "is that the amount of capability and functionality is so enormous that it's easy to get lost. You almost need a college degree to navigate through it."

According to Carter, the solution is to organize such systems around a metaphor. "Using such an organizing metaphor cuts down on the training requirements to use the system, because people are already familiar with the interface."

In the case of TIM, the interface that a commercial lender sees on his or her computer looks much like a desk with files, notepads, and calendars. All the underlying computing is transparent, whether it's a call across a network to a video server for a piece of film or the use of rules to solve a problem.

TIM integrates a number of off-the-shelf products, such as Microsoft Mail, Excel, and Word. The API of each is wrapped in an object in TIM to integrate the applications. "Each type of application is different to wrap in an object," says Orttung. "An Excel spreadsheet, for example, is easier,

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because it is structured in discrete pieces, as opposed to a Word document, which is one big chunk."

TIM's client machine enables a commercial lender to view information at a high level, such as a summary of all loans. It also enables the user to scan relevant news or dive into the details of a specific loan. The entire complex application is glued together with the KBS's object-oriented representation capabilities, as embodied in Art*Enterprise.

This electronic shopping mall application *uses virtual reality techniques to create a metaphor interface. Each person on the screen is an agent with a knowledge base from which the agent formulates answers to your queries.*

Virtual Knowledge

Andersen Consulting is working on a virtual reality–like system using hypermedia to design an electronic shopping mall. You "walk" through the stores in 3-D space using a mouse or joystick. Intelligent agents advise you on, say, buying a business suit. One agent might tell you about the latest fashion trends. Another might act as a tailor. And another might be a confidante, frankly telling you how you look in an outfit.

The equipment needed to create the mall will be set up in your home, and it will include a personal computer, a converter that sits atop your TV, a CD-ROM multiplayer, and a port connected to your telephone or cable box. The system will be tested next year.

The biggest obstacle is bandwidth: The highest rate at which standard copper phone lines transmit data is 19.2 Mbps. This rate simply isn't adequate for the data traffic of the system. It will require fiber-optic lines

State of the Art

A NASA Ames researcher *uses a Boom to look at data on computational fluid dynamics. Simulation software created on a Cray supercomputer by NASA processes the math. You can explore the data produced by the Cray by running Fakespace's interactive-virtual-environment application on a Silicon Graphics workstation.*

that are capable of transmitting up to 40 Mbps, which many telephone and cable companies are now installing at a rapid pace.

John Laird, an associate professor of electrical engineering and computer science at the University of Michigan (Ann Arbor), is exploring the nascent area of integrating KBSes and virtual reality. The work is part of an initiative funded by the U.S. Department of Defense to use virtual reality in the training of tank personnel. Laird is developing intelligent agents who serve as enemies that seem real but fire only virtual ammunition.

At Fakespace (Menlo Park, CA), clients are using KBS–virtual reality technology with robots. Cameras mounted on a robot look at the real world. A KBS captures the data relayed by the robot and checks it against its model. If there are discrepancies, the KBS determines the cause. For example, if radioactive material has been released in the atmosphere and there is mist in the air, a computer can diagnose the cause and recommend or initiate action.

Even though the integration of KBSes with multimedia and virtual reality technology is experimental today, the implications of adding intelligent storage, access, analysis, and problem solving to such systems are tremendous. You may feel like you're stepping into your favorite science fiction book. Perhaps you are. ■

Sara Hedberg is president of Emergent (Issaquah, WA), a marketing-services firm specializing in emerging software technologies. You can reach her on BIX c/o "editors" or on the Internet at hedberg@ halcyon.com.

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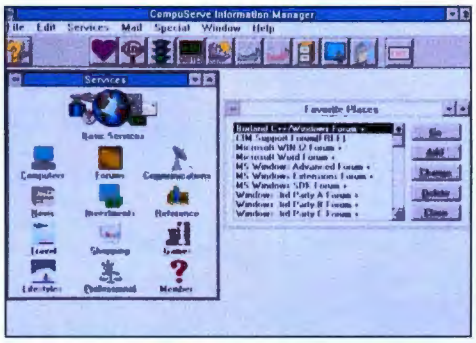

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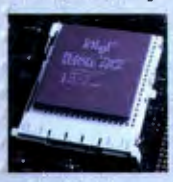

CPU upgradability is only part of the story. Check out the number of drive bays and open slots on the PC you want to buy. ZEOS gives you *six* bays and eight slots —two of which are local bus!

Q. I want incredible speed. What should I look for?

A. For high-speed video that's upgradable with industry-standard graphic adapters, *you want a system that has VESA-standard local bus slots.* As we mentioned above, ZEOS gives you two of them. Our standard super-fast local bus SVGA card includes Windows acceleration, and if you want the video performance that PC Magazine said "blew all competitors away," choose our optional Viper video card. And, because you're getting the VESA standard, you won't get stuck with some proprietary architecture that's obsolete in 6 months. Demand VESA standard with your system!

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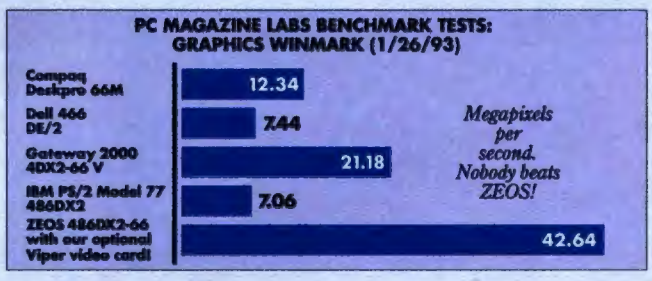

Q. What other things should I look for when I buy a system?

A. Check out the software. Most ZEOS packages come with *everything you need* to get started: your choice between *two* spreadsheet programs (Lotus 1-2-3 for Windows or the exciting new Lotus Improv), a word processing program (Ami Pro) or a presentation program (Freelance Graphics for Windows). That's in addition to Lotus Organizer, Windows, and DOS 6.0 with Enhanced Tools (the latest and greatest!). With all the free software you get with your ZEOS, you save hundreds of dollars!

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486SX-33	1395	1895	2295	2595
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486DX2-50	1695	2195	2595	2895
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Intel 486 CPU	■	■	■	■
ZIF upgrade socket	■	■	■	■
MB of RAM expandable to 64MB on motherboard	2	4	8	16
High-speed IDE hard drive (MB)	107	214	340	452
Built-in hard drive cache	32K	128K	128K	256K
Local bus IDE hard drive interface	■	■	■	■
Seek time (ms)	16	16	12	12
1.2MB floppy drive	■	■	■	■
1.44MB floppy drive		■	■	■
ZEOS 14" high-resolution mono VGA monitor	■			
ZEOS 14" high-resolution 1024x768 non-interlaced SVGA monitor		■	■	■
Monitor dot pitch (mm)	.28	.28	.28	.28
1MB high-speed VESA local bus card with Windows accelerator	■	■	■	■
Eight expansion slots including two VESA local bus	■	■	■	■
Two serial ports, one parallel port	■	■	■	■
Shadow RAM/EMS support	■	■	■	■
Socket for optional on-board SCSI	■	■	■	■
Flash BIOS	■	■	■	■
High-capacity 200W power supply and built-in surge suppression	■	■	■	■
ZEOS SpaceSaver case with six drive bays	■	■	■	■
Two cooling fans	■	■	■	■
ZEOS 101-key tactile/click keyboard	■	■	■	■
Microsoft DOS 6.0 (plus Enhanced Tools)	■	■	■	■
Microsoft Windows		■	■	■
Microsoft Mouse		■	■	■
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Applying the Power of the Pen

Nine pen-centric applications, from spreadsheets to note-takers, challenge the notion that pens are just for vertical markets

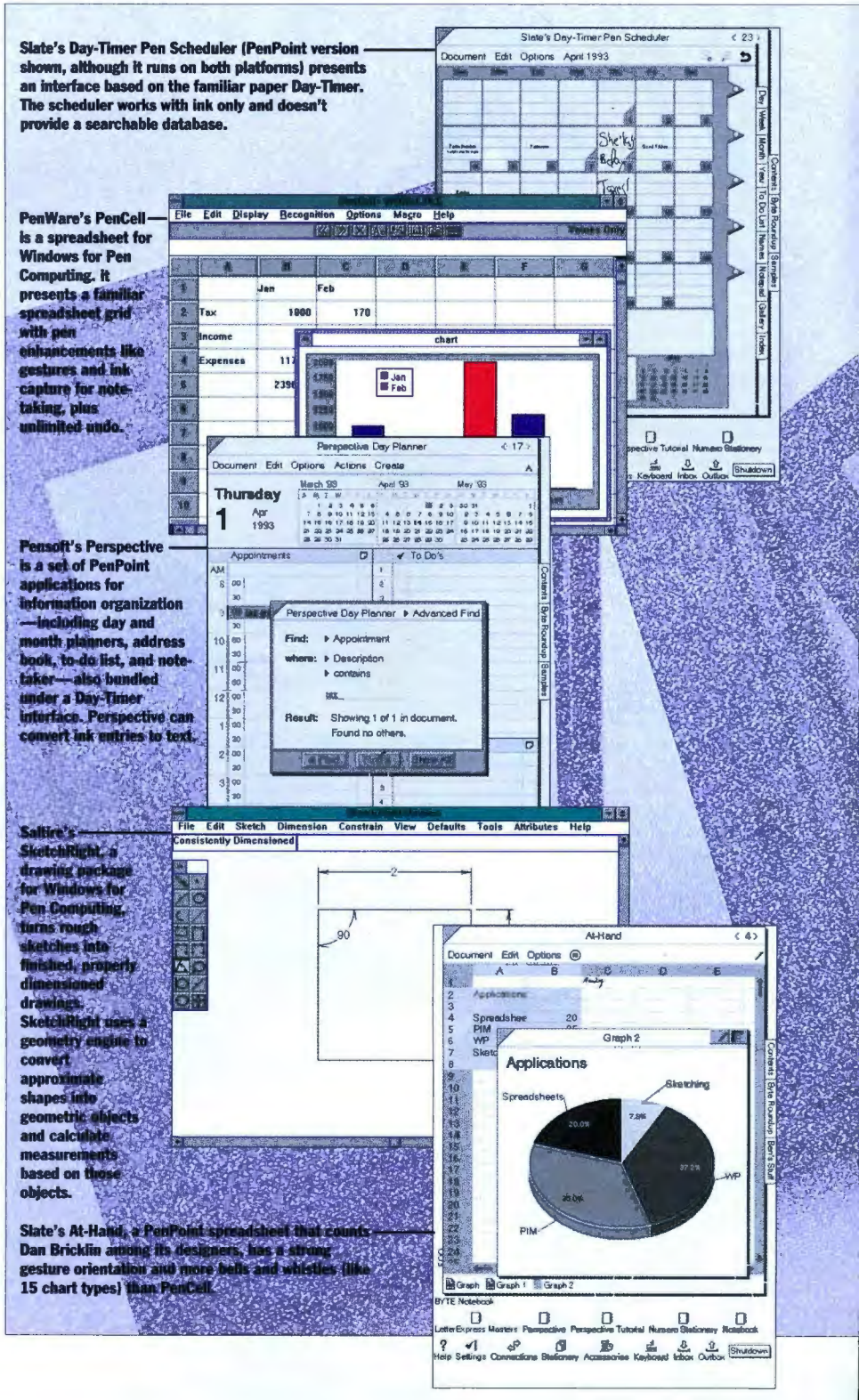
HOWARD EGLOWSTEIN

Despite the hype, pen-based computers are nothing new—it's been over 25 years since a CRT and a light pen first made interaction between system and stylus possible. But though we've cleared many technical hurdles since those early days, pen computing remains an exotic niche. What's recently kept pen systems relegated to such a small chunk of the personal computer market can be summed up in one word: software. Well, actually in two words: no software.

With the advent of lightweight, tablet-like machines and sophisticated digitizers, pen hardware has clearly improved. And pen-based operating systems like Go Corp.'s PenPoint and Microsoft's Windows for Pen Computing have laid the groundwork for general-purpose applications that can make pen computers mainstream.

Traditionally, the developers of pen applications targeted vertical markets that had the greatest requirement for pen input, such as delivery services, insurance agencies, hospitals, and police departments. However, pens potentially provide a more natural working environment for a broader audience using more general-purpose tools, such as spreadsheets, word processors, and PIMs (personal information managers).

In this article, I'll review nine of these general-purpose applications. I'll try to give an idea of what it's like to use each package and point out some of the unique features that a pen interface can provide.



Schedulers and PIMs

Pen-based PIMs look remarkably like their paper counterparts, consisting primarily of day/month calendars and address books. You'll usually spend more time looking through your schedule than entering items or revising them. A pen is ideal for flipping through pages and selecting items. Working with a pen to control your scheduling software uses the pen to its best advantage: navigating quickly through existing information.

Slate Corp.'s Day-Timer Pen Scheduler

PenPoint

The Day-Timer Pen Scheduler looks exactly like the standard Day-Timer notebook from which it is licensed. You can view schedules by day (broken down to the nearest half hour), by month, or by year. Tapping on a month or day brings up an enlarged view, where you can read, write, and edit your entries. Tapping on arrows lets you scroll from one day or month to another. Day-Timer also keeps track of your to-do lists and addresses.

Anything you write on the schedule page or in a to-do list is stored as a graphical image ("ink" in pen jargon). The to-do list appears as a series of rectangular image blocks. When you finish with an item, you delete it by writing an *X* in its deletion box. Because the items are stored as images, you can't search your to-do lists. The address book functions similarly, although you can search through address entries, since Day-Timer converts these to text. An alphabetic index at the bottom of the screen lets you move directly to any address book entry.

Pensoft's Perspective

PenPoint

Perspective is a PIM similar to Day-Timer but with additional features. Its interface also mimics a standard paper schedule. One fundamental difference between Pensoft's and Slate's implementations is that Perspective can convert most of your input to text, although you choose whether to leave your entries as ink or convert them. Converting them allows you to search for specific events. If, for example, you only vaguely remember an appointment with your accountant, you can find the entry quickly by tapping on Find and writing in *accountant*.

Switching from a day view to a month view is more difficult in Perspective than in Pen Scheduler. This is because Perspective uses separate applications to handle the different views. However, Pensoft does a better job of capitalizing on PenPoint, letting you use Perspective's address book as the underlying contact database for all your PenPoint applications. Perspective also includes a note-taking module.

Of the two, Day-Timer is more practical. The integration of daily, monthly, and annual views is a definite plus, and I don't find much call for search capability on an appointment schedule.

Spreadsheets

If you've ever used Excel on an airplane, you've probably found yourself struggling to use a mouse in close quarters, even just to review information. Spreadsheets designed for a pen interface can make

manipulating data easier. In addition, the pen's character recognition lets you make limited data entry and perform simple calculations. However, I generally found the spreadsheet applications frustrating. The recognition errors made entering information tedious, especially in Windows, where I spent more time correcting my entries than entering data. You might find these useful for reviewing your spreadsheets on the plane, but certainly not for data entry. For the moment, pen-based spreadsheets just aren't as powerful as their keyboard counterparts.

PenWare's PenCell Spreadsheet

As spreadsheets go, PenCell is simple and has relatively few features. It's well suited for quick calculations, but it doesn't have all the bells and whistles you might expect. For example, you can select a range of values and display charts, but you're limited to bar, line, and pie charts. I would not recommend PenCell for creating graphical presentations, although you might find it handy for checking data while traveling, to save in Excel or Lotus format for further polish later.

Here's an example of where PenCell comes in handiest: Say you've put together a proposal for a new building. While en route, you think of a way to save cost on some part of the design. PenCell can whip up some quick graphs of overall cost, let you change a few figures, and then graphically show you what you've saved. Later, you can use that information as a basis for a more refined presentation you develop in Lotus 1-2-3 or Excel.

Slate's At-Hand

At-Hand uses a standard X-Y grid of cells you fill with numbers and labels. Like PenCell, it's a basic spreadsheet with very few frills. However, At-Hand's set of chart types is substantially richer than PenCell's; it includes a variety of 3-D charts and a basic set of 2-D types.

There are some nice pen-centric innovations: To add a range of cells, you highlight the range and write a "+" in the result cell. There are a number of other small improvements delivered by At-Hand's pen design. However, the shortcut gestures for moving around require some mighty fancy pen motions. The worst of these is the quadruple flick, a motion with four quick swipes across the screen. If done correctly, this scrolls any column or row to the edge of the screen, but it takes practice.

PenMagic's Numero

Numero is a unique spreadsheet. Rather than launching you into a blank cell grid, it starts you in a blank page. To create cells and thereby design the page, you select areas and write in them. Alternatively, you can choose from among a half dozen or so predesigned paper types, such as checks, timesheets, or expense reports.

Gestures form a key element in Numero's design. If you draw a line under a column, it totals the column. To convert your writing to text, you double-tap on a cell. Unfortunately, Numero is very finicky with its gesture recognition. I had

Windows for Pen Computing vs. PenPoint

One thing I learned when designing pen-input hardware seven years ago: For a pen application to be effective, it has to treat the screen like an intelligent piece of paper. It's the application's responsibility to figure out what the user wants; the user should not have to tell the computer what the pen input means.

Windows falls short of the mark (and casts a shadow over all the Windows applications) by requiring users to move the pen to the menu bar to make selections (thus saying, "Computer, treat this input as a menu choice"). Windows is just not the way to use a pen.

PenPoint does a better job, but you still have to tell the operating system what application to use when creating a new page or changing input modes in some of the applications. Ideally, when you create a page, the operating system should see what you enter and then launch the appropriate application.

MICROSOFT WINDOWS FOR PEN COMPUTING

Windows for Pen Computing is an MS-DOS environment based on Windows 3.1 with a series of pen extensions. The pen is enabled as the Windows pointing device; installed libraries provide gesture and handwriting recognition as an alternative to keyboard input, or you can add sections of pen input as objects into any standard Windows program. Windows has an advantage over other pen environments in that thousands of applications already exist that can use a pen. Run any Windows application under Windows for Pen Computing and the pen supports it.

However, a pen application should take special advantage of pens. Windows applications typically don't. Moving the cursor to the upper left of a window to grab the menu is cumbersome with a mouse; it's downright annoying with a pen. On top of that, the handwriting and gesture recognition that ships with Windows is less than 95 percent accurate. For every 100 characters or gestures I drew, I had to correct five.

A Windows for Pen Computing application comes to bat with two strikes against it: poor recognition and poor control mechanism. Recognition will improve over time and through third-party recognizers; hopefully, control mechanisms will as well.

GO CORP.'S PENPOINT

Go's PenPoint is built from the ground up for pen computing. It's based on a notebook metaphor; a collection of files becomes a group of pages in a notebook. The directory becomes a tabbed index at the front of the notebook. To go to a specific document, you simply touch the page in the index. PenPoint switches to that page and opens the appropriate application for you.

Like Windows for Pen Computing, PenPoint comes equipped with gesture and handwriting recognition. The recognition engine in PenPoint is more accurate than the one in the Windows version. Input is also more efficient. In Windows for Pen Computing, since the pen replaces the mouse, many operations still require a three-step operation (highlight, tap, and press a key). In PenPoint, you simply write over a word or section of text to manipulate it. This pen orientation, combined with the more accurate recognition engine, gives PenPoint the edge over Windows for Pen Computing. Although you won't find a great quantity or assortment of shrink-wrapped PenPoint applications, PenPoint provides a more productive platform for all the applications reviewed here.

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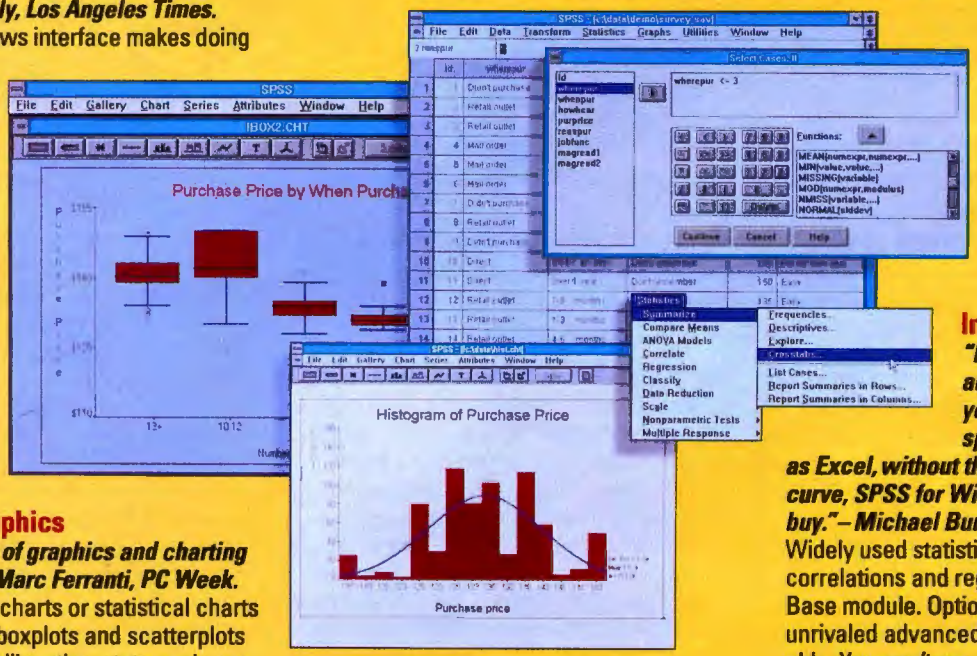

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Pen Hardware

Grid Convertible

- CPU: Intel 25-MHz 386SL
- RAM: 4 MB
- Hard drive: 125 MB
- Modem: internal 2400-bps fax
- Operating system: Microsoft Windows for Pen Computing
- Weight: 6 lbs., 11.5 oz.
- Removable external floppy drive
- Attached keyboard
- Price: $2799 as tested

Toshiba T100X Dynapad

- CPU: AMD 25-MHz 386SXL
- RAM: 8 MB
- Hard drive: 40 MB
- Modem: 2400-bps Data/Fax PCMCIA
- Operating system: PenPoint and Microsoft Windows for Pen Computing
- Weight: 4 lbs., 7 oz.
- Removable external floppy drive
- Port for attaching external keyboard
- Price: $4397 as tested

To test these pen applications, we used a Grid Convertible running Microsoft Windows for Pen Computing and a Toshiba T100X Dynapad running PenPoint. These configurations reflect the systems as tested. We measured "traveling" weights—with power supplies but without the external floppy drives.

The T100X's pen uses 13M batteries, commonly used in hearing aids and available in pharmacies. The Grid Convertible has a pop-up screen exposing a notebook-size keyboard underneath the tablet. Its pen uses standard 393 alkaline batteries. Both systems are expandable to 20 MB of RAM.

no trouble using the demonstration spreadsheets and some of the standard layouts, but because of the difficulty in working with gestures, I never got very far into customization. Eventually, I just put Numero away in frustration.

Despite the nice concept and a complete and thorough manual, I never got the hang of making this product work well. I simply couldn't get Numero to recognize my commands in a usable way. The limitations of the digitizer (on the Toshiba T100X) and PenPoint's recognition made this product difficult to manage.

Word Processing

The word processing applications I reviewed represent two types. The first is a simple ink-capture program for scribbling quick notes to yourself. The second is a combination word processor/form letter application. Word processing seems the most natural application for pen computers; after all, a pen is first and foremost a tool for writing.

However, while a pen interface gives a word processor a real advantage for editing (with gestures), it severely detracts from the software's ability to handle bulk text entry. Unfortunately, the hand-printing recognition offered by today's operating systems makes writing entire paragraphs (or even sentences) impractical.

These two applications put a new spin on word processing by eliminating the requirement for heavy text entry. LetterExpress provides letter templates, while NoteTaker deals mostly with unconverted ink.

The advantage of ink capture over text recognition is that it's fast and accurate. Everything you do with the pen is captured as ink; it's up to you to figure out what it means later. If the application applies recognition to your input, you may be able to search and edit it later.

Ink Development's InkWare NoteTaker

PenPoint

Inkware NoteTaker is a simple ink-capture application that captures whatever you do with the pen and saves it on a page. It's more like a paint program than a word processor. In fact, if you were using Windows instead of PenPoint, you could achieve most of the same effects using Windows Paint.

In NoteTaker, you have at your pentop the following tools: a pen, a fat pen, a highlighter, text, an eraser, and scissors. The pens and highlighter are specific instances of custom pens. Any pen can have a number of attributes, such as size, color, and transparency. If you create a custom pen, you can name it anything you like.

The text tool is where recognition comes in—it converts your input to text and stores it on the page as a text object. You can select and move the text, but if you stop writing for more than a second, NoteTaker converts what you have written so far and starts a new object. The end result is a collection of fragmented text objects that bear no relation to each other. What's worse, the original input is not stored as ink but thrown away. If you're writing quickly, you'll probably have recognition errors, and without the original input for reference, you may lose valuable information.

PenMagic's LetterExpress

PenPoint

LetterExpress is a fill-in-the-blank application that lets you produce business documents quickly, without a lot of writing. The bulk of your letter is already written; LetterExpress ships with 72 standard business letters. All you do is select a template and answer the questions. The end result is a formatted business letter ready for printing.

Highlighting and pen tools let you circle important parts, scribble notes in the margin, add keywords for searching, or mark up the document in just about any way you like.

The LetterExpress address book stores address and contact information you can include in your letters. Like Pensoft's Perspective, it also supports standard PenPoint address books, so you can incorporate addresses from other applications.

LetterExpress helps solve one of pen computing's fundamental problems. Pen input is the slowest way to construct a letter from scratch. LetterExpress does most of the work—you just personalize the letter and fill in the details. All in all, it's a good compromise that takes advantage of the pen computer's portability while minimizing slow, imprecise text input.

Other Applications

The following products represent an assortment of CAD, networking, and integrated "works" applications. Now that pen computing is growing up, you can find most types of applications in pen form.

CAD lends itself well to pen input. We are accustomed to drawing with a pen, so CAD is a natural application. Networking and communications are of course critical for all systems, and pen computers are no exception. Finally, an integrated package can make transitions between applications (both pen-centric and non-pen-centric) a lot easier.

continued

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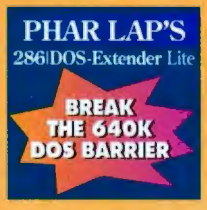

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Applying the Power of the Pen

Saltire's SketchRight

Saltire designed SketchRight for people who need geometric measurements from field data. It takes your pen sketches and turns them into precision drawings. Saltire's geometry engine underlies the interface, allowing SketchRight to calculate unknown measurements given sufficient information. SketchRight connects lines and adjusts object sizes to reflect the newly computed dimensions. It's not really CAD, it's not a paint package, it's something else—like an artist or engineer looking over your shoulder.

The dimensioning is all-or-nothing; SketchRight puts dimensions on everything it considers critical. If you leave stray marks on the drawing or leave an object drawn incorrectly on-screen, SketchRight insists on filling the screen with meaningless and confusing dimensions. Removing these or correcting the errors takes a lot of practice. Personally, I'd prefer having control over which objects were critical and which were dependent. I was also unimpressed with the selection mechanism. A short up-down flick gesture is the command to add an object to a selected group, but it doesn't work consistently. Since I was using a Grid Convertible (with a keyboard), I finally resorted to using the Shift key to select objects.

SketchRight is an interesting application. I didn't master it after several weeks' use, but it uses the pen well—letting you sketch a quick graphic and make simple modifications. If you need finer control, you can export the file to your CAD package for finishing.

SunSelect's PenCentral

PenPoint

PenCentral epitomizes SunSelect's effort to supply networking to and from all computers, regardless of configuration or platform. A version of the popular TOPS networking environment (the PenTOPS client) comes bundled with every PenPoint operating system. All you need to connect your PenPoint machine to a network is a TOPS server.

That's what PenCentral provides, through your desktop computer. PenCentral is different from the other applications here in that it doesn't actually run on a pen-based system: PenCentral is a DOS application.

To connect a PenPoint machine to a PC, Novell, or LAN Manager network, you simply install the DOS PenCentral server software and connect the pen system to the server via a serial or parallel cable. A few seconds later, the desktop system recognizes the pen computer and establishes the link. From that point on, the floppy drives, hard drives, network drives, and printers available to your desktop machine are also available to your pen system.

To use PenTOPS through PenCentral, you simply tap on the Connections icon on the PenPoint screen and then select Network View and the drive or printer you need to access. PenCentral takes care of everything else. To set up a remote connection for copying files to or from your office later, you simply set the PenCentral server to provide a modem connection and put the modem on auto-answer.

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SunSelect's PenCentral works well and couldn't be easier to use.

Slate's Grid PenEssentials

Specifically for the Grid Convertible (and now bundled with the computer when you buy it), Grid PenEssentials is a bundle of four Slate applications: the Day-Timer Pen Scheduler, the LooseLeaf NoteTaker, the PenBook Electronic Book, and Delrina's WinFax Pen software. In addition, you receive a custom nylon carrying case for the computer and a spare pen.

The Day-Timer application is the same as the PenPoint version reviewed above. LooseLeaf is an ink-capturing note application similar to InkWare NoteTaker (but without the text conversion). As ink-capture applications go, LooseLeaf is perfectly adequate. It doesn't have all the bells and whistles of NoteTaker, but then it doesn't really need them.

PenBook is an application that displays files stored in Slate's BookFile format, created in PenBook Author. The last piece of software is the pen version of Delrina's WinFax. WinFax lets you create an output document and transmit it through the Grid's internal modem. Once you create your fax with text and graphical elements, WinFax takes care of dialing through the fax modem and establishing your connection. It works much like WinFax does under Windows.

As a group of applications, the Grid PenEssentials collection is fairly effective. It isn't an integrated package in the conventional sense; the packages don't work together under a single shell. What holds them together is a single philosophy of presentation and style. Sometimes it makes sense to use a group of simple, related applications rather than a single monolithic one. That's especially true in a pen-computing environment, where you don't usually have the luxury of a keyboard or a second mouse button for control.

The PenEssentials collection is not an integrated package in the conventional sense.

If you consider the price ($349), PenEssentials is worth it even if you only use one or two of the applications. Slate now offers similar bundles for PenPoint and for pen-based systems from other manufacturers.

As Good as Paper?

Are pen applications strong enough to make pen computing as mainstream as other types of portable computing? Not yet. Unfortunately, the technology just isn't there: All the applications are just too slow on the processors in the machines I used, and handwriting recognition just isn't in acceptable shape.

Largely because of the problems in handwriting recognition, pens are not yet efficient for entering data or taking notes. They are better at selection, thumbing through documents, highlighting, or otherwise annotating text. These current problems don't dampen my enthusiasm for pens; hand-held PDAs (Personal Digital Assistants) with the capabilities of these machines will be welcome systems.

Nonetheless, the state of the technology puts a restriction on most of these applications. Of the pen applications here, the schedulers are currently the most useful. However, scheduling is obviously not pen computing's "killer app," and it doesn't provide the incentive for buying a $3000 computer. Although many of these applications present innovative interfaces, they are still running on top of a foundation—both hardware and operating system—that's just too shaky to support critical, general-purpose applications. ■

Howard Eglowstein is a BYTE Lab testing editor. Prior to joining BYTE, he was the vice president and cofounder of Hindsight, a design firm that specialized in pen-based workstations for teaching learning-disabled students. You can reach him on BIX as "heglowstein."

Items Discussed

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(as tested)
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Westlake, TX 76262
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Circle 1225 on Inquiry Card.

InkWare NoteTaker $145
Ink Development Corp.
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Perspective $299
Pensoft Corp.
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Redwood City, CA 94065
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PenCell Spreadsheet $295
PenWare, Inc.
845 Page Mill Rd.
Palo Alto, CA 94304
(415) 858-4920
fax: (415) 858-4929
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SketchRight $249
Saltire Software, Inc.
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Beaverton, OR 97075
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At-Hand $295
Day-Timer Pen Scheduler $195
Grid PenEssentials $349
Slate Corp.
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Scottsdale, AZ 85260
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PenCentral $149
SunSelect
2060 Challenger Dr.
Alameda, CA 94501
(800) 677-6265
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Toshiba T100X Dynapad $4397
(as tested)
Toshiba America Information Systems, Inc.
9740 Irvine Blvd.
Irvine, CA 92718
(800) 334-3445
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NetWare Goes Global

Version 4.0 scales up for serious enterprise networking, but its new directory service doesn't accommodate NetWare 2.x and 3.x servers

JON UDELL

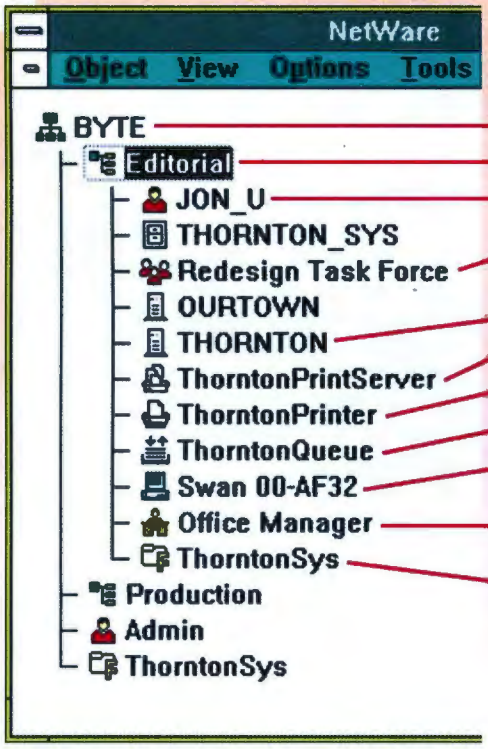
At BYTE, like everywhere else, networks grow like weeds. Last time I checked, we had four independent NetWare LANs serving four different departments. Of course, BYTE is part of a much larger company, McGraw-Hill, and in that context our Peterborough, New Hampshire, operation is just a drop in the corporate bucket. How can PC networks scale up to meet the needs of multidepartment divisions like BYTE and multidivision companies like McGraw-Hill? NetWare 4.0 supplies the crucial ingredient.

The X.500-style NDS (NetWare Directory Service), a treelike database of users, data, software services, and equipment, can span all the NetWare 4.0 servers on a company's LAN or WAN (wide-area network). Administrators who tend these trees will shape them so that the logical view of a network superimposes precisely on the organization chart that is the logical view of the company served by that network. Users, as a result, will be able to interact with the network at appropriate organizational levels.

As a BYTE editor, my workaday context would be something like `Editorial.BYTE.McGraw_Hill`. But to send a message to David Cohen in BYTE's production department, I'd cross department boundaries and address the message to `dcohen.Production.BYTE.McGraw_Hill`. And to communicate with Neil Canavan, a Datapro telemarketer, I might cross divisional lines and address a message to `ncanavan.Sales.Datapro.McGraw_Hill`.

Among the features new to NetWare 4.0, NDS rightly gets top billing. A credible Novell framework for serious enterprise networking is clearly a landmark event. Vines users who have long enjoyed global directory services may view it with understandable skepticism. In fact, Novell's NDS outdoes Banyan's StreetTalk in three ways: It's replicated, it can represent complex hierarchy, and it supports user-defined object types. On the other hand, NDS is today little more than a framework. NetWare 2.x and 3.x servers don't support NDS. Neither does UnixWare, or Novell's own E-mail and network management products, never mind all the third-party VAP (value-added process) and NLM (NetWare loadable module) applications.

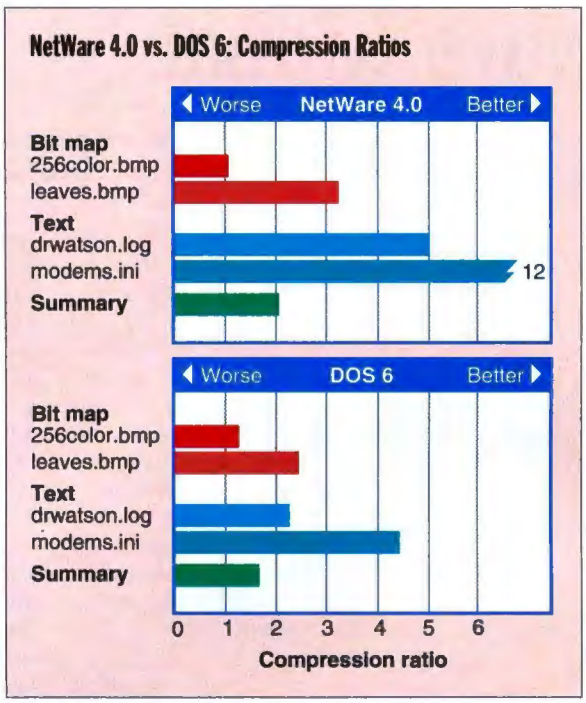
So while NetWare users wait for the world to catch up with the new directory service, what other 4.0 features deliver immediate value today? Notable ones are file compression, CD-ROM sharing, NLM protection, read-ahead caching and block suballocation, smarter memory management and thread scheduling, burst-mode packet delivery, large Internet packets, improved security and auditing, target service agents for workstation backup, data migration to optical jukebox, NDIS protocol support, a true DOS requester, and a host of new and improved server and client utilities. File compression alone could tip



NetWare Directory Service Objects

TYPE	PURPOSE
Organization	A top-level container for servers, users, organizational units, and other objects.
Organizational unit	A subsidiary container for servers, users, and other network objects.
User	A single networkwide store of information about a user, including name, password, rights, log-in script, and many other attributes.
Group	A list of users. Note that users sharing a given container implicitly form a group, so explicit groups are needed less often in 4.0 than in 2.x and 3.x.
Server	Stores basic information about the server, such as its network address.
Print server	Can be used to view and modify printer assignments, operators, and users.
Printer	Can be used to view and modify configuration, queue assignments, and notification.
Queue	Can be used to view and modify operators and users.
Computer	Can be used to track owner, serial number, and location. Network management software that tracks assets can extend this object by adding other attributes.
Organizational role	Logical name for a user who is the "occupant" of the role. Useful for indirection, since it can be referenced in rights assignments instead of a hard-coded user name.
Directory map	Logical name for a path specification. Useful for indirection, since it can be referenced in log-in scripts instead of a hard-coded path.

the scales in 4.0's favor. In NetWare 4.0, compression runs as a low-priority background thread, in 32-bit mode (like all NetWare tasks), with plenty of linear memory to work with. The result is that 4.0 really does more than double your disk (see the figure "NetWare 4.0 vs. DOS 6: Compression Ratios").



NetWare 4.0 consistently outcompresses DOS 6 on some file types. Results are mixed for bit maps and text files, but on the whole NetWare 4.0 really is a disk doubler. The summary figure represents the composite compression ratio for all files in the Windows directory.

Smooth Start, Rough Acceleration

I installed NetWare 4.0 on a Gateway 66-MHz 486DX2 EISA machine with 16 MB of RAM, an NE3200 network card, and an UltraStor Ultra 24F SCSI controller cabled to a 525-MB Seagate ST3600N SCSI drive and a Toshiba XM-3401 CD-ROM drive. CD-ROM is the default mode of installation for 4.0. If you need floppy disks, you'll have to make them yourself from the supplied CD-ROM or order them separately. (The same policy applies to printed documentation.) What if you don't have a SCSI CD-ROM drive that NetWare supports? Not to worry. Installation pulls files from a DOS-mounted CD-ROM, so while you may or may not succeed in sharing discs as read-only NetWare volumes, as long as DOS can see your drive you'll be able to install NetWare.

The installer scans the network for an existing directory services tree, and if (as in my case) that search fails, it will create a new one. It prompts for the new server's location in the tree—an organization and (optionally) an organizational unit. After installing the server, you can cut installation floppy disks from the CD-ROM for DOS/Windows and OS/2 workstations. After installing the DOS/Windows client software on my Swan 386/25, I rebooted and tried to log in. I was stumped for a while. The privileged user in 4.0 is ADMIN, not SUPERVISOR, but the command `LOGIN ADMIN`, which should have granted access to the directory service, kept failing, as did the more explicit `LOGIN ADMIN.Editorial.BYTE`. Eventually I figured out why.

User object ADMIN lived in a top-level container (organization BYTE), but server object THORNTON lived one level down (organizational unit Editorial). Attaching to THORNTON, I acquired its context. Because the search for an object looks downward in the tree, not upward, user ADMIN wasn't found. One solution was to use the command `CX O=BYTE`, which set the context appropriately for the command `LOGIN ADMIN`. (Note that ADMIN can then manage not only the resources of the Editorial unit but those of other units belonging to BYTE.) Another was simply to name the correct context (i.e., `LOGIN ADMIN.BYTE`).

Things were simpler for the new user accounts I then created as ADMIN, since I put those objects in the same part of the tree as the server itself. But for administrators, mastery of the nuances of NDS will require a major conceptual shift. It's worth the trouble. For example, I reflexively created a group EVERYONE and began putting new users into that group. Then I discovered that 4.0 obsoletes that old habit. Users in a "container" object inherit rights and log-in scripts from the container, so they are implicitly members of a group. The object orientation of NDS is powerful, once you learn to let it work for you.

You manage the tree with a pair of graphical tools (or their textual equivalents). The NetWare Administrator navigates the tree and creates, renames, moves, and edits NDS objects. Creators of new object classes can extend this tool by writing "Snap-in Object DLLs." The Partition Manager subdivides the single directory-services database created during installation into smaller pieces and can replicate those pieces to local or remote servers.

You replicate in order to safeguard directory information and ensure speedy access to that information in a WAN environment. If you install two servers into a single container, this replication happens automatically. You probably won't need to replicate manually unless you're operating a WAN. In that case, since replicas synchronize continually as changes occur, you will have to plan carefully how much directory information to distribute. You cannot yet gauge whether the usage of a given replica justifies the communications cost of maintaining it, but Novell recognizes the need for such a capability and says the hooks are in to provide it.

New DOS and OS/2 Requesters

I installed the client software on a handful of machines running DOS/Windows and one running the OS/2 2.1 beta. The DOS client has changed dramatically. After loading the ODI (Open Data-Link Interface) software that talks to the network adapter, you run a loader called VLM.EXE that pulls in an assortment of "virtual loadable modules" into conventional, expanded, or extended memory. Each VLM performs one function—DOS redirection, printing, encryption, directory services, and so on.

The redirector reforms NetWare's old habit of hooking INT21, although "dirty" NetWare applications that rely on that hook can still have it. Another module binds IPX to the NCP and signals Novell's readiness to let NetWare ride on other transports. In fact, the NetWare client is prepared to run NCP over IP today, and once the server can do the same (Novell is not saying when), administrators of mixed networks who want to standardize on a single wire protocol will finally be able to do so.

DOS and OS/2 clients now get both NetBIOS and named-pipes drivers and, importantly, an NDIS-over-ODI driver that enables users to multiplex LAN Manager (and other NDIS-oriented clients) with NetWare over a single adapter. Unfortunately, I found no obvious way to substitute the NetWare 4.0 client for the NetWare support included with Windows for Workgroups.

The OS/2 requester can virtualize network support to multiple DOS boxes in two ways. One enables a VDM (virtual

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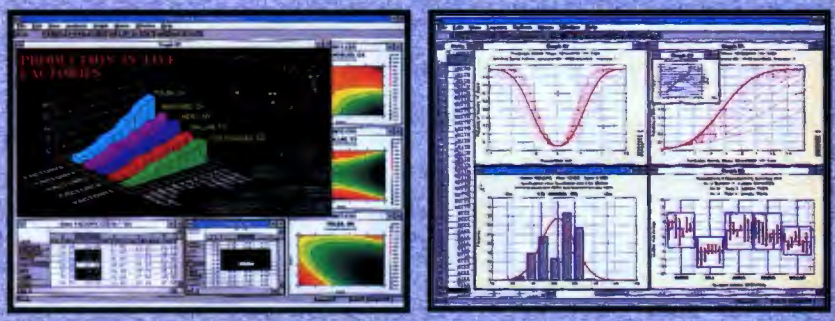

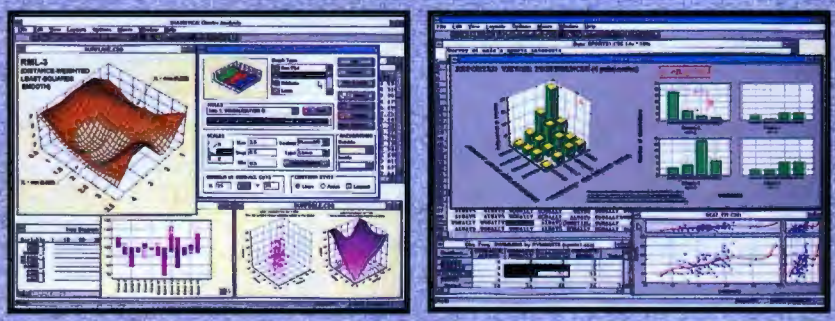

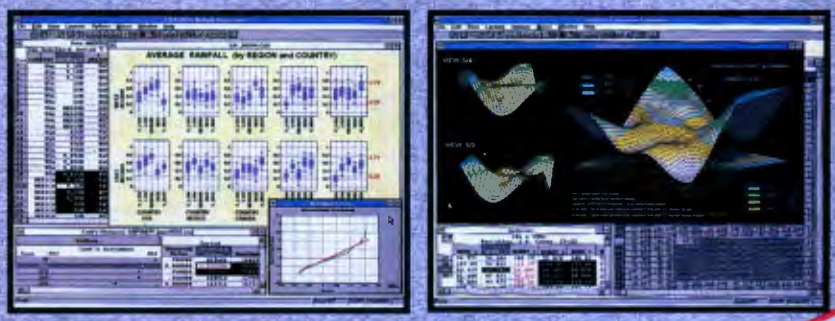

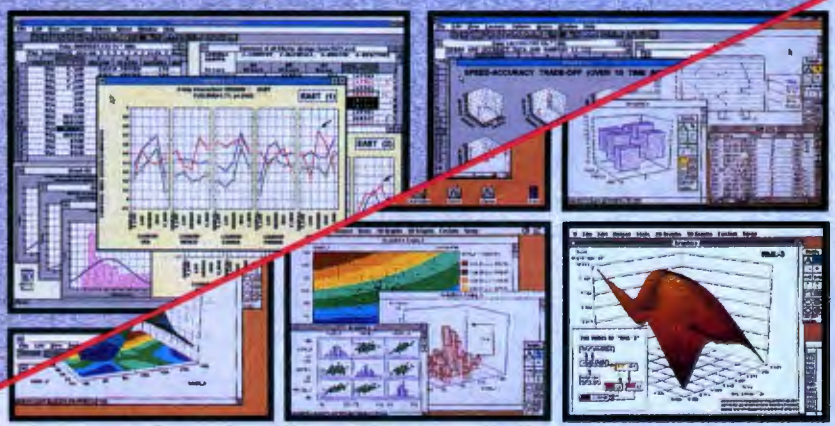

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Reviews NetWare Goes Global

DOS machine) to share the original (public) OS/2 log-in. The other grants a VDM its own private log-in. Coupled with asynchronous host software (e.g., pcAnywhere) running in the VDM, this technique can make an OS/2 2.x machine into a poor man's NetWare Access Server.

New Server Tricks

When NetWare 3.0 made its debut, the fact that NLMs ran fast and naked at ring 0 raised a lot of eyebrows. How could Novell permit a failing application to take out the kernel? That complaint turned out to be slightly off target. Software that runs with NetWare by definition provides a mission-critical service, and it just can't afford to fail. The real question should have been: How can *developers* make headway in a hair-trigger environment?

NetWare 4.0's answer is DOMAIN.NLM, a tool that can isolate unproven NLMs from the kernel. There's an associated cost, of course. BYTE's NLM benchmark ran 5 percent slower in the OS_PROTECTED domain (ring 3) than in the OS domain (ring 0). Real applications that exercise user code more than kernel code will degrade even more. But NLM protection doesn't really try to make NetWare a protected operating system. It's just a way to help get reliable NLMs built quickly, and developers tell me they're mighty grateful for it.

CDROM.NLM mounts a CD-ROM as a read-only NetWare volume. To get it to work, you first need to load a driver that enables CD-ROM.NLM to speak ASPI (advanced SCSI programming interface) to your drive. The Adaptec version of that driver wasn't happy with the UltraStor controller's flavor of ASPI, but the Meridian Data implementation enabled me to mount and share the Toshiba CD-ROM drive. Other new server utilities include SERVMAN, which you can use to observe and twiddle various system settings, and DSREPAIR, which fixes damaged directory-services partitions.

Storage Management Still Evolving

NetWare 4.0 provides a trio of server-based TSAs (target service agents) that ship data to backup engines that support the SMS protocol. The server TSAs handle NetWare 3.11 and 4.0 file systems, as well as the 4.0 directory-services database. I also tested the TSAs that SMS engines can use to pull data from OS/2 and DOS workstations. However, though I established TSA-to-server communication in all five cases, I couldn't convince SBACKUP's support driver, TAPEDAI.NLM, to use the UltraStor's ASPI driver and so couldn't move any data to either my Tecmar or my Archive DAT drives.

What troubled me more, though, was the realization that 4.0's data-migration feature has almost nothing to do with SMS. For data migration, 4.0 introduces the HCSS (high-capacity storage system), part of a joint effort with Kodak to enable NetWare for image processing.

To use HCSS, you buy an MO (magneto-optical) jukebox (only HP's 10- and 20-GB models are currently supported) and then load the HCSS NLM and point it at portions of a NetWare volume. It automatically migrates files between primary magnetic storage and secondary MO storage according to demand. What's wrong with this picture? I thought I'd be able to use disk-grooming SMS backup software and tape auto-changers this way, but the migration hooks that Cheyenne and Palindrome would need aren't in SMS, they're in HCSS. Novell is painfully aware that tiered storage was the raison d'être of SMS and admits that its unification with HCSS is imperative.

Difficult Choices

NetWare 3.0's quantum leap in performance and ease of use made the decision to upgrade almost a no-brainer for many 2.x users. While 4.0 advances the state of NetWare in an equally profound way, the immediate gains are harder to quantify. The failure of NDS to accommodate 2.x and 3.x servers rankles. If Banyan can put StreetTalk on those platforms (in the form of Vines Enterprise Network Services) why can't Novell manage the same trick with NDS? NetWare servers have an annoying habit of refusing to die, and I worry about the drag they'll exert on deployment of NDS-aware software.

Despite these concerns, NetWare 4.0 is obviously headed in the right direction. Its early adopters may suffer some growing pains, but they'll never look back. ■

About the Product

NetWare 4.0

Prices:
Five users, $1395
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(other levels available)

Novell, Inc.
122 East 1700 South
Provo, UT 84606
(801) 429-7000
Circle 1224 on Inquiry Card.

Jon Udell is a BYTE senior technical editor at large. He maintains BYTE's PC network. You can reach him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.

Dynamic Documents

Folio Views lets you manage and distribute large quantities of text, numbers, and graphics. Version 3.0 brings Folio's electronic publishing tools to Windows.

ROBERT SCHMIDT

Electronic publishing has long been touted as a revolutionary replacement for paper as a means of delivering information. Unfortunately, this type of publishing has been the exclusive province of large publishing, database, and multimedia companies. Only they could support the laborious production of books, CDs, and on-line databases. With the release of Folio Views 3.0, Folio Corp. hopes to make electronic publishing available to a mass market.

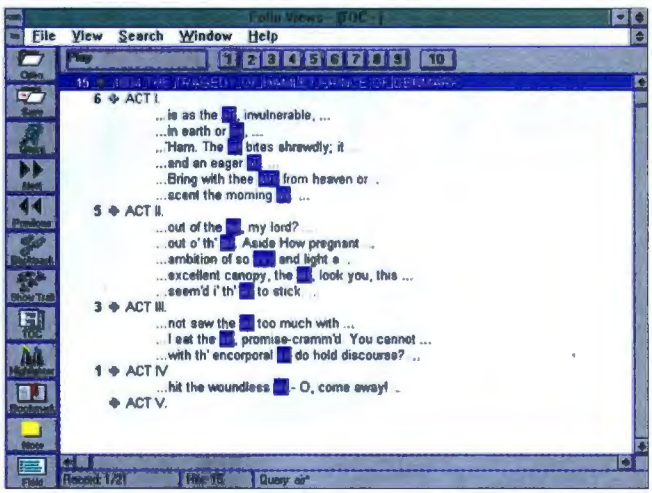
New to the Windows platform, Folio Views 3.0 ($495) lets you produce, manage, and distribute large bodies of information. It brings editing, publishing, and retrieval tools together to automate the information life cycle. Its primary market is organizations that regularly publish masses of information on paper. For departments and workgroups, the bundling of real-time editing and retrieval functions will be irresistible: no more corralling an undisciplined agglomeration of data in incompatible formats.

The Folio Infobase

Folio pioneered the concept of an *infobase*, a dynamic repository of free-format data that can hold text, numbers, graphics, and sound. Examples include technical documents, legal proceedings, parts catalogs, and the complete works of Shakespeare. Views combines properties of word processing, desktop publishing, database and text management, groupware, and multimedia. It contains a wealth of functionality, much of it new to version 3.0.

New features include an open client/server architecture, concurrent multiuser editing with automatic record locking, graphics placed directly into an infobase, robust filters for WordPerfect and Microsoft Word, and embedded multimedia objects such as sound and video files. One important element still missing from Views is cross-platform support. An infobase created in the Windows version can be loaded into the DOS version of Views, but 3.0 includes neither a DOS nor a Macintosh viewer. The DOS viewer should be available by the time you read this; the Mac viewer is scheduled for later this year.

Although the current release of Views doesn't support multiple platforms, the open client/server architecture portends a smooth migration path. The Views engine, which is written in C++, is an independent executable handling low-level file calls. The code can be ported by recompiling for different platforms. In the near future, Folio plans a Views engine for Unix and Windows NT servers, which you could access from Windows or Macintosh clients. The client workstations will send out queries to the server, allowing the server hardware to handle resource-intensive tasks, such as searches, updates, and builds against the central infobase.



The Table of Contents view reveals the structure of an infobase, the number of query hits per level, and the results of a wild-card search in context. Levels expand and contract when the plus icon is selected.

Unlike file managers such as XTree or Magellan, Views doesn't organize directories of files. Instead, it manages all information under one infobase umbrella. Infobases, limited to 2 GB in the previous version, may be up to 16 TB in size in 3.0. Although Views permits standard and user-definable fields, its retrieval capabilities are most comparable to those of such full-text databases as askSam and ZyIndex (for a synopsis of products that help organize and retrieve documents and files, see "Info-Management Tools" on page 148). Views indexes every word as it's entered, but because of compression, the resulting infobase and index combined is often smaller than the source file.

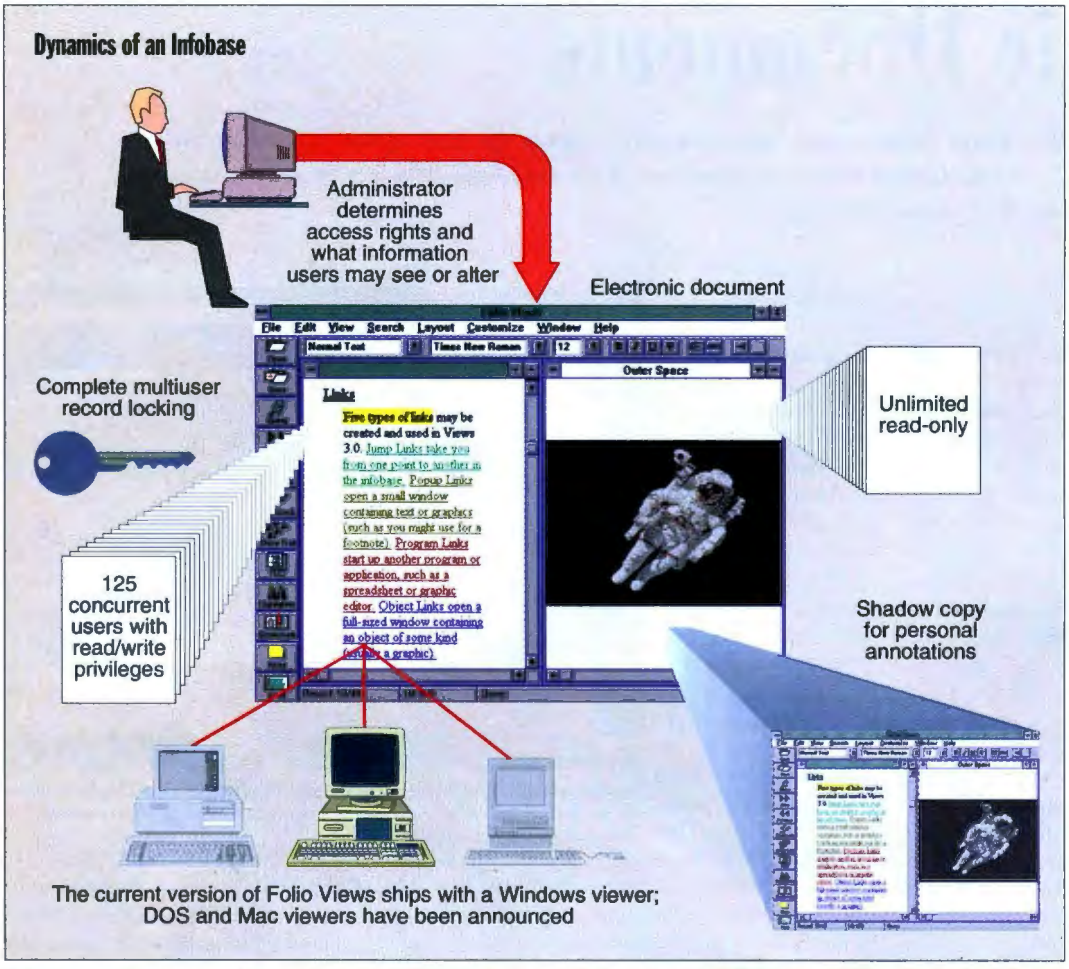
Concurrent Editing and Dynamic Links

All of Views' viewing and editing features are available in a multiuser environment (see "Dynamics of an Infobase" on page 146). Up to 125 users can post notes, highlight text, or add information simultaneously, and an unlimited number can have read-only access (a scaled-down version of Views, Folio Annotator, costs $195 and provides tools for viewing, searching, and making personal annotations). Security options let you control not only who may access the infobase but what levels or kinds of information they can see or alter. With the addition of User Groups, 3.0 lets you set identical access rights for every member of a defined group.

Shadow files are also new to Folio Views. You can make shadow copies of the infobase for your personal use. The shadow copy is an exact replica of the file that can reside on your local disk. You can use the shadow file for reference purposes, adding personal notes and your own annotations that will not affect the original version.

Folio Views now supports a number of different types of links, including the following:

- Popup Links for generating electronic "sticky" notes. A Popup may include text or graphics.
- Jump Links for moving from one point in the infobase to any other point. You



Folio Views creates dynamic, editable electronic documents for shared access on a network. With complete multiuser record locking, Views supports up to 125 concurrent users with read/write privileges. An administrator controls access rights.

can also jump to a different infobase.
- Object Links for calling graphics, sound, or video objects.
- Program Links for invoking an external application from within Views.
- Query Links for performing queries.

Each type of link can have an associated style (e.g., green italicized Times Roman). Clicking on this styled text initiates the appropriate action. Object Links give you the beginnings of true multimedia by linking to other applications through Microsoft's OLE. Views acts only as an OLE client and includes no native tools for calling or editing video and sound. But an object dialog box, displaying a list of supported OLE objects and offering options for previewing objects, makes it easy to work with external applications and to embed multimedia sources.

Infobase Hierarchy

I reviewed Folio Views on a 33-MHz Compudyne 486 with 4 MB of RAM, DOS 5.0, and Windows 3.1. Installation was straightforward and took about 15 minutes. The program occupies 13.7 MB of disk space, but most of that is sample infobases and tutorials that you can erase. Without the sample programs but with all functions enabled, Views requires a little over 2 MB.

A Views infobase has several structural levels. Records are the basic structural element of an infobase. A record may be a line, a paragraph, or another natural unit of information.

Levels provide a hierarchical structure for the infobase, just as an outline or table of contents does. In a documentation set, for example, the levels might be Book, Section, and Chapter. While levels impose a structure from the top down, *fields* aggregate related bits of information from the bottom up. You can tag all dates, wherever they appear, and include them in a Date field, or place all personal names in a Name field.

The Table of Contents offers a way of browsing and viewing a file. You can click on any line (level) of the Table of Contents and jump to the corresponding point in the text. You can collapse or expand the outline by clicking on the pluses and minuses (see the screen on page 145) or display it to a certain depth with numerical indicators just below the menu bar.

Complex Queries

Folio Views has strong searching capabilities. You can search an entire infobase or define a specific scope. The indexed words in that scope appear in the Word box. You can click on a word or type an entry in the Query box. This is an intelligent query: As you type, Views attempts to finish the term for you. You can access previous searches with the scroll bar and apply them across multiple infobases. The Results Map gives you a running tally of the number of hits. In the Table of Contents view, you can show the outline headings with search hits, reveal or hide the search results in context, and omit or display the number of hits.

As with most search programs, you can hunt for phrases (in quotes) or multiple words linked with AND, OR, and NOT. You can do wild-card and proximity searches, stem searches (e.g., *eat%* for *eat*, *ate*, and *eating*), and even thesaurus searches (e.g., *fly$* for *soar*, *glide*, *flee*, and so on). Combination searches are possible, although they occasionally produce unfathomable results. Also, the Results Map does not give a hit count on a complex query, and you can't do either case-sensitive searches or searches that include punctuation (no *sue* vs. *Sue* or *us* vs. *U.S.*).

Building an Infobase

You can build an infobase from scratch with Views' editing tools. But it's more likely that you'll develop a document in a word processor or other program and bring it into Views. Views has filters for

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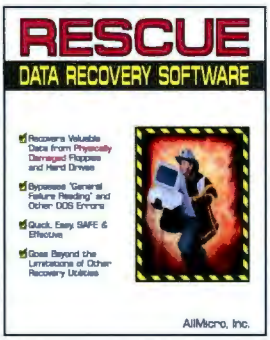

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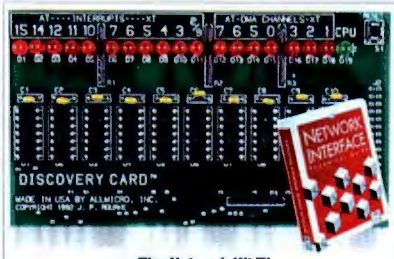

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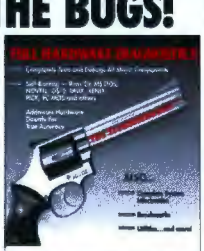

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INFO-MANAGEMENT TOOLS

Software supporting electronic information takes many forms, from simple indexers to complex authoring software. The table displays some of the various approaches, but the designations are as dynamic as the software: Some software packages span categories; others defy them altogether.

 **File indexers**	**ZyIndex Magellan ISYS**	**Index a group of files on a network or local drive. Excellent tools for finding and retrieving data but not for creating on-line electronic documents.**
 **Document managers**	**PC Docs SoftSolutions KeyFile**	**Maintain live documents or images of documents. Tools for version tracking. Best for tracking document work flow within an organization.**
 **Hypertext word processors**	**Ami Pro WordPerfect MS Word**	**Provide simple tools for bookmarks and links. Support OLE for embedded sound and video. No stand-alone viewers; can't track large groups of documents.**
 **Digital paper solutions**	**Acrobat Common Ground**	**Produce an electronic copy of any document through priut driver. Anyone can read with stand-alone viewer. Styles and formats maintained, but electronic copy is not editable.**
 **Authoring tools**	**Authorware OWL Guide MS Viewer**	**Produce interactive multimedia applications. Sophisticated and powerful programming environment.**
 **Free-format multiuser databases**	**Folio Views Lotus Notes askSam**	**Pull free-form data into a large repository for multiuser viewing and editing.**

Microsoft Word, WordPerfect, and ASCII that preserve much of the source's formatting.

When you convert a text file into an infobase, planning is critical. You'll want to consider the background and education level of the intended audience, how often the infobase will be revised or updated, how it will be distributed, and so forth. Then you can decide the number of levels and fields and their styles, the formats of paragraph and character styles, the highlighters and linkages that you wish to include, and the placement of objects, bookmarks, and other features.

You can import raw text into Views and apply the functionality there, but you'll find that many things are easier to add in WordPerfect or Microsoft Word. Views can take a WordPerfect table of contents and build levels and a dynamic table of contents for an infobase. Footnotes and Endnotes in WordPerfect become Note Links in Views. WordPerfect's cross-reference feature creates Jump Links.

A Word document has paragraph marks at the end of every line, which makes each line a record. To create levels and a dynamic table of contents, you apply Word's heading styles at the proper places. Word Frames are not supported in Views, so you have to place all information in-line. You can add two kinds of links in Word. Views will derive the first, Popup Links, from existing footnotes. For Jump Links, you must put a GOTO BUTTON command at the launching point and a bookmark at the destination. You can import embedded OLE objects from Word, but links to the server application will be lost.

You add fields to the infobase after you've created it from a document. You can tag records and place them in a field if you want to include entire records. However, you can't use Views' search-and-replace utility to apply fields or styles—a lamentable shortcoming. Your best bet in automating field and style designations may be to import the file as ASCII, because Folio provides coding that you can add to a *Flat File*.

A Folio Flat File consists of ASCII text with embedded codes for generating a complex infobase. Although Views does not support SGML (Standard Generalized Markup Language) or any other standard markup language, you can use the search-and-replace utility to change any embedded markup codes to the Folio equivalents. Views can then use the resulting Flat File to automatically build the infobase. Direct support of SGML would be a nice addition, but the current conversion process is extremely flexible, handling a wide variety of generic markup techniques.

Who Needs Folio Views?

Users of previous versions of Folio Views will find the new program improved almost beyond recognition. Views' query options let you locate items in a multitude of ways. Searches may grow unwieldy as they increase in complexity, but only the most challenging queries will cause trouble. Browsing the results is easy, especially with the Table of Contents.

Views sparkles with its variety of text formatting, methods of organization, and links to external objects. For freewheeling group efforts, its collaborative benefits are impressive. For more structured projects, adding traits throughout an infobase is a problem. The authoring tools are not yet fully developed.

If all you want is to index static files on your hard drive, either a structured text management system (such as ZyIndex) or a free-form one (such as askSam) will suffice. The extra work of adding levels, fields, and so forth will not improve your update and retrieval ability substantially. But if you want tools for a workgroup, document control, links, and other benefits of electronic publishing, Folio Views may be the answer. ■

About the Product

Folio Views 3.0 .....$495

Folio Corp.
2155 North Freedom Blvd., Suite 150
Provo, Utah 84604
(801) 375-3700
fax: (801) 374-5753
Circle 1234 on Inquiry Card.

Robert Schmidt is a freelance writer and consultant specializing in information management and tools for writers. As system manager for the LA Times *Editorial Library, he maintained a system for creating, manipulating, and storing the full text of the* LA Times *on an electronic database. You can contact him on BIX c/o "editors."*

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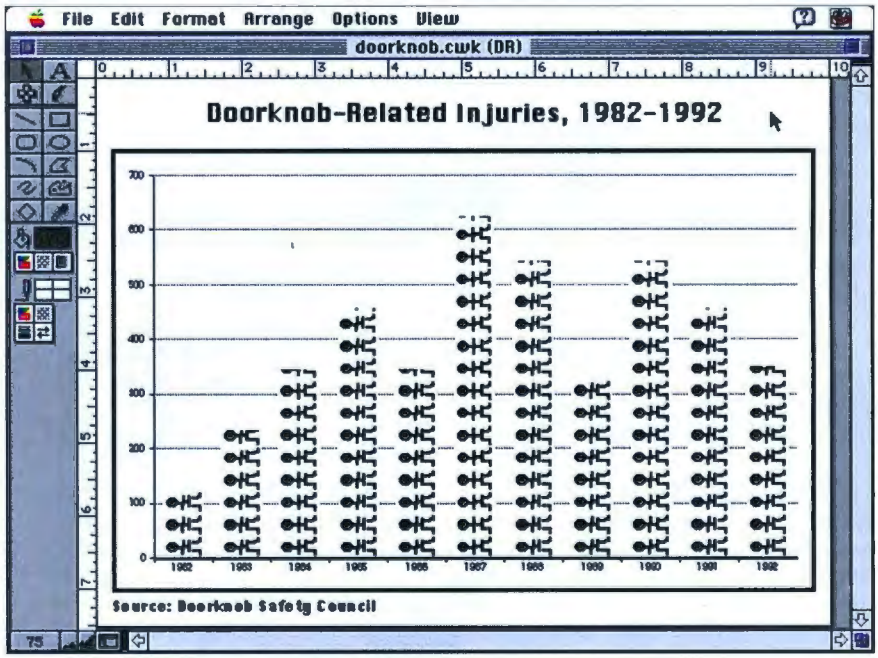
ClarisWorks 2.0 for Macintosh

The latest version gives you fewer reasons to spend thousands for a suite of Mac applications or dedicate dozens of megabytes of storage

TOM R. HALFHILL

Since its debut in 1991, ClarisWorks has become the dominant integrated software package for the Macintosh, toppling the longtime leader Microsoft Works and overtaking two other contenders (WordPerfect Works, formerly known as BeagleWorks, and Symantec's GreatWorks). With the recent release of version 2.0, Claris's leadership position is now even stronger.

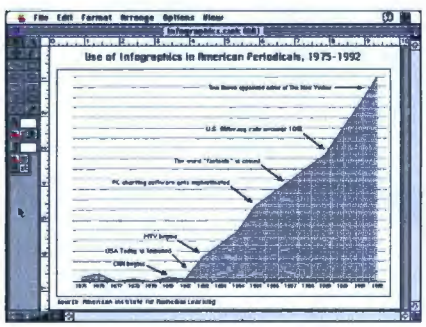
It's not hard to see why. ClarisWorks is the most smoothly integrated product in its class and is a good match for Apple's growing line of hot-selling, affordable Macs. The most popular Macs are street-priced between $800 and $1400, and Apple now offers more than half a dozen models in that range. The people who are buying those machines tend to want software that's priced proportionally, and ClarisWorks offers almost everything they need for less than $300. In fact, some buyers (particularly those who choose Performas, Apple's consumer-oriented Macs) will find that ClarisWorks is included when they buy their computers—a strategy that has significantly boosted Claris's market share.



ClarisWorks' spreadsheet/charting module lets you turn ordinary bar charts into pictograms by repeating a graphical element. The chart remains linked to the spreadsheet and mirrors any changes.

Hundreds of Enhancements

ClarisWorks 2.0 offers more than 300 enhancements over version 1.0, including three completely new modules. In addition to the word processor, spreadsheet, flat-file database manager, drawing program, and telecommunications module, there's now an outliner, a 256-color paint program, and a slide-show module that lets you chain ClarisWorks screens together for business presentations. Every module has been upgraded, and a new "shortcuts" feature lets you click on a floating palette of miniature icons to access the most commonly used functions.



Charts created with the spreadsheet module can be pasted into the draw or paint modules for additional manipulation. Only in the drawing environment, however, does the chart remain linked to the worksheet.

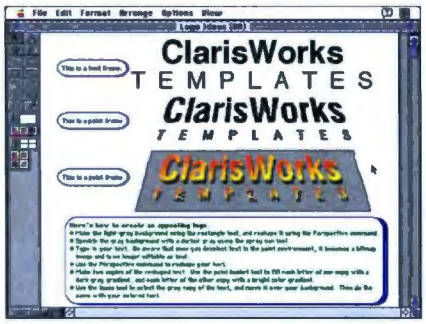
In the word processor, you can now define custom text styles, set up multiple columns with a single click, and flow text around graphics. Text wrapping is supported within spreadsheet cells, too, and the charting features are greatly improved. You can easily generate pictograms, like the ones popularized by *USA Today*, with stacks of graphical objects instead of plain bar charts. The database filer in ClarisWorks 2.0 can automatically validate fields and contains more than 50 predefined formats for Avery mailing labels. The drawing module now has 32 black-and-white and color gradient fills, plus two new polygon tools.

Even more impressive, ClarisWorks 2.0 delivers all these features (and hundreds

No Quadra Required

To judge how well ClarisWorks performs on low-end Macs, I tested it on two systems: a Mac LCII with 4 MB of RAM, an 80-MB hard drive, and System 7.0.1; and a Mac SE with 1 MB of RAM, a 20-MB hard drive, and System 6.0.5. The six-year-old SE, a 68000-based machine, is close to the minimum configuration that will run ClarisWorks. Performance was annoyingly sluggish, especially in the word processor, which failed to keep pace with my typing.

The 68030-based LCII fared much better, though it still lagged at times, particularly when redrawing complex screens. The LCII represents the minimum configuration being sold today, delivering about the same performance as the Classic II, the Color Classic, the Performa 200, and the Performa 400.



ClarisWorks 2.0 lets you transform text in 12 different ways, including these perspective effects.

more) while bucking the trend toward fatware. At 601 KB, it's hardly larger than version 1.0 and still runs comfortably in as little as 1 MB of RAM. Full installation—including folders filled with sample files, tutorials, file translators, spelling dictionaries, and a thesaurus—requires less than 5 MB of hard disk space, and you can get by with much less.

A Spreadsheet in Your Word Processor

Something else that hasn't changed in 2.0 is its seamless integration, the salient feature of ClarisWorks. Instead of simply bundling a collection of mini-applications that can share files, Claris takes a more flexible, frame-based approach to software integration. For example, if you want to add a table or a chart to a business letter, you can simply click on the spreadsheet tool, open a spreadsheet frame anywhere in the word processing document, and either start entering numbers manually or paste a range of cells from an existing worksheet. When you click outside the spreadsheet frame, you're back in word processor mode. If it weren't for the context-sensitive menus and tool palettes, you'd never know you were switching from one application to another. ClarisWorks is like a glimpse of the interoperable future promised by Apple and Microsoft; if operating system and application vendors live up to their promises, we'll be able to work like this with all applications.

Of the three new modules in ClarisWorks 2.0, the paint module plugs the most obvious gap. Version 1.0 had a drawing module, but it's often handier to work with pixel-based graphics rather than vector graphics. Version 2.0 gives you the choice of using either, and the frame-based integration lets you combine both kinds of graphics in a single document. The only drawback to combining the two is that vector frames cease to behave independently once you click them into paint graphics. In other words, the frame is no longer an application module; it is converted into a pixel-based image, just like the rest of the paint document.

This brings up a small but important point: The integration in ClarisWorks is often so seamless that it leads to momentary confusion. Even after extensive experience with ClarisWorks, I sometimes still click on a multiframe document and lose track of which module I've activated. Often your only clues are subtle changes in the tool palette and menu bar.

The new outliner in ClarisWorks is integrated with the word processor and offers several different formats. In addition to the common numeric and diamond outlines, you can choose from Harvard and legal formats and bulleted or checkmarked lists, or you can design your own custom format. Subtopics can be expanded, collapsed, and shuffled within the 16-level hierarchy. You can define custom styles for headings and other text, just as you can in the word processor.

The new slide-show module is a great addition, especially for PowerBook users. ClarisWorks is already an ideal PowerBook companion, and now, without buying any extra software, you can turn your documents into slides for presentations. You can even create slides that play QuickTime movies.

The new slide-show module lets you display ClarisWorks documents in a predetermined sequence for group presentations.

Failure to Communicate

Some things in ClarisWorks could stand more improvement. The communications module, a weak link in 1.0, still suffers from major deficiencies. Claris has added a phone directory, Kermit file transfers, and unlimited scroll-backs through captured text, but there's still no scripting language for automating on-line sessions, and the macro recorder is no substitute.

For instance, I spent 3 hours trying to record a macro that would simply log on to CompuServe, with both ID and password. Finally, I gave up and telephoned Claris's technical support. I was courteously informed that a ClarisWorks macro can respond to only one string of incoming text—something not mentioned in the manual. That means you have to record a separate macro for each prompt (`User ID:`, `Password:`, and so on) and then record yet another macro to link all the other macros together.

A Logical Decision

Despite a few shortcomings, ClarisWorks 2.0 is a remarkably versatile package whose modules compare favorably to some stand-alone applications. For home, school, and small-business users who are new to the Mac, ClarisWorks is the most logical first software purchase.

For many people, ClarisWorks may also be the last major application they'll ever have to buy. ■

Tom R. Halfhill is a BYTE senior news editor and a longtime Mac user. You can reach him on BIX as "thalfhill."

WHAT'S NEW IN CLARISWORKS 2.0

- 256-color paint module
- outliner integrated with word processor
- slide shows for presentations
- floating "shortcuts" palette
- text wraps around irregular shapes
- improved spelling checker
- custom text styles
- multiple columns of text
- more flexible chart customization
- polygon and Bézier drawing tools

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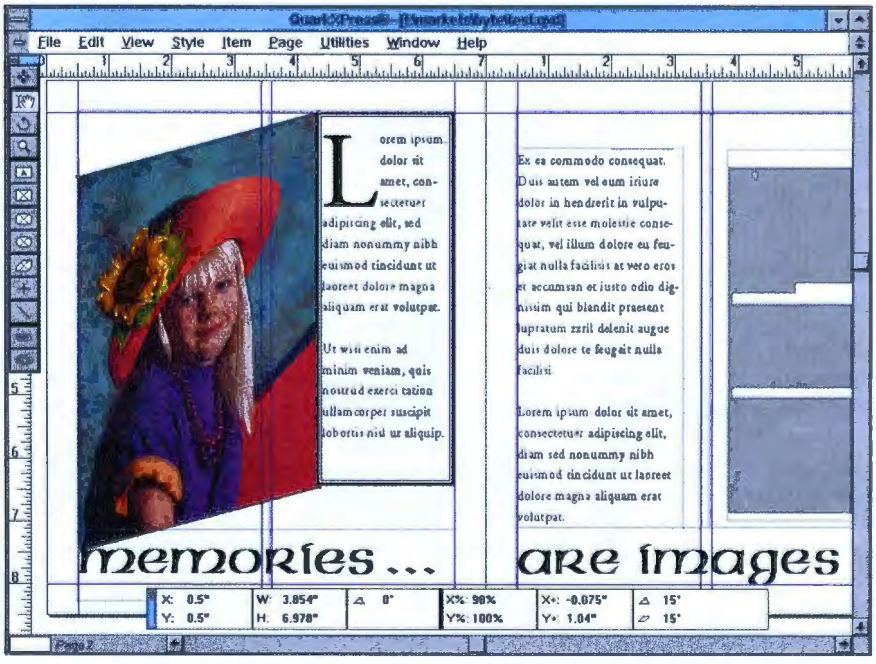
PageMaker 5.0 vs. Quark 3.1

Both compete on Windows and on the Mac. Both have dedicated followings. But in this round, at least, PageMaker has the upper hand.

G. ARMOUR VAN HORN

The competition between PageMaker and QuarkXPress has always seemed a religious issue or, to some, a holy war. With the release of PageMaker 5.0, Aldus has gone on a crusade to retain its historical market with a new level of intensity. Publishers adopt reverent feelings toward their page-composition programs because it's where they live. For subsidiary tasks (e.g., text editing, illustration, or image editing), the artist or author can choose from a changing set of programs—but everything needs to go through the layout program.

In the past, QuarkXPress adherents crowed about functions that were stronger in their program, stipulating that PageMaker was probably more intuitive for less demanding tasks. Times change. Where Quark once had measurably finer typographic and dimensional control, the differences are now smaller than the finest printable unit on a high-resolution imagesetter. But now that PageMaker has controls to match Quark's, it also has the complexity. (Its command to keep text locked to the baseline grid is five dialog boxes deep in the Styles menu!)



PageMaker 5.0 (above) and QuarkXPress 3.1 share a similar Windows interface. Both support a toolbox, rulers, grids, palettes, and a dimensions window. Note PageMaker's convenient page icons at the bottom left corner of the screen. Both programs could skew the images, but QuarkXPress could not skew the text box, a shortcoming addressed in the announced QuarkXPress 3.2 upgrade.

In the final analysis, little can be done with one program that cannot be done with the other. But there are differences in implementation: Some functions are supported directly, some require plug-in modules (i.e., Quark XTensions or Aldus Additions), and some depend on other software. Aldus claims—and for my requirements I concur—that equipping QuarkXPress to match PageMaker's features significantly increases its cost. For comparison purposes, I will limit my evaluation to features included in the basic packages.

In preparing this review, I looked at QuarkXPress 3.1 and a beta version of PageMaker 5.0 on Macintosh and Windows platforms. I'll compare each package in three broad categories: text handling, graphics, and display and print support.

From Text to DTP

Both programs can import straight ASCII text (with and without style tags), RTF,

Text Features

PageMaker
- Supports more formats for import/export
- Spelling checker shows words in context
- Faster editing in Story Editor
- Inexpensive multilingual support
- Generates tables of contents and indexes

QuarkXPress
- Automatically generates and updates "continued on" and "continued from" tags
- More powerful and flexible support for drop caps
- Styles can control a single character
- Stronger support for embedded tags

and documents saved by Microsoft Word for Windows, WordPerfect, Windows Write, Ami Pro, and XyWrite on the Windows platform. PageMaker can also import text from DEC WPS, Microsoft Word for DOS, MultiMate, PC-Write, Samna, Wang, WordStar, Ventura Publisher, and existing PageMaker documents. Each program can export text from a publication for use by most of the same programs that it can import from. PageMaker can import spreadsheet data from Lotus 1-2-3 and Excel, as well as dBase databases.

Both programs can automatically place text on successive columns and pages, as well as let you manually extend a chain of text from one place to another. Quark has chain commands for connecting manually created text boxes, while PageMaker lets you pick up overflowing text from one block and immediately place that text in a new block by clicking in an empty column or dragging out a marquee in another location. Quark generates automatic "continued on..." and "continued from..." tags that are updated when pages are inserted or removed between the two blocks.

Elaborate initial caps have been part of publishing since medieval days, but many publishers simply embed a larger letter (called a drop cap) at the beginning of some paragraphs. Both programs support this capability, but Quark performs the task more gracefully. PageMaker includes an Addition that increases the size of the first letter and styles it as a subscript, separating the balance of the paragraph from the drop cap by inserting soft returns and tabs. This operation cannot be undone and takes time to dismantle. With Quark, you can control the number of lines the drop cap extends and apply the treatment to the first several characters. The drop cap is applied to the paragraph style and can be undone with a few mouse-clicks.

Named styles are important in both programs, but PageMaker has some significant limitations. PageMaker styles apply only to paragraphs, while Quark styles can control a single character. Both programs can read style tags from imported text, but PageMaker cannot adopt complex paragraph formatting from imported tags. For example, take a fairly complex style: Say the first paragraph in a selection requires a drop cap with no indent, three words in bold small caps, and the balance of text in the default font; subsequent paragraphs then revert to a standard style with a 2-pica indent. Tags embedded in the imported story can control this specification completely in Quark. In PageMaker, you could tag the opening paragraph to turn off the paragraph indent and to set all subsequent paragraphs normally, but you would have to set the drop cap and small cap attributes manually.

Text Tools

Both programs include spelling checkers and allow search-and-replace for both text and formatting attributes. Quark performs these functions with the document open (its only mode). PageMaker performs these functions from the Story Editor, a separate window that comes up in front of the document view. Both programs can work on a single word, a single story, or the entire document, although Quark can't search both the master pages and the balance of the document at the same time.

PageMaker's spelling checker is very similar to a word processor's, stepping through the story showing each unknown word in context and proposing a list of replacements. Quark also shows replacements, but it does not show the word in context. *Theer* may be flagged, but there is no hint from Quark whether *three* or *there* was the author's intent.

Both programs allow typing and editing of any visible text in the document, but PageMaker's Story Editor enables much faster editing, since it displays a fixed font and shows only standard, italic, and bold typefaces.

Non-English-language publishers can adapt either product, but at dramatically different prices. Aldus sells a package of 20 dictionaries, including legal and medical dictionaries for U.S. or U.K. English and 11 European languages with hyphenation, for $99. Quark offers a dedicated multilingual version called QuarkXPress Passport for $2495 that handles English and nine European languages.

PageMaker has long had the ability to generate tables of contents based on style definitions or user tags, and it can generate elaborate indexes from user-inserted tags. Quark offers neither of these features.

A Place for Pictures

With either program, you can create simple graphical elements, including lines, boxes, and ovals. Both allow you to draw lines in the document and to position the lines from the control palette. PageMaker lets you draw rectangles (with square or round corners) and ovals directly on the pasteboard; Quark allows you to apply lines and fills to picture boxes, including polygon boxes that have no equivalent in PageMaker.

Most publications include some of these drawn elements, but a good page-layout program must incorporate images from divergent sources, primarily scanned photographs and illustrations in EPS (Encapsulated PostScript). With PageMaker, you can import or place these graphics directly on the document, while Quark requires picture boxes to hold the images.

Each approach has advantages. To display all of a picture in a Quark picture box, you must size the box to match the image. PageMaker displays the entire image immediately. On the other hand, Quark lets you easily apply borders and fills to picture boxes, while PageMaker users must carefully align a new box with the underlying image. Unlike earlier versions of PageMaker, version 5.0 can group the image and the border into a single element so that they remain aligned when moved or copied. Quark picture boxes crop whatever image is placed inside them. With PageMaker, you must select the cropping tool to crop an image or to move the image within the cropping borders.

PageMaker has much better cross-platform file support. It automatically converts Macintosh PICT files to Windows metafiles when they are opened on the PC, and it accepts compressed TIFF files. PageMaker files are compatible across the platforms, so documents can be easily moved from a Mac to a PC (and back

Graphics Features

PageMaker
- Much stronger cross-platform (Mac/Windows) support
- Supports compressed TIFF files
- Direct placement of images on the page

QuarkXPress
- Easier to apply image borders and fills
- Automatic cropping within a picture box
- Can apply color to line art and gray-scale pictures

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Reviews PageMaker 5.0 vs. Quark 3.1

again) easily. Quark won't support bidirectional transfers until the next release, but the Windows version can open Mac files now.

Quark picture boxes normally repel text at the same point that they crop the underlying image. Graphics placed in PageMaker can have either rectangular or complex polygonal text-wrap borders that can be completely independent of the graphic. The steps involved are different, but you can accomplish similar results in either package.

When color EPS files are placed in PageMaker, the colors are added to the color palette and can be used for other elements, assuring that extra spot-color separations won't be created. Quark doesn't have this capability. Both programs use Pantone, TruMatch, and FocalTone color systems and can print separations of CMYK files included in documents.

Display and Print

Each program supports a toolbox, rulers, guides, and a range of palettes including a master control palette. PageMaker's control palette includes a small "proxy" near the left end, so you can select anchor points for the selected item. Clicking the point at the center of the proxy forces any size change or rotation to occur relative to the center; if the upper left corner is selected, new size information would force the right or bottom edges (or both) to move. Basic arithmetic is allowed in the numerical fields, such as +10 after a percentage value or /2 after a type size.

PageMaker includes page icons at the bottom left of the screen for quickly moving to any spread. Quark requires a Go To Page command from the menu or keyboard, or you can navigate through the thumbnail box or with the scroll bars.

Both programs use master pages as templates, allowing running heads, page numbers, borders, or guides to automatically become part of every new page. PageMaker allows only one master page per document, while Quark allows up to 127 different master pages in a single document. With PageMaker, you can break documents into chapter files that are strung together via the Book option, effectively allowing one master per chapter.

Display and Print Features

PageMaker
- Easier page navigation with icons
- Interruptible screen redraw
- Prints discontinuous page ranges
- Saves common settings

QuarkXPress
- Thumbnail and user-definable views
- Multiple master pages
- Traps colors to prevent printer misregistration
- Suppresses printout of selected items

Unlike Quark, PageMaker has neither user-definable views nor thumbnail views, but it supports one magnification (800 percent) beyond Quark's maximum of 400 percent. PageMaker's screen redraw is now completely interruptible, so menus or keyboard commands can be activated without waiting, making the program feel more responsive.

PageMaker and Quark support all Windows output devices. PageMaker uses the same Adobe-specified PPD (PostScript Printer Description) files that are used by Illustrator, FreeHand, and other programs. Quark handles these applications with its own printer drivers, but any professional service bureau will have appropriate files for its output devices.

PageMaker now prints discontinuous ranges of pages, a big time-saver when you're proofreading a story that jumps from the opening section of a publication to the back. PageMaker's rewritten printing routines for version 5.0 are generally quicker than those of either Quark or previous versions of PageMaker and can include a PostScript error handler for troubleshooting and cropping images.

When the Dust Settles

In many ways, PageMaker has moved past QuarkXPress with version 5.0. It's a complete product, highly capable of publishing documents of all kinds. Quark is obviously aware of the feature list of the latest PageMaker, and even though version 3.1 is no slouch, 3.2 will add many features that respond to PageMaker's challenge. For now, the price/performance ratio has tipped in PageMaker's favor, but both companies have become much more aggressive competitors. This holy war could become a boon for us innocent bystanders. ■

About the Products

PageMaker 5.0 for Windows and Macintosh
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QuarkXPress 3.1 for Windows and Macintosh
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Denver, CO 80203
(303) 894-8888
fax: (303) 894-3399
Circle 1223 on Inquiry Card.

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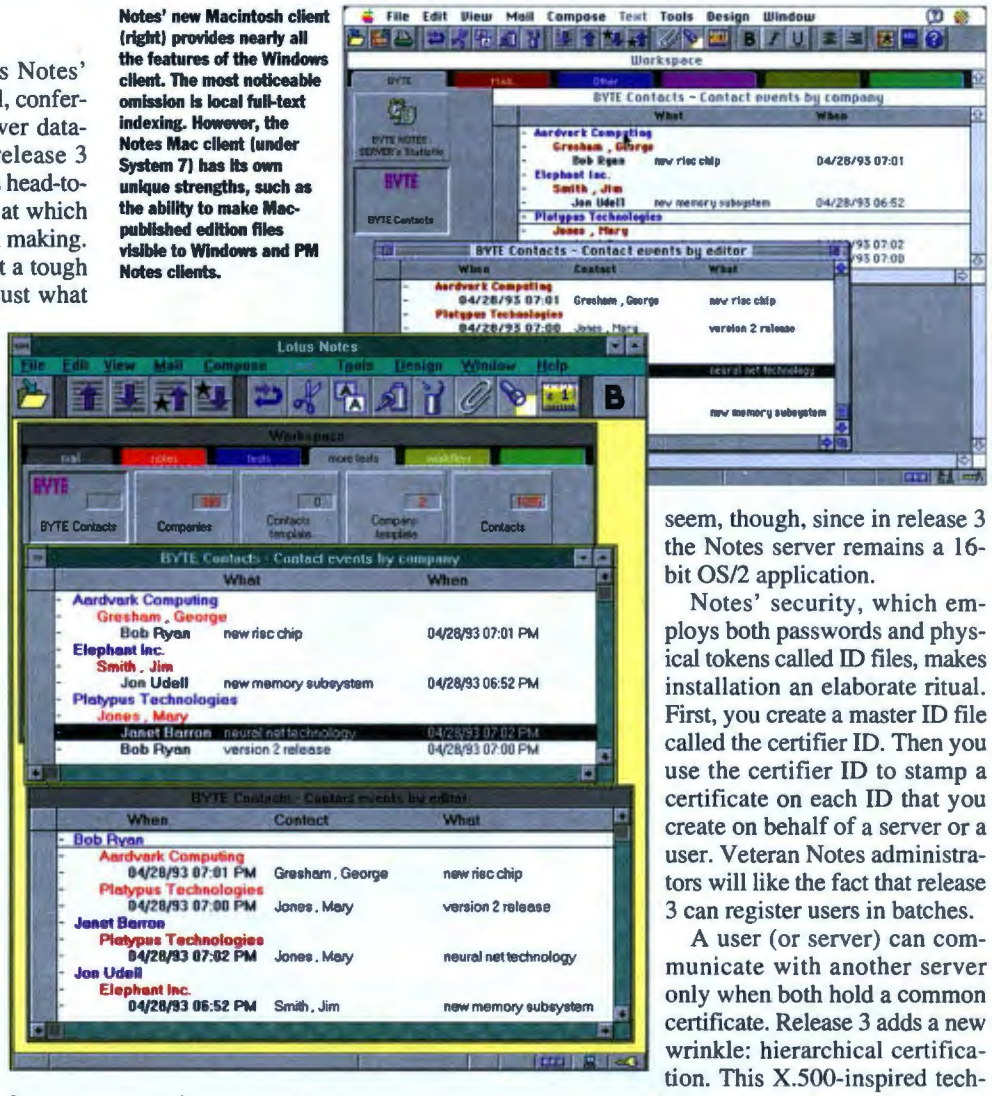
One Thumb Up, One Thumb Down

Lotus Notes release 3 is the Cadillac of cross-platform E-mail and conferencing, but for work-flow automation, it's still a Model T

JON UDELL



Notes' new Macintosh client (right) provides nearly all the features of the Windows client. The most noticeable omission is local full-text indexing. However, the Notes Mac client (under System 7) has its own unique strengths, such as the ability to make Mac-published edition files visible to Windows and PM Notes clients.

No other product offers Notes' unique blend of E-mail, conferencing, and client/server database technology. Amazingly, release 3 comes to market facing no serious head-to-head competitor. The windmills at which it tilts are entirely of Lotus's own making. The $495-per-seat price makes it a tough sell. The difficulty of defining just what problems Notes solves, and exactly how it solves them, makes things even tougher.

In a recent speech, Lotus president Jim Manzi suggested that Notes, as a refiner of information and an organizer of work, can have "infinite" value to a company. Since my duties include evaluating and implementing BYTE's own E-mail, conferencing, and database services, I was highly motivated to learn how release 3 redraws the boundary between Notes myth and Notes reality.

Release 3 broadens the Notes client base with Macintosh support. It also adds features that will appeal to users (e.g., full-text indexing and background replication) and developers (e.g., new macro functions and design templates). Regrettably, Notes still has some significant problems. Chief among these are its Byzantine security administration and a programming model that's inadequate for the kinds of groupware applications Lotus wants developers to create for Notes.

Peeling the Security Onion

Release 3 introduces a Windows 3.1 server to complement the familiar OS/2 1.x version. I tested the OS/2 server only. I began installing it on the 16-MB IBM PS/2 Model 90 I'm using to test the beta of OS/2 2.1. Because the PS/2 connects to BYTE's LAN by way of the NetWare requester for OS/2, that configuration would have exercised Notes' new ability to use IPX/SPX, as well as its traditional NetBIOS and asynchronous protocols.

I shortly discovered, however, that using OS/2 2.1 would have prevented me from testing another new protocol, AppleTalk. At least initially, release 3's Mac support will require an OS/2 1.x server. So I switched horses and installed OS/2 1.3 on an 8-MB Advanced Logic Research Flyer (a 66-MHz 486DX2) and then, lacking the 1.3 NetWare requester, opted for a NetBIOS setup after all: LAN Manager 2.2 for the Notes server and Presentation Manager client, and Windows for Workgroups for the Windows client. Dropping back to OS/2 1.3 was not the hardship it might seem, though, since in release 3 the Notes server remains a 16-bit OS/2 application.

Notes' security, which employs both passwords and physical tokens called ID files, makes installation an elaborate ritual. First, you create a master ID file called the certifier ID. Then you use the certifier ID to stamp a certificate on each ID that you create on behalf of a server or a user. Veteran Notes administrators will like the fact that release 3 can register users in batches.

A user (or server) can communicate with another server only when both hold a common certificate. Release 3 adds a new wrinkle: hierarchical certification. This X.500-inspired technique, which is optional, permits you to create and manage a tree-like namespace that reflects your company's organizational structure. It simplifies the exchange of Notes' data within and between organizations. However, it does not eliminate one disadvantage of Notes' reliance on physical IDs: You can't grant temporary access, or set up a one-time data transfer, with just a phone call. An exchange of IDs must precede any exchange of data.

Notes release 3 uses public-key encryption technology to authenticate users and to affix digital signatures to mail messages. Notes' application builders can also

create and distribute ad hoc keys that augment the server-, database-, document-, and section-level access controls with field-level encryption. It's a formidable security system, but one that's massively complex and difficult to apply. To protect a section of a document (i.e., a cluster of fields), you manipulate an access control list just as you would to protect a whole document or database. But to hide an individual field, you designate it encryptable, create a key, and then mail that key to the users you trust to access the field. They, in turn, must incorporate the key into their user IDs. Still another procedure governs regulation of access by *roles*, which are per-database groups of users that override public groups on an ad hoc basis.

This abundance of procedures may remain the Achilles' heel of Notes' security. Experience with Notes 2.1 demonstrates how even vigilant administrators can get tangled in the web of Notes' security management. One Notes administrator told me that when he moved from company A to company B, he found A's databases listed in B's catalog. The database catalog kept on each Notes server does not store documents belonging to databases it lists but does store metadata, including the *policy document* that describes the contents and intended use of each database. My source was shocked to discover A's policy documents—which themselves contained sensitive information—on B's server. He suspects that A and B accidentally replicated catalogs through contact with a server at company C. How could this happen?

A Lotus representative explained that prior to release 3, a newly installed server's catalog defaulted to a universal replication ID, so that catalogs would replicate freely among servers within a company. However, if you planned to let your servers talk to another company's servers, you had to throw away the default catalog and create a new one from the supplied template so its replication ID would be uniquely yours. Although security-conscious, companies A, B, and C apparently failed to notice and follow that procedure.

Does release 3 plug this hole? Yes, but getting that question answered took two Lotus support technicians more than a week and left me with serious concerns about the administrative burden of Notes' security.

Cross-Platform Client/Server Made Easy

I set up the Notes server to run three protocols: NetBIOS, AppleTalk, and Lotus' own dial-up protocol, XPC. (Other options now include IPX/SPX and, at extra cost, TCP/IP and X.25.) Then I installed the client software on a handful of Windows and Mac machines and used them to access the server locally through BYTE's Ethernet LAN as well as remotely by dialing the server's SupraFax modem.

The reliable sameness of Notes in all these configurations is a stunning technical achievement. Offsetting the few features not supported in the Mac version, such as local full-text indexing, is the remarkable capability for a System 7 Mac client to subscribe from within a shared Notes database to an edition published by a System 7 Mac. This arrangement, I discovered, makes the Mac-based edition visible not only to other Mac Notes clients, but to Windows and PM Notes clients as well.

Dial-up connections worked flawlessly. A 9600-bps link is clearly preferable, but you can accomplish useful work even at 2400 bps. The client/server architecture of Notes has always accommodated remote access nicely, and release 3 further improves matters by enabling workstations to run replication as a background task. Most E-mail and conferencing systems require special logic to support off-line reading and composition. Notes handles that scenario effortlessly. Mail and conference messages live in databases that replicate just like all other Notes databases. If I replicate an order-entry database from a server to my laptop and then hit the road and add some orders to the replicant, I

NOTES 3: A PARTIAL SOLUTION

ENHANCEMENTS

- **New Client and Server Platforms**
  Windows, Macintosh, and dial-in users get powerful, and remarkably similar, client interfaces. Release 3 adds a Windows 3.1 server.
- **Hierarchical Certification**
  This administrative enhancement lets you manage a hierarchical tree that represents your organizational structure.
- **Background Replication**
  Workstations can run replication as a background task, allowing you to synchronize databases even while sending and receiving mail.
- **Verity Text Engine**
  The integration of the Verity text engine adds impressive search capabilities to indexed Notes databases.
- **Column Picklists**
  Notes' new `@DbColumn` function delivers relational capabilities with the ability to generate picklists for forms from data in table columns.
- **Mail Automation**
  The `@MailSend` function gives programmatic control over Notes' mail functions, including attachments and links.

DEFICIENCIES

- **32-bit OS/2 Server**
  Release 3's server is a 16-bit OS/2 application.
- **Manageable Security**
  Security features have been enhanced, but the procedures required to maintain security remain so complex that it's easy to overlook significant leaks.
- **Character-Based Client**
  There is no character-mode client for existing low-end PCs and laptops not equipped to run Windows.
- **Database Import Features**
  There is no .DBF or comma-delimited ASCII import. Even when data is in acceptable format, Notes' import is slow.
- **Intelligent Lookups**
  Table lookups return an entire result set to the client instead of buffering parts of the query results on the server.
- **Interactive Design Tools**
  There are no immediate windows for testing macros under development and no debugging facilities.
- **High-Level Application Builder**
  The programming model for Notes still relies on macros, which (lacking even callable functions) are inadequate for work-flow applications.

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can synchronize it with the master database the next time I dial the server (even as I'm simultaneously sending and receiving mail).

What about multiple updates? Release 3 supports two flavors of version control, and the database designer can opt to record a complete change history for each document. One method makes the update subordinate to the original document; the other does the reverse. You can also now replicate selectively, regulating the bidirectional exchange with the same kind of formula you use to select the contents of a view. That's a boon, although in practice it may be difficult or impossible to write a formula that says, "Get the documents I might need while I'm off-line."

Finding the Needle in the Haystack

The integration of the Verity text engine with Notes is superbly done. If you have an unindexed database, the Find command leads to an ordinary text-search dialog box. On an indexed database, Find attaches a panoply of full-text search paraphernalia to the window in which you view the database. You can create and execute complex queries that use wild cards, Boolean and proximity operators, and value-based expressions like `Severity >= 5`; save these queries for later use; and schedule them for automatic execution. You can order search results by relevance or by date, or distribute the hits throughout the current database view as disjoint selections.

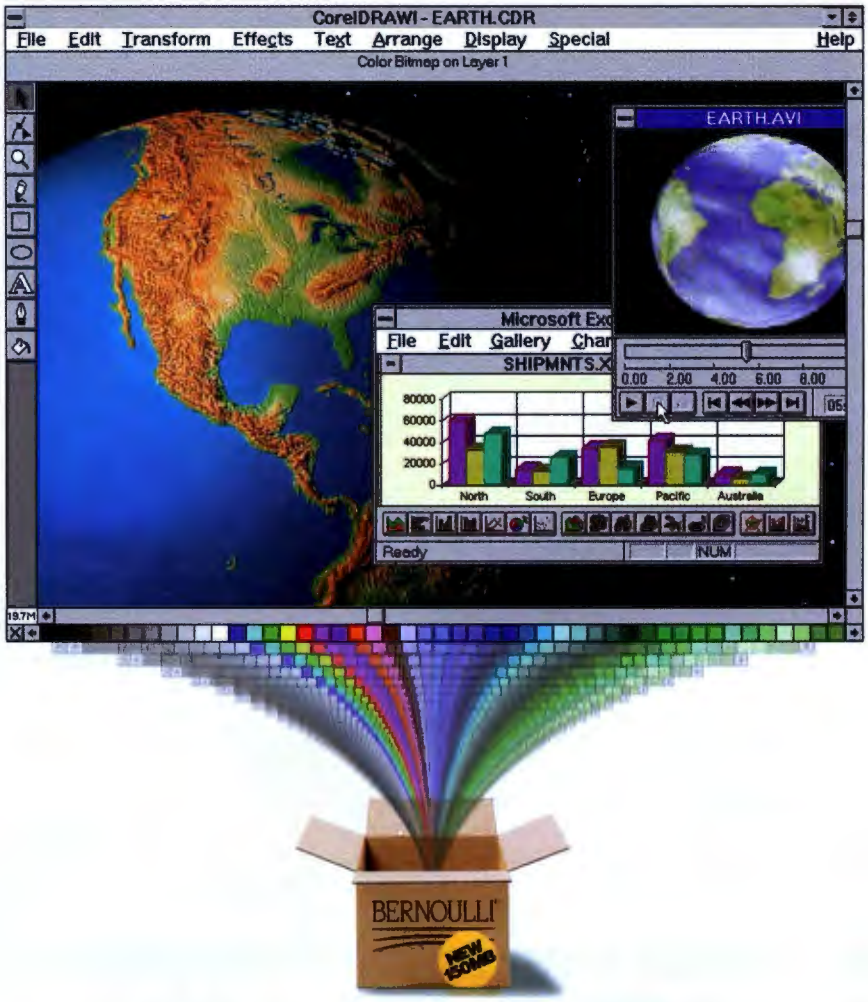
The same forms through which you enter data into the views of a database serve double duty as query-by-example templates. You can also use these forms to specify updates to the result set. If you search across multiple Notes databases, however, you'll probably want to revert to the generic query builder, since one database's forms likely won't mean anything in the context of another database.

Indexing is impressively simple, and very fast. The 486DX2/66-equipped ALR Flyer built a 1.2-MB index from a 6-MB database in under 3 minutes. Workstations index local databases in the foreground. Any user with appropriate access can also initiate indexing of a server-resident database, and this occurs in the background on the OS/2 server. You update local indexes manually. Shared databases support incremental reindexing that you can schedule to occur immediately upon change, or at hourly, daily, or other intervals.

Building Notes Applications

Release 3 instantly establishes Notes as the premier cross-platform E-mail/conferencing system for Windows, PM, and Macintosh clients. (Lotus is also developing a Motif client for Unix, but not, sadly, a character-based version for the hordes of low-end PCs and laptops that could profitably use it.) Conferencing is the crucial ingredient. Too many otherwise-worthy E-mail programs support it feebly or not at all. People who wax ecstatic over the benefits of electronic conferencing are not exaggerating. There is no more effective medium for day-to-day corporate communication, and a Notes discussion database—with full-text search, expandable categories, ordered views, rich text, tables, attachments, and links—represents the Cadillac of conferencing technology.

Notes will not remain unchallenged on the E-mail/conferencing front, however. SoftArc's FirstClass and Grapevine by Office Express are two strong contenders that



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already support Windows and the Mac, and a Windows version of Pacer's Mac-based PacerForum is forthcoming. Lotus's ambitions for Notes, though, are grander. The company wants to position it as a general-purpose platform for applications that collect, organize, and distribute "semi-structured" information, route documents, and manage work flow. In support of that goal, release 3 gives database designers new tools to process data and messages.

For my first experiment, I converted a contact manager that I'd written in FoxPro into a Notes application. Why? FoxPro today delivers neither the cross-platform support nor the remote-access capability that I'm keen to provide. Moreover, Notes encourages an appealing model in which free-form discussion can decorate a trellis of structured data. Notes' forte admittedly is not structured data, but I thought 5000 company and contact records would be a reasonable load, and I was willing to trade speed for other benefits.

You build a Notes application—which is to say a heavily customized Notes database—around a set of forms and views. A form defines the fields that make up a document (i.e., a record) in a Notes database, and it handles data entry and queries. A view presents a selected subset of the documents in that database, typically sorted and often grouped by expandable categories. Although the documentation does not explain how, you can easily achieve relational effects by treating several views as tables related by a common key.

Once I realized this, I built the forms and views needed to relate companies to contacts and imported my FoxPro data. Unfortunately, that was easier said than done. Notes offers a weak list of import formats. There's no .DBF format, never mind the nearly universal comma-delimited ASCII, so I had to write a FoxPro report to render my data as files of field-name:value pairs that Notes could import as structured text. It did so, but slowly—8 minutes for one 3000-record import file on the 486DX2/66 server, and a half-hour for the same file on a 386/25 workstation.

Picklists and Menus

Next, I explored the new `@DbColumn` function, which enhances Notes' relational capabilities by picklisting a field using the contents of one column of a view. My FoxPro application uses this technique to enforce relational integrity, and `@DbColumn` at first looked like the right solution for the Notes implementation. However, a 5-second delay on first use of the picklist made me suspect that `@DbColumn` was, disastrously, reading the whole list into workstation memory. My suspicion was confirmed when, as I dialed into the server from home, the 5-second delay became 10 minutes. Clearly, that's an unworkable solution for all but the most trivial lookups. When Lotus adds foreign database support to `@DbColumn`, an intelligent scheme for buffering the returned data will become even more imperative.

Searching for a way to work around `@DbColumn`, I tried exploiting a form's ability to inherit field values from the active view. If a user has the Contacts view open and has selected a Lotus contact, the Compose Contact form can inherit the company name without requiring picklist selection. That worked, but only when the user's current view was one that could supply a company name. Unfortunately, you can't programmatically disable the

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Compose Contact menu item, so I couldn't guarantee that the Compose Contact form would always present a valid company name. With DBMS software, you can tailor menus to meet this requirement; with Notes, you can't.

Tackling Work-Flow Programming

With some release 3 experience under my belt, I moved on to build a new application to route manuscripts through BYTE's editorial pipeline. The key enabling feature, new to release 3, is the `@MailSend` function, which automates use of the Notes mail system. Of special importance is `@MailSend`'s ability not only to attach copies of documents to messages but also to include *doclinks* that point to shared documents. In the approval cycle for a manuscript, for example, you might want a technical editor, then a copy editor, and then the managing editor to review the live manuscript (not a copy!), each in turn. Notes release 3 makes it possible to build such an application. But it doesn't make the job easy.

One obstacle is the development environment itself. Notes needs a BASIC-style immediate window in which to try out user-written macros. Lacking that, you end up drilling down through several layers of dialog boxes to get to the place where you can write a snippet of code, then backing out to test it, and then drilling down again when you find you've botched the syntax. Better up-front syntax-checking would also help, as would a rudimentary debugger.

A larger problem is that functions like `@MailSend` are, in effect, just the assembly language of work-flow programming. To route a document through an approval cycle requires sophisticated state transition and tracking logic, not just the ability to pipe data from one user to another. The Notes macro language, which does not even permit you to write callable functions, is a clumsy way to express that logic. And while the templates supplied with release 3 illustrate the basic techniques you'll need, they're not reusable in any meaningful way.

Companies serious about creating business-process applications in Notes will need better tools. Lotus and Action Technologies are, in fact, working on an application builder that will let you describe work flow abstractly and will then generate the code to implement it. It won't be available until the year's end, and it isn't scheduled to become a standard feature of Notes. I hope Lotus rethinks that plan. Release 3 delivers all the raw materials to create work-flow systems. But if those systems are to succeed in the real world, you'll need faster, easier, and more productive ways to build them.

My recommendation? Use Notes for its deluxe E-mail and conferencing, if you can afford to. But don't plan to use it to reengineer your business. ■

Lotus Notes release 3

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Five users $1395
100 users $8795
1000 users $47,995
(other levels available)

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Cambridge, MA 02142
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Jon Udell is a BYTE senior technical editor who manages BYTE's PC network. You can contact him on BIX as "judell" or on the Internet as judell@bytepb.byte.com.

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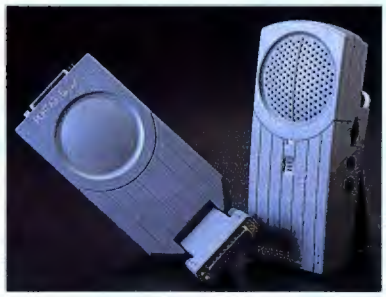

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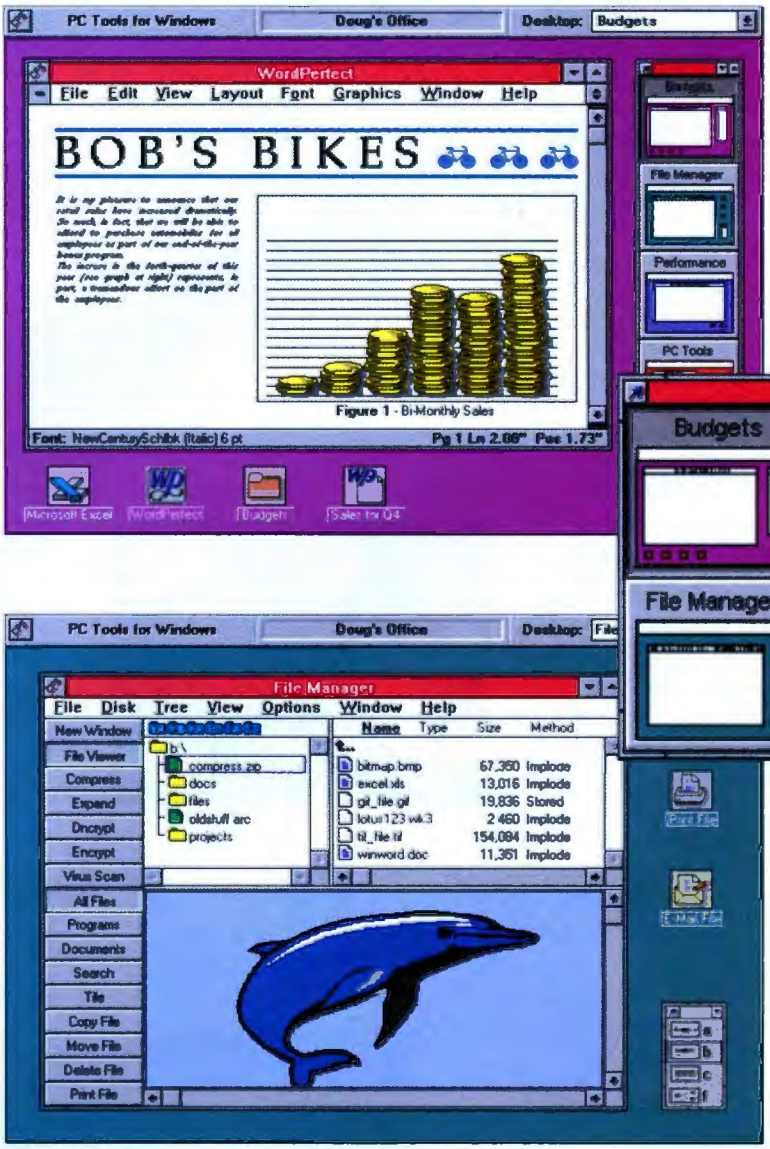

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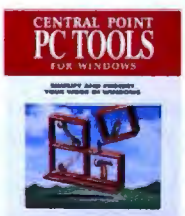

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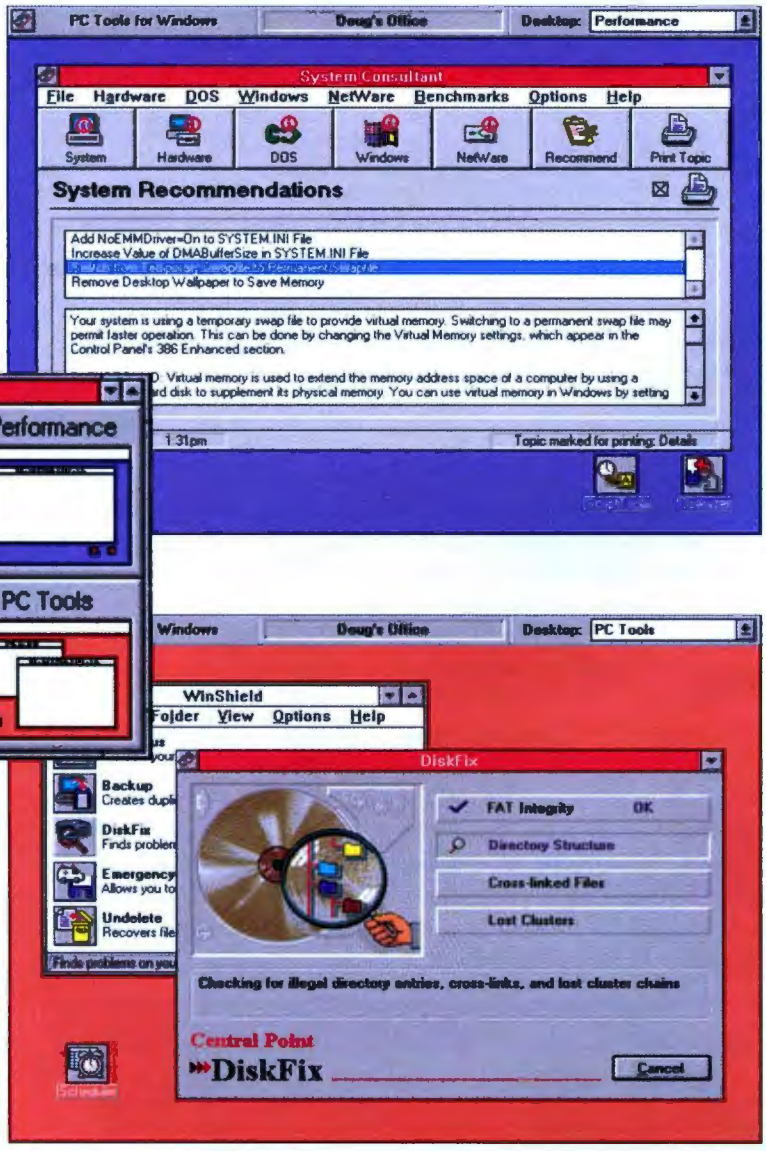

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HANDS-ON TESTING

V.32 OR BETTER:

Line-impairment and data throughput tests measure the efficiency of 9600-bps and faster modems

JIM HURD

First, the good news: We subjected 69 modems to some of the most sophisticated tests ever conducted by a magazine's testing lab and found that modems are faster, more reliable, less expensive, and smaller than ever. The bad news is that you won't find all of these improvements in any one package.

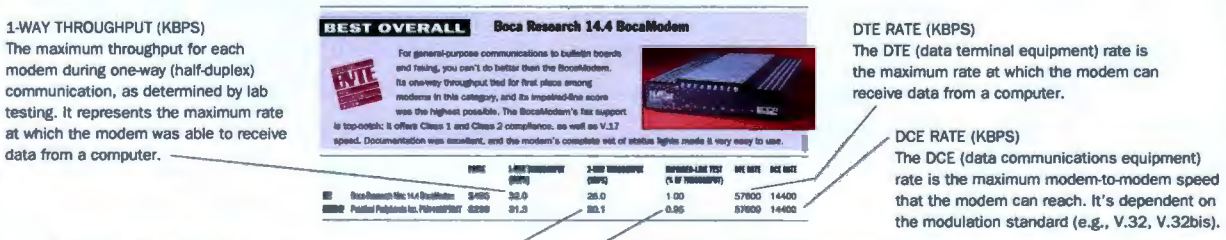
If you want to push the envelope on transmission speed, you'll have to pay: The fastest modem in our test, the Motorola Codex 3260 Fast, costs an eye-popping $1395. Nevertheless, it ran our data throughput tests at an impressive 53.4 Kbps, 29 Kbps faster than today's mainstream V.32bis modems. You'll also have to trade off low cost to get the ultimate in portability, because most of the portable modems we tested cost a few hundred dollars more than their desktop-bound equivalents.

If you have less exotic requirements and are simply searching for an all-around desktop modem, you'll find plenty of choices nearer the middle of the speed curve. V.32bis modems reign as the best price/performance buys today and remain the fastest modems that support a standard modulation scheme. Of the 49 V.32bis modems we tested, 21 had list prices of under $400, putting them squarely in competition with the last generation of V.32 (9600-bps) modems.

We ran the 69 modems, each capable of at least 9600-bps transmission, through speed and impaired-line tests. Our line-impairment tests create 25 telephone-line conditions that simulate everything from satellite transmissions to poor connections to telephone-company switching stations. These conditions, generated by a TAS (Telecom Analysis Systems) line simulator and representing most conditions of the U.S. telephone network, showed that the modems were remarkably robust: We found 13 modems that could run at their top speeds across all the impaired lines. See "How We Tested" on page 176 for details of our tests and test methodology.

How to use this guide

To find the right modem for your application, choose the category that most closely matches your requirements from among the four main topics (All-Around Communications, Portables, High Speed, and Data Only). In each category, we select one modem as Best Overall; this is the modem we recommend for most jobs related to that category. If you have more specialized requirements, look to the other selections; for example, if your communications require full-duplex operation, consider modems listed under "Two-Way Communications."



69 MODEMS

Critical Communication Components

SERIAL PORT
The fastest modems accept data at 115.2 Kbps (DTE speed). Be sure your modem can accept data at rates at least four times faster than its line rate (DCE speed): 57.6 Kbps for a V.32bis modem and 38.4 Kbps for a V.32 modem.

CPU
Pocket modems generally use slower CPUs to process commands and compress data; this can hurt their overall performance, especially when transferring data in both directions. Slow command processing can also occasionally cause compatibility problems with software. The CPU has much less to do when faxing, because the host computer generally handles fax compression and decompression.

RAM
RAM can be more important than CPU speed to overall data throughput. The amount of RAM is a limiting factor in the amount of compression that the modem can reach. Modems typically use either 2 KB or 4 KB for data dictionaries. RAM size is not generally a performance factor when faxing, but a buffer that is too small can cause headaches for fax software.

DATA PUMP
The data pump converts between digital information and analog transmissions, and it determines how well the modem can handle impaired lines. Traditional designs use specially designed chips, but designs based on general-purpose DSPs (digital signal processors) have come on strong. A DSP-based modem, such as the AT&T Paradyne Comsphere 3830, can offer the flexibility of adding modulation schemes through software upgrades.

EPROM
The modem software is stored in EPROM. Generally, you only need to worry about the EPROM when bug fixes are required, but some vendors, such as Zyxel, routinely offer modem upgrades via EPROM replacement. AT&T Paradyne uses an EEPROM in the Comsphere; we were able to accelerate our Comsphere from 14.4 Kbps to 19.2 Kbps by downloading some new software.

BEST

ALL-AROUND COMMUNICATIONS

Boca Research 14.4K External BocaModem

Whether you're sending E-mail, communicating by fax, or hooking into bulletin boards, the BocaModem is an outstanding choice. Most notable was its perfect score on our impaired-line performance tests. Besides excellent speed and reliability for data communications, the BocaModem offers Class 1 and Class 2 fax compliance. **PAGE 174.**

PORTABLES

Practical Peripherals PM14400FX PKT

Not much bigger than a deck of cards, the PM14400FX PKT packs a lot of modem into a small package. It supports V.32bis (14.4-Kbps) data transmission speed and 14.4-Kbps (V.17) fax. Despite its size, it doesn't skip usability features, such as a good speaker and status display. **PAGE 180.**

HIGH SPEED

Motorola Codex 3260 Fast

This is the fastest modem on the market today. Its nonstandard modulation allows it to reach 24 Kbps when communicating with other Codex Fast modems. Our tests confirmed this speed: The modem simply blew away all other contenders on our one-way transmission tests. The 3260 Fast also handled impaired lines well, although it rarely managed to hit peak performance under less-than-perfect conditions. **PAGE 186.**

DATA ONLY

AT&T Paradyne Comsphere 3830

If you don't need fax support but want fast data communication with standard protocols, choose the Comsphere 3830. Its ability to handle DTE rates of up to 115.2 Kbps gives it a performance edge over other high-speed V.32bis modems. This DSP-based modem is also easy to upgrade. **PAGE 189.**

MODEMS FOR

ALL-AROUND COMMUNICATIONS

For all-around communication tasks, the best choice today is a 14.4-Kbps, V.32bis desktop modem with good fax capabilities. Whether you're setting up E-mail links, connecting to bulletin boards, or performing almost any general communications task, V.32bis modems are data communications workhorses.

Performance and price are the biggest advantages of 14.4-Kbps modems. They cost only slightly more (as little as $50 in some cases) than 9600-bps devices, which run at only two-thirds the speed. Some V.32bis modems, like the Practical Peripherals PM14400FXMT, list for less than $300.

In fact, when all the testing was done and prices and features compared, not a single V.32 modem made it onto the Best Overall list, or even onto the list of low-cost modems we recommend. The performance difference simply outweighs the minor cost differential, even when price is a major factor.

Our Best Overall selections highlight the fastest modems for one-way communications. These are most suitable for users who connect to bulletin boards, send E-mail, log onto electronic services like CompuServe, and send data files with communications software (e.g., Procomm Plus) that supports ZMODEM, XMODEM, and YMODEM protocols. We also considered fax to be essential for a general-purpose modem and made that one of our selection criteria.

Because two-way communications can be essential for users of RELAY and BLAST communications packages, we also identified the leading modems for this application. RELAY and BLAST use software protocols that handle full-duplex communication, although most communication software does not.

We judged the best modems based on their throughput speeds for one-way and two-way communication, as appropriate. Throughput speed represents two-thirds of each modem's total score.

Our second most important criterion was the modem's performance in our impaired-line tests, which measured how well each modem maintained its top speeds when faced with noisy telephone-line transmissions. The score is based on the average performance on impaired lines, measured as a percentage of maximum performance. A modem scored 100 percent if it ran at top speed over all 25 of our simulated lines. Most modems dropped back on the line that simulated satellite transmission with long delays. Scores below 95 percent on this test indicate potential problems when making long-distance connections, especially internationally.

Finally, because these modems are called upon to perform a variety of tasks for people who aren't necessarily communications experts, we evaluated them for features and ease of use, considering the quality of their documentation, whether status lights or LCD panels were informative, and the ease with which we could change default settings.

We found price to be only a small differentiator: Although some good modems in this category sell for as much as $989 (the Zyxel U-1496Plus), the top five modems in this class all sell for between $300 and $600.

All the modems listed under Best Overall support the V.17 standard for fax speeds up to 14.4 Kbps. In general, avoid fax modems that don't fax at this rate, or you'll waste a lot of time faxing documents as V.17-compliant fax machines and fax modems proliferate. V.17 support doesn't cost extra: Even

SQUEEZE MORE SPEED FROM YOUR MODEM

COMMUNICATION SOFTWARE

Communication software must be fast enough to keep up with the modem and smart enough to use file transfer protocols that can tolerate the latency of error-correcting modems. Of the popular protocols, ZMODEM is the best choice, followed by sliding-window Kermit and YMODEM-G. Proprietary protocols like BLAST can squeeze more performance out of many modems by transferring data in both directions simultaneously.

PC SPEED

A PC UART (universal asynchronous receiver/transmitter) can buffer only one to 16 characters; the PC must be able to read the UART constantly to prevent it from overflowing. Graphical operating systems like the Mac and, especially, protected-mode Windows can slow the computer to the point where it can't read the UART fast enough to prevent overflow. You may need a serial coprocessor card to achieve maximum speed with high-end modems in these environments.

PC SERIAL PORT

Fast modems need buffered UARTs in the computer for maximum effectiveness. A 16550 UART buffers up to 16 characters—enough to provide reliable operation at 115.2 Kbps. But some 16550s have bugs (fixed in the 16550A) that prevent their reliable use above 57.6 Kbps. All Macs have a UART with a three-character buffer—plenty for reliable 57.6-Kbps communication.

CABLE

The main consideration for a modem cable is that it wire the hardware handshaking lines (pins 4 and 5), carrier detect (pin 8), and DTR (Data Terminal Ready; pin 20), in addition to the required data lines (pins 2, 3, and 7). For best results, keep the cable length down to 6 feet or less. Don't assume that your modem will come with the cable you need; most do, but some don't.

the least expensive modems have it.

At $699 and $799, the two Multi-Tech modems that ranked in our Best Overall class are pricey compared to the $395 BocaModem, but Unix users can consider either Multi-Tech as a reasonable replacement for a $949 Telebit T3000. Like the T3000, the Multi-Tech MT1432BA supports spoofing, which makes it an excellent choice if you use UUCP's g-protocol. (See "Spoofing: Serious Speed Benefits" on page 186).

The three Zyxel modems we tested scored a three-way tie for best two-way communications modems. The $469 Zyxel U-1496E is a real bargain—it performs just as well as the higher-priced Zyxels when used at V.32bis speeds, and it offers an attractive array of features, including caller ID, distinctive ringing, and voice recognition. In addition, the U-1496E achieves 16.8-Kbps communication speeds when used with other Zyxel modems. (For this application, we considered test results at 14.4 Kbps; see "High-Speed Communications" on page 186 for the Zyxels' high-speed scores.) Unfortunately, the Zyxel modems don't support Class 1 fax, the current standard.

Many of the low-cost modems, especially the Practical Peripherals PM14400FXMT and USRobotics Sportster, performed admirably in our speed and reliability tests, and we can recommend them without reservation. These modems are especially attractive if you don't need high-speed bidirectional throughput. For example, if you dial into bulletin boards and download information, a PM14400FXMT will perform at nearly the level of the Zyxel modems for a much lower price. The PM14400FXMT has an excellent feature set, including Class 1, Class 2, and V.17 fax. Pick the PM14400FXMT for one-way applications. If you use BLAST or RELAY, choose the Sportster; it's the best two-way communicator among low-cost modems.

BYTE BEST — ALL-AROUND COMMUNICATIONS

Need speed and flexibility?

BEST OVERALL — Boca Research 14.4K External BocaModem

JULY 1993 BYTE BEST ALL-AROUND MODEM

For general-purpose communications to bulletin boards and faxing, you can't do better than the BocaModem. Its one-way throughput tied for first place among modems in this category, and its impaired-line score was the highest possible. The BocaModem's fax support is top-notch: It offers Class 1 and Class 2 compliance, as well as V.17 speed. Documentation was excellent, and the modem's complete set of status lights made it very easy to use.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Boca Research 14.4K External BocaModem	$395	32.0	26.0	100	57.6	14.4
RUNNER-UP	Practical Peripherals PM14400FXMT	$299	31.3	20.1	95	57.6	14.4
RUNNER-UP	Zoom Telephonics VFXV32bis	$349	31.7	22.0	97	57.6	14.4
RUNNER-UP	Practical Peripherals PM14400FX PKT	$499	31.3	20.3	95	57.6	14.4
RUNNER-UP	Practical Peripherals PM14400FXSA	$549	31.4	24.1	95	57.6	14.4
RUNNER-UP	Multi-Tech MT1432MU	$699	31.4	21.4	99	57.6	14.4
RUNNER-UP	Multi-Tech MT1432BA	$799	31.4	21.4	99	57.6	14.4
RUNNER-UP	Zyxel U-1496Plus	$989	32.0	31.3	99	76.8	19.2[1]

Do you use RELAY or BLAST?

TWO WAY — Zyxel U-1496E

The Zyxel U-1496E's performance in two-way communication was top-notch: The modem tied for first place on speed and scored an impressive 99 percent on the line-impairment tests. What's more, the U-1496E's feature list is among the most comprehensive for general use: The modem supports fax, voice, DTMF decoding, caller ID, distinctive dialing, and fax/voice switching. Zyxel actively upgrades modems in the field by sending new EPROMs to users as additional features become available. Zyxel does not license the Hayes guard-band patent or use TIES (Time Independent Escape Sequence), but we had no problem with false escapes.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Zyxel U-1496E	$469	31.8	31.2	99	76.8	16.8[1]
RUNNER-UP	Zyxel U-1496EPlus	$649	31.8	31.2	99	76.8	19.2[1]
RUNNER-UP	Zyxel U-1496Plus	$989	32.0	31.3	99	76.8	19.2[1]
RUNNER-UP	AMT Star 1442I	$399	31.7	30.5	100	57.6	14.4
RUNNER-UP	GVC FM144/144V	$399	31.7	30.6	99	57.6	14.4
RUNNER-UP	The Complete PC Turbo Modem Plus	$399	31.7	30.6	99	57.6	14.4

Looking for low cost?

LOW COST — Practical Peripherals PM14400FXMT

The 14400FXMT's one-way throughput score was just a hair behind that of the fastest performer, the BocaModem. Its one shortcoming was its impaired-line score of 95 percent, resulting from its failure on the two simulated satellite lines. If your communications don't travel through satellite links, the PM14400FXMT is comparable to the BocaModem and sells for nearly $100 less. The PM14400FXMT also doesn't compromise on features or ease of use: It offers Class 1 and Class 2 fax support, and its documentation is clear and informative. It's also one of the few modems that supports caller ID.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Practical Peripherals PM14400FXMT	$299	31.3	20.1	95	57.6	14.4
RUNNER-UP	Cambridge Telecom 1414XE	$269	29.4	16.4	97	57.6	14.4
RUNNER-UP	USRobotics Sportster14400 Fax	$299	30.3	25.5	99	57.6	14.4
RUNNER-UP	Zoltrix 144/144e	$239	31.7	22.1	85	57.6	14.4

[1] Maximum DCE rate; test scores reflect modem's performance at 14.4 Kbps.

How We Tested

Our modem performance tests subjected the modems to 25 telephone-line conditions and eight kinds of data transfer tasks using as many as four different modulation types. We used DOS, Windows, and Macintosh platforms to drive the data through the modems.

Ours are among the first published tests using line-impairment conditions specifically designed to mirror real-world conditions. The impairment combinations we used are based on the working papers of the EIA/TIA's (Electronic Industries Association/Telecommunications Industry Association) TR-30.3 committee, which was consulted for the tests. Our test conditions cover a major subset of the lines discussed in TR-30.3's PN-3064 draft recommendation for network simulation for modem testing.

These test lines are based on a comprehensive survey of the U.S. Although they are therefore reflective of the state of the telephone network in the U.S. only, they include impairments (e.g., satellite delays) that are also found in non-U.S. locales.

THROUGHPUT TESTS

Our unimpaired-line throughput tests are also unique. Many modem tests focus on the ability to transmit data in one direction, but modems are often called on to perform two-way transmissions. The tests we ran show how well modems can simultaneously transmit and receive files.

Our *throughput* tests rate a modem's ability to send data as quickly as possible over an unimpaired line using standard data-compression and error-correction techniques. Throughput tests measure the performance of the data-compression and error-correction engines in each modem. All the tested modems support V.42 error correction and V.42bis data compression.

We connected like pairs of modems via a PBX and ran the throughput tests from a Mac. We used four different files: a compressed file, a graphics file, a text file, and a database file. These files have potential V.42bis compression ratios of 1 to 1, 2 to 1, 3 to 1, and 4 to 1. Data files were developed at NSTL.

For testing modems with a 57.6-Kbps DTE rate, we used Creative Solutions' coprocessed Hurdler boards in a Quadra 950. By using coprocessors for each serial card (and a powerful computer), we ensured that modems would be sent data as fast as they could handle it. For modems rated at 115.2-Kbps DTE speed, we tested using a program called HowFast by Softart. HowFast requires dual 16550 UARTs and a 486 computer: We used a Hayes ESP board in a Compaq 486/33.

We ran each modem pair using factory default settings, with the following exceptions: Modems were configured to receive data from the computer at the fastest rates they supported (up to 115.2 Kbps); modems were configured to use V.42bis data compression and V.42 error correction, even if the default settings specified MNP protocols; and all modems were configured to use RTS/CTS (hardware) flow control instead of XON/XOFF.

For data-compression and error-correction parameters, we chose defaults for dictionary and window sizes. We chose default sizes even if a modem supported larger-than-default dictionary sizes for unidirectional transmissions (we assumed that users are unlikely to reconfigure the modem each time they conduct bidirectional transmissions).

Once we got them configured, we set the modems to transfer the four types of files, ranging from 32 KB to 48 KB in length, at the fastest possible rates. We measured throughput for one-way and two-way transmissions. With a one-way test, modem A transmits each type of file four or more times to modem B; there is no transmission from modem B to modem A. For two-way tests, modem A transmits each type of file four or more times to modem B, while modem B simultaneously transmits a different type of file to modem A.

LINE-IMPAIRMENT TESTS

The heart of our line-impairment testing was a TAS Series II modem tester. This

The TAS (Telecom Analysis Systems) Series II modem tester enabled us to re-create 25 telephone-line impairments; this helped us judge how well each modem worked under real-world conditions.

advanced telephone-line simulator can re-create almost any line condition that you may encounter anywhere in the world, even if you're sending data over satellite networks. This latest generation of TAS equipment is more sophisticated than ever: It allowed us to exactly simulate the standard local-loop impairments in addition to usual central office impairments. Our 25 test lines simulate combinations of a variety of impairments: long satellite delays, phase roll, and noise, to name a few.

The line-impairment conditions were developed by the EIA/TIA TR-30.3 committee, which also developed the TSB (Technical Systems Bulletin) 37 line conditions for testing V.32 modems. The 25 line conditions are not part of an official standard, but were developed to test modems that conform to the emerging CCITT V.Fast specification for high-speed modems. According to the developers, the 25 line-impairment conditions conform closely to the actual telephone network in the U.S.

For our line-impairment tests, we connected like pairs of modems to the TAS system, which simulated a trunk line and local loops at both ends of the connection. We configured the modems to factory defaults, with the exceptions noted previously. Each modem transmitted a 32-KBps compressed file over a given simulated line at least four times.

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How We Tested *(continued)*

We recorded throughput times and averaged the results. We measured throughput rather than performing a BERT (bit-error rate test) because most users will take advantage of error correction.

Line-impairment scores are given as a percentage of best-case throughput (determined by the throughput tests), and we present an average across all impaired lines. There is a 1 percent margin of error on these scores (i.e., consider a score of 99 percent to be statistically equivalent to 100 percent).

Approximately one third of the modems negotiated all the lines without any problem. Of the rest, most ran aground on the satellite lines, but several modems had difficulty with long local loops. Satellite delays of the magnitude we tested are virtually nonexistent within the U.S. network, but they can be encountered in other locations. Long local loops do exist within the U.S. network, and if you have one, you have few options short of moving. (The local loop is the connection from your phone to the local phone company's switch). All the modems handled the most common lines well; it is the difficult lines that show differences in the modem architectures.

High-speed modems can "drop back" and pick a slower-than-maximum data speed when they encounter an impaired line. The faster the modem, the more likely it is to need to drop back. While most 9600-bps modems were able to use their top speed on all impaired lines, the Motorola Codex 3260 Fast kept maximum performance only on mildly impaired lines. Modems like the Codex 3260 Fast are designed to take maximum advantage of every connection, whereas previous generations of modems were more conservatively designed to deliver full speed even on the worst lines. Since most connections on the U.S. network are virtually unimpaired, the Codex approach makes a lot of sense. Even averaging 90 percent of its top speed, as it did on our tests, the Codex 3260 Fast is still the fastest modem on the market.

Modems don't only drop back; they also "fall forward"—that is, they can increase speed as the quality of connection improves. Picking the right rate is tricky, and modem vendors employ different strategies. The trick is to maximize throughput by balancing higher speeds against increased risk of errors. We solicited input from all the vendors regarding the best configuration for each company's modem.

Testing team (clockwise from left): Alan Joch, Helen Holzbaur, Siva Kumar, and Jim Hurd.

SIMULATING REAL-WORLD IMPERFECTIONS

Our impairment tests were created by combining the following four different trunk-line types and seven different local loops.

TRUNK LINES

Digital	Digital lines have few impairments, but the typical PCM (pulse-coded modulation) that converts the analog signal generated by a modem to digital can cause quantization distortion. This is a particular problem for those who use their modems for long-distance calls, because most long-distance circuits today are digital. (Regional telephone companies are in the process of digitizing their networks, but some are not as far along as long-distance carriers).
Digital with multiple conversions	Simulates the "worst case" scenario with digital lines: The digital transmission passes through a region with analog switches. This means that modems can be "hit" three times with PCM conversion, and the associated difficulties.
Analog	Analog lines typically present more impairments than digital lines. Even the best analog lines present some impairments to modems. Callers in the U.S. typically encounter an analog line on a call that goes through a regional network that hasn't completed the transformation to digital.
Satellite	Important for those making transcontinental calls. Problems occur when a delayed echo interferes with the transmitted signal. Echoes occur during the conversion between four-wire and two-wire transmission at the far end of the connections; satellite delays arise during the time it takes the signal to travel to the satellite and back. Some modems can "cancel" the echo using DSP (digita signal processing) techniques. Those that can't do so won't be able to connect. This was one of the most common failures for modems that received a score of 95 percent or less in our tests. Our tests simulated a delay of 700 milliseconds, which was severe enough to stress-test today's modems, but also representative of what can occur in the real world.

LOCAL LOOPS

Our seven local-loop simulations ranged from a short, 2000-foot loop to 7000–15,000-foot loops with and without bridge taps, to 30,000-foot loops with four or five loading coils (which modify the frequency response of loops).

Contributors

Helen Holzbaur, *Consultant/NSTL, worked as a network manager and systems administrator for Temple University for 10 years.*

Jim Hurd, *Vice President of Research and Development/NSTL, has tested scores of modems, as well as applications software and operating systems, during the last 10 years at NSTL.*

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network-operating-system testing.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.

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MODEMS FOR

PORTABILITY

Portable modems are essential if you need to access company data, run applications remotely, or fax from the road. They can also do double duty by serving your desktop computer when you're back at the office. If you go that route, however, you'll have to accept a slight performance penalty. Our tests showed that, on average, desktop modems outperformed portables by a margin of about 300 bps. Portability also adds to cost: The portable modems we tested cost an average of 40 percent more than their desktop counterparts.

Pocket modems can run on either AC or battery power. The smallest modems, like the Practical Peripherals PM14400FX PKT and the Hayes Optima 144 Pocket, use external batteries. Slightly larger modems, like the USRobotics WorldPort14400 Fax, the Multi-Tech MT1432MU, and the Megahertz P2144, incorporate batteries inside the modem case. The E-Tech modems and the Twincom Voyager are almost as large as desktop modems, but they weigh less and include a battery.

We chose our Best Overall modem based on its one-way data throughput score, its performance on difficult lines, the range of its features, and its ease of use. We selected two-way communications winners by ranking performance on two-way throughput tests. Because portable modems might be called on to handle a more diverse range of line conditions than their desktop counterparts, we weighted the line-impairment scores second to throughput; the higher the percentages, the more likely the modem can handle whatever types of lines you encounter on the road.

Overall, the performance scores of portable modems were closely matched, and we found features and ease of use to be the real differentiators between the winners and the runners-up. A clear, easily understandable status display, like the Practical Peripherals PM14400FX PKT's, is essential and can avoid frustration when you're trying to troubleshoot a modem in your hotel room.

The cream of the portable modem crop are the Practical Peripherals PM14400FX PKT and the Multi-Tech MT1432MU. The set of indicator lights on each is easy to read, and both modems performed well in our speed tests. The PM14400FX PKT gets our vote for Best Overall based on its fast one-way throughput and because it supports both Class 1 and Class 2 fax. Practical Peripherals' portable modem is also $200 cheaper than Multi-Tech's.

SPEED LIMITS

DATA

Don't assume that the fastest modem is always the best: You can never communicate faster than the slower modem in any connection. For example, if all you use a modem for is to connect to CompuServe, the fastest data speed you'll achieve is 9600 bps. If you pay $800 to $1400 for one of the high-speed modems, such as the AT&T Paradyne Comsphere 3830 or the Motorola Codex 3260 Fast, your data transfer speed won't be any faster than if you use a $249 Practical Peripherals PM9600FXMT, a 9600-bps modem.

CompuServe isn't unique. Most public on-line services offer 9600-bps access. Bulletin boards generally offer 14.4-Kbps V.32bis, and a good number of them offer 16.8-Kbps USRobotics HST. Public-access Unix hosts generally offer V.32bis, and many offer PEP and Turbo PEP at speeds of up to 23 Kbps. AT&T Mail supports 19.2-Kbps V.32terbo.

If you control the modem on both sides of your communications link, you have many more options. You can take advantage of speeds above 14.4 Kbps. Telebit offers excellent unidirectional throughput with Turbo PEP. Bidirectional throughput with PEP is limited because PEP is asymmetric; it is optimized for data flowing primarily in one direction. USRobotics HST is also asymmetric, but HST is not as fast or as flexible as PEP. PEP uses a multicarrier approach that allows it to balance the speed of the two channels, as well as to fall back in very small increments in the face of line impairments. HST uses two fixed-speed channels and simply changes directions as necessary.

Both of these asymmetric modulations are generally outperformed by AT&T's V.32terbo and Zyxel's proprietary 19.2-Kbps modulation, and Motorola Codex's 24-Kbps modulation.

FAX

Most fax communication follows the V.29 standard, which specifies a maximum speed of 9600 bps. V.17-compliant modems (half of those in this review) can send faxes at speeds of up to 14.4 Kbps. V.17 includes other performance optimizations, including more fall-back speeds and optional fast connections. Sixty of the 69 modems tested support V.29; 37 support V.17.

V.17 support aside, fax modems have little effect on fax speed, because most of the fax processing is done in the computer. Fax page data is typically not error corrected, and the computer must compress the data before sending it to the modem. Since errors are not corrected, data transmission errors show up as errors in the final document. Modems that score well on the BYTE line-impairment tests will give you better overall fax quality.

However, the Practical Peripherals pocket modem fails to connect in error-correction mode on the two lines simulating long satellite delays. That is not to say that it can't be used on satellite connections—our delay of 700 ms is longer than most you'll encounter.

The Multi-Tech MT1432-MU also supports spoofing of the most popular file transfer protocols. If you are forced to use a nonwindowing protocol like XMODEM or UUCP, a pair of Multi-Tech modems can put your old software into high gear. Although several other pocket modems were faster for full-duplex transmission, none had the features of the PM14400FX PKT or the MT1432MU.

The Megahertz P2144 is an alternative to the Practical Peripherals modem, and it has the same price. The P2144 was the fastest pocket modem for one-way transfers, and it supports Class 1 and Class 2 fax. However, it's not an easy modem to use: It holds the distinction of being the only modem we tested that had no status display whatsoever.

The Hayes Optima 144 Pocket is a good-looking new addition to the pocket marketplace, but it is slower than the top two modems. It also has a problem with long satellite delays.

E-Tech's UFOMate P1414-MX and USRobotics' WorldPort14,400 Fax are the fastest pocket modems for two-way data transfer. The E-Tech modem takes the top spot on the basis of its lower price.

The two modems have different strengths. The P1414MX has a slightly better performance and has features that are unique among the pocket modems we tested—caller ID and distinctive ringing. But the off-the-shelf WorldPort performed our tests flawlessly, while the P1414MX, the lower-rated E-Tech UFOMate P1496MX, and their Twincom Voyager twin required patches to their EPROMs in order to complete our tests. The WorldPort also did better on the impaired-line tests.

BYTE BEST — PORTABLE MODEMS

Need desktop performance for the road?

BEST OVERALL — Practical Peripherals PM14400FX PKT

JULY 1993 BYTE BEST PORTABLE MODEM

Practical Peripherals' pocket modem is nearly as fast as the fastest pocket modem on half-duplex tests, and it's a pocket modem without compromises: It has an excellent status display, which can help you quickly configure the modem when you're on the road. Other important ease-of-use features are a small form factor, a good-quality speaker, and excellent documentation and support. Class 1, Class 2, and V.17 fax also adds up to top-notch fax support.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Practical Peripherals PM14400FX PKT	$499	31.3	20.3	95	57.6	14.4
RUNNER-UP	Multi-Tech MT1432MU	$699	31.4	21.4	99	57.6	14.4
RUNNER-UP	Megahertz P2144	$499	32.0	26.1	97	57.6	14.4
RUNNER-UP	Hayes Optima 144 Pocket	$599	31.2	18.3	95	57.6	14.4
RUNNER-UP	E-Tech UFOMate P1414MX	$429	30.8	29.0	95	115.2	14.4
RUNNER-UP	USRobotics WorldPort14,400 Fax	$649	30.1	28.0	98	57.6	14.4

Looking for the fastest in full-duplex?

TWO WAY — E-Tech UFOMate P1414MX

With a leading score of 29 Kbps in the two-way throughput test, the E-Tech UFOMate P1414MX packed the most power for demanding two-way applications. In addition, its one-way throughput and impaired-line scores were competitive with the other contenders in this category. The P1414MX's rich feature set helped it to pull ahead of the pack to become the best two-way choice; it is the only pocket modem with caller ID and support for distinctive ringing. Unlike its lower-rated lookalike,the E-Tech UFOMate P1496MX, the P1414MX supports V.17 fax speeds. Negatives include uninformative status lights and the lack of Class 1 fax support. The Megahertz P2144 is a strong contender here, but it suffers from its lack of a status-light display.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	E-Tech UFOMate P1414MX	$429	30.8	29.0	95	115.2	14.4
RUNNER-UP	USRobotics WorldPort14,400 Fax	$649	30.1	28.0	98	57.6	14.4
RUNNER-UP	Megahertz P2144	$499	32.0	26.1	97	57.6	14.4

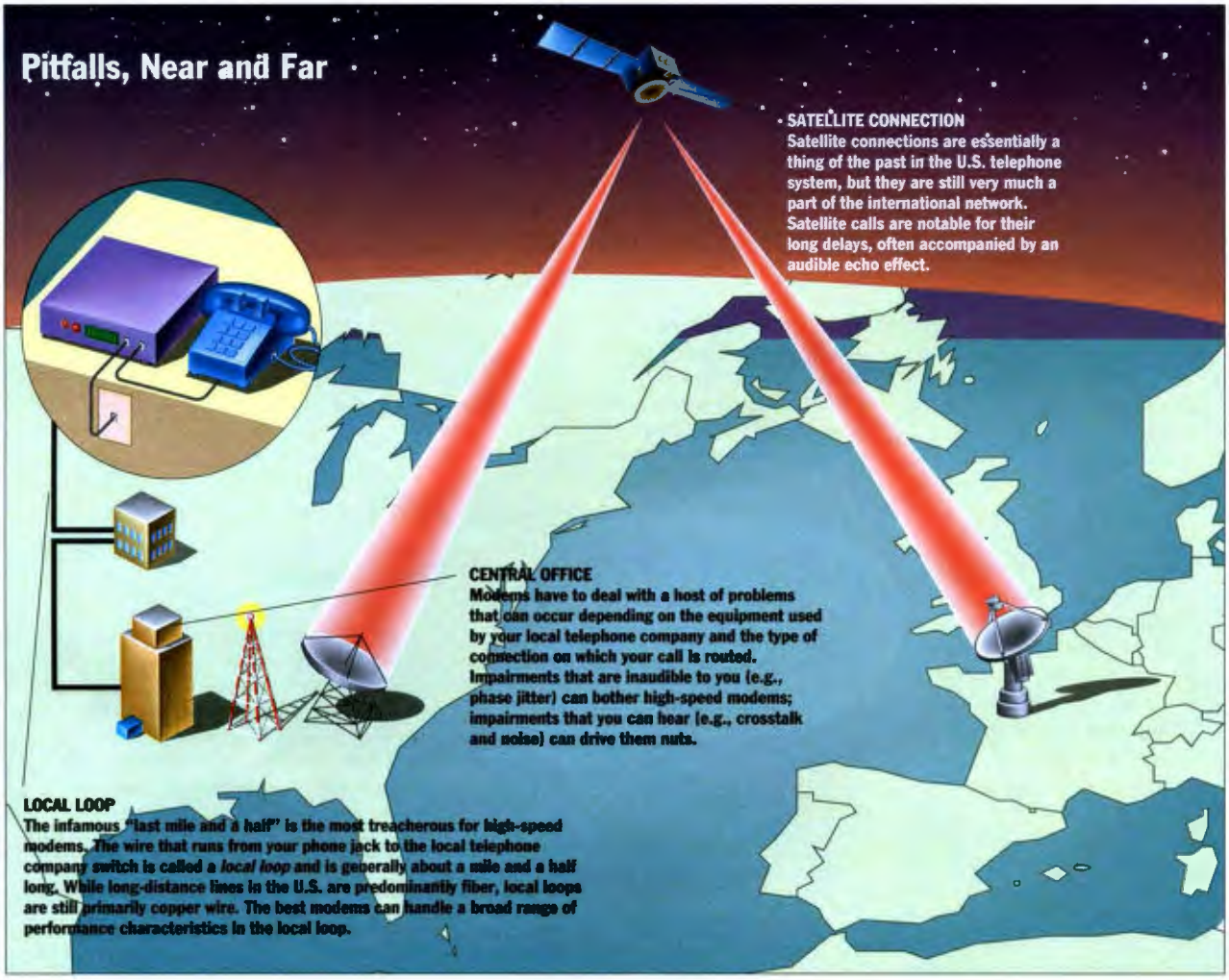
Cost-conscious?

LOW COST — E-Tech UFOMate P1414MX

The P1414MX supports 14.4-Kbps data and 14.4-Kbps fax, and it was the second fastest portable modem on two-way data transmission. But its most outstanding feature is its price: At $429, its price is $160 lower than the average price of the pocket modems given consideration for Best Overall. There are trade-offs, of course: The P1414MX is almost as big as a desktop modem (though lighter), and we had some initial data-loss problems (which were solved by an upgrade from E-Tech). Beware if you must communicate via satellite: The E-Tech modems were unable to connect over lines with long satellite delays.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	E-Tech UFOMate P1414MX	$429	30.8	29.0	95	115.2	14.4
RUNNER-UP	E-Tech UFOMate P1496MX	$379	30.8	29.1	95	57.6	14.4

How Modems Connect



DATA SPEEDS DEFINED

MODULATION STANDARDS

V.32 (9600 bps). Largely made obsolete by V.32bis technology, V.32 modems can still offer inexpensive access to on-line services like CompuServe and Prodigy. Most on-line services do not yet offer V.32bis speeds, so for this application exclusively, paying more for the extra speed of V.32bis may not make sense.

V.32bis (14.4 Kbps). The current standard for corporate dial-up modems. Most bulletin boards and public-access Unix systems offer this speed. The typical 50 percent speed boost over V.32 modems comes at only an incremental price premium.

V.Fast (28.8 Kbps). V.Fast modems should hit the market late this year or early next year. These modems will probably command a high price premium over V.32bis modems, so expect both to coexist for a long time. The standard is still changing, so regard claims of "V.Fast upgradable" with caution.

V.32terbo (19.2 Kbps). A new "standard" offered by a coalition of modem vendors including AT&T, Penril, and Data Race. V.32terbo modems exist today and often cost only a little more than V.32bis modems. V.32terbo looks like a good bet to supplant V.32bis, but many modem vendors are resisting it.

PROPRIETARY PROTOCOLS

HST (16.8 Kbps). A proprietary speed offered by USRobotics. The company's Courier modems with HST are popular with PC bulletin board operators. If you make a lot of long-distance connections to a variety of bulletin boards, HST can mean cost savings on your phone bills. HST is asymmetric; it is effective only for one-way data transfer.

Zyxel (16.8 Kbps). The Zyxel modems offer a proprietary 16.8-Kbps symmetric mode (i.e., in both directions simultaneously). This capability gives Zyxel's low-cost modems an edge over V.32bis modems while providing its high-end modems with a good fall-back speed.

Zyxel (19.2 Kbps). Zyxel modems running at proprietary 19.2-Kbps speeds produced some of the fastest times of the modems we tested, especially for bidirectional transfer. One drawback was that the Zyxel high-speed handshake confused some V.32bis modems, so they couldn't link up with the Zyxel modems at V.32bis speeds. (The workaround is simply to set the Zyxel modem to do a standard handshake.)

PEP/Turbo PEP (23 Kbps). PEP is a popular high-speed modulation that predates the V.32bis standard. It is mainly found in Unix environments; Telebit modems have become the standard Unix modem on the strength of PEP and their innovation in areas such as UUCP spoofing. PEP never caught on with other modem vendors. Turbo PEP is the new update of PEP, with speeds up to 23 Kbps. Like PEP, Turbo PEP is based on multiple carriers, giving it the ability to adjust to line conditions in increments much smaller than those of other modulation schemes. And like PEP, Turbo PEP is asymmetric—bidirectional throughput suffers.

Codex V.Fast (24 Kbps). Motorola Codex raised the ire of many modem vendors when it adopted the name "V.Fast" for its top-of-the-line dial-up modems. Motorola Codex claims modems supporting its proprietary 24-Kbps modulation will be upgradable to V.Fast, but no one will know until the standard is complete. While the company's scheme may not be V.Fast, it certainly is very fast—the Codex modem was clearly the fastest for one-way transfers.

FAX SPEEDS

V.27ter (4800 bps). Offers fax speeds of up to 4800 bps.

V.29 (9600 bps). Offers fax speeds of up to 9600 bps. All 60 modems that supported fax supported this speed.

V.17 (14.4 Kbps). Much of the world fax "network" is still 9600 bps or slower, but V.17 speeds are gaining popularity as prices tumble. V.17 also supports more incremental fall-back speeds and short retraining sequences.

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10 Tips for Buying Modems

1 Buy a modem with a DTE speed at least four times greater than the DCE rate: for example, 38.4 Kbps for a 9600-bps modem and 57.6 Kbps for a 14.4-Kbps modem. Lower DTE speeds can leave your modem starving for data as the data pump and compression engine run faster than the incoming data.

2 Don't pay a premium to get 115.2-Kbps DTE speed on a V.32bis modem. If your environment is Macintosh or Windows, you probably won't be able to use that speed anyway. Without a serial coprocessor, few systems are fast enough to maintain 115.2 Kbps under the overhead of a multitasking operating system.

3 Don't buy a pocket modem to be a desktop modem. The pocket modems are considerably more expensive (and somewhat slower) than their desktop counterparts.

4 Be wary of software bundles. Many offer excellent values, but others are simply collections of obsolete software that are not worth your time and energy to learn. For example, most of the Macintosh bundles include Microphone 1.7. Ironically, this older version of Microphone does not support high-speed protocols; it supports only XMODEM and YMODEM.

5 Be wary of compression claims. Use the modulation names such as V.32, V.32bis, and V.32terbo to guide you.

6 Get a modem that will support V.17 (14.4 Kbps) fax speeds. V.17 fax is proliferating, and you can save yourself time and money by using the higher speed. Don't assume that your 14.4-Kbps data modem can fax at that speed: Many V.32bis modems (13, including the Telebit T3000) do not support V.17 and will fax only at 9600 bps.

7 Get a modem that supports the Class 1 fax command set. Class 1 is an established standard that practically all fax software supports. Class 2 is not yet a standard, and the modems we tested all support an older (now incompatible) draft of the proposed standard.

8 The exception to Tip 7 comes if you ever plan to write your own software to send faxes. Writing software to support Class 1 modems is painstaking and difficult; Class 2 support is trivial.

9 For bidirectional applications like network bridges, get a symmetric modem. If you have an asymmetric modem, configure it for V.32bis.

10 Find out what recourse you'll have for bugs. We encountered bugs in modems ranging from inexpensive E-Techs to expensive UDS FasTalks. Vendors can usually fix bugs with new EPROMs, but ask how your dealer would handle them.

ESCAPE SEQUENCES

An escape sequence is the way a computer signals the modem to switch from transmission mode to command mode. It signals that the next segment of data coming down the data stream is to be interpreted as a command rather than transmitted. The simplest and safest way to put the modem into command mode is to configure the modem to enter command mode when the computer drops the RS-232-defined DTR (Data Terminal Ready) signal. Because this happens on a wire that's never transmitting data, the modem always knows that DTR transitions are signals. This is called out-of-band signaling.

Since not every RS-232 connection has a line readily available to use to signal command mode (e.g., those in Macs), modem vendors have developed different methods of in-band signaling. The problem in in-band signaling is distinguishing modem commands from normal data.

Fax protocols use the ASCII code DLE for this purpose. But a DLE can appear in a real data stream. The computer then must do "byte stuffing" as it sends data to the modem: It has to replace each DLE with the sequence DLE DLE, to keep subsequent data from being interpreted as commands.

DLE DLE

Hayes introduced a different method of in-band signaling using guard bands. Hayes modems time-stamp characters as they arrive and use this time stamp as an additional data channel. A Hayes escape sequence is a pause followed by three escape characters followed by another pause. (The default escape character is always "+," although the length of the pause and the escape character are user definable). The pause prevents the modem from mistaking escape characters found in a data stream for a command signal.

[pause] + + + [pause]

Hayes ignited the fury of the rest of the modem industry when it received a patent for guard-band signaling and began to extract royalties for its use.

Vendors not wanting to pay royalties have had to substitute other methods. A coalition of modem vendors, including Multi-Tech, TwinCom, Digicom, and others, adopted the TIES (Time Independent Escape Sequence) approach. TIES modems check to see if data after the escape sequence represents a valid AT command followed by a return. Hayes responded with advertisements that portrayed the TIES approach as a bomb waiting to explode (taking your data with it). That led to lawsuits, and an out-of-court settlement between Multi-Tech and Hayes.

Multi-Tech has recently proposed a new sequence, TIES out-of-band, which uses a break signal as the command character (a break is a distinguishable signal that cannot be mistaken for any character). The problem with this sequence is that it is incompatible with the Hayes sequence, so Multi-Tech will have to convince software vendors to support it. Multi-Tech will continue to support TIES for Hayes-compatible software.

+ + + ATH

Zyxel has its own algorithm, for which it claims compatibility with existing code. Since the Zyxel algorithm is proprietary, we can't comment on its strength or weakness. However, it caused no problem in our testing.

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MODEMS FOR HIGH-SPEED COMMUNICATIONS

Think 14.4 Kbps from V.32bis modems is fast? Take a look at the proprietary speeds of today's fastest modems: 24 Kbps (Motorola 3260 Codex Fast), 23 Kbps (Telebit WorldBlazer), 19.2 Kbps (AT&T Paradyne Comsphere 3830 and Zyxel U-1496EPlus and U-1496Plus), and 16.8 Kbps (US-Robotics Courier Dual Standard, Zyxel U-1496E). If you use long-distance telephone lines to set up network bridges, remotely control PCs, access leased lines, or create SLIP links, these modems could save you their cost and more in long-distance charges.

But you can reap these benefits only if you control both ends of the line. For this category, we considered only the handful of modems now on the market that achieve data throughput speeds higher than 14.4 Kbps. Although CCITT's V.Fast will define faster standard communications, no such standard currently exists. Therefore, each of these high-speed modems uses its own modulation schemes, and each can communicate at its highest speeds only with another modem of its own kind.

The exceptions to the both-ends-of the-line rule are Telebit's PEP and Turbo PEP, which can be found on a variety of public Unix hosts, including UUNET; Courier HST modems, which can be found on many PC bulletin boards; and Comspheres, which you can use with AT&T Mail (no surprise since AT&T manufactures these modems).

Performance is, of course, the key criterion for this class of modems. We picked winners for both one-way and two-way communications. High-speed links for transmitting graphics files are excellent one-way applications, and asynchronous network bridges are prime examples of two-way applications. All the high-speed modems we tested can be run in either mode, but as the results show, many of the modems have an advantage in one mode over the other.

The Motorola Codex 3260 Fast blew everything else away on the one-way throughput tests: It ran 23 percent faster than the second-place AT&T Paradyne Comsphere 3830. The Codex 3260 Fast also maintains its performance reasonably well on impaired lines, the second most important performance indicator in our evaluations. Impaired-line reliability shows which modems can handle telephone-line impairments without dropping back to slower speeds, and although it hit 100 percent on just four of the 25 line tests, the Codex 3260 Fast maintained good throughput regardless of impairment type.

The AT&T Paradyne Comsphere, the Zyxel U-1496Plus, and the Telebit WorldBlazer held their high speeds better on impaired lines than did the other high-speed modems. The Comsphere was within 5 percent of its maximum throughput on all but five of the 25 impaired lines, so you can expect to achieve 19.2-Kbps transmissions on most calls. The WorldBlazer dropped more than 5 percent on 13 of the 25 lines; however, it falls back in lesser increments than do other modems, so chances of maintaining higher-speed connections are better. The Zyxel U-1496Plus performed within 5 percent of maximum on all but seven lines.

The Comsphere's strong showing on impaired lines seems to contradict V.32terbo naysayers. Rockwell and Hayes, among others, have suggested that V.32terbo is a stopgap modulation scheme that's too weak for real network conditions (i.e., impaired lines). Based on our tests, V.32terbo looks like a good intermediate step between V.32bis and V.Fast if AT&T and other V.32terbo proponents can muster enough support.

The Comsphere, the Codex 3260 Fast, and the high-end Zyxel U-1496Plus all have LCDs, which makes using them easy. Their menus make it easy to change defaults and are particularly useful for vertical applications like kiosks and automatic teller machines or for mainframe applications where a PC is not readily available. All the modems can be configured remotely; the Comsphere can even have its firmware replaced remotely.

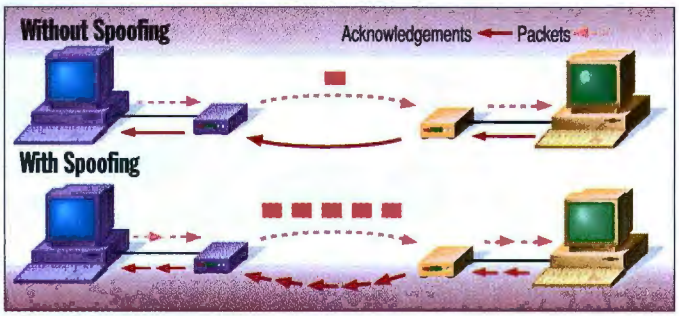
The Codex 3260 Fast and AT&T Paradyne Comsphere command a high price for their excellent performance. You can expect to pay as much as four times more than for a V.32bis modem; in return, you'll get a 50 percent boost in performance. Of course, you may save money on your phone bill and through increased productivity.

We were disappointed with the Codex 3260 Fast's inexplicably slow performance in our two-way throughput tests. We expected the 24-Kbps modem to outpace the slower Comsphere and Zyxels, but the Codex 3260 Fast came in fourth. At press time, Motorola Codex was looking into the problem.

Spoofing: Serious Speed Benefits

Spoofing allows older software, using older protocols, to run efficiently at high speeds. XMODEM, for example, chokes high-speed modems that don't spoof, because XMODEM sends only 128 characters and then sits and waits for a response. Consequently, the modem sits idle much of the time.

Modems that spoof, such as those from Telebit, accelerate XMODEM and other so-called stop-and-go protocols by returning a false acknowledgment as soon as a packet is sent from the DTE to the modem. The spoofing modem then continues to receive data from the DTE and continues to send to the remote site. Later, the modem "swallows" any actual acknowledgment from the other computer. This allows the modem to receive succeeding packets from the computer while it continues sending.



The Comsphere 3830 was the top modem for sending data in both directions simultaneously. The Zyxel modems are also very fast at bidirectional transfers, but they top out at a DTE speed of 76.8 Kbps. We tested the Zyxels at a DTE rate of 57.6 Kbps, because most environments do not support the unusual 76.8-Kbps speed. With a 57.6-Kbps DTE connection, the Zyxel modems begin to starve for data on files that compress at better than 3 to 1, as the compression engine and data pump outrun the serial connection. But all the Zyxel modems are faster than the Comsphere at sending files that compress at less than 3 to 1.

Zyxel's unusual handshake sequence uses a number of tones that confuse some V.32bis modems (e.g., the Hayes Optima 144 Pocket). Zyxel uses these tones to identify other Zyxel modems so higher-speed Zyxel proprietary modulations can proceed. The Zyxel U-1496E connected to the Optima Pocket at only 2400 bps until we explicitly shut off the high-speed negotiation sequence. With the U-1496E set to negotiate only to V.32bis, connection went smoothly.

The Telebit WorldBlazer is still the only high-speed modem to support spoofing, so using older protocols like XMODEM and UUCP with it will achieve far better performance than with other high-speed modems. Get this modem if you can't or don't want to mess with changing old protocols. The WorldBlazer is well designed for this work: Its excellent one-way throughput is all that is necessary for spoofing applications, because very little data must traverse the reverse channel.

HST from USRobotics is showing its age. The oldest of these proprietary modulations, HST has become a popular way to link to bulletin boards from long distance. The Courier Dual Standard was by far the slowest of the high-speed modems we tested. It was, however, still faster than V.32bis modems for one-way transfers of compressed files.

BYTE BEST — HIGH-SPEED MODEMS

Need the fastest modem on the market?

BEST OVERALL — Motorola Codex 3260 Fast

At 24 Kbps, the Codex 3260 Fast is the fastest modem on the market today. Our tests also showed it to be reasonably reliable, although line-impairment tests show that it averages only 90 percent throughput over bad lines. It managed peak performance on only four lines, but 90 percent of 24 Kbps is still pretty impressive. However, there are drawbacks: Ease of use is only average; automatic baud detect is capped at 38.4 Kbps; the AT command set is unique to Codex, so there's a good chance your communications package won't support the Codex modem without custom configuration; and finally, the defaults often needed some tweaking for compression and flow control. The modem lacks spoofing, so be sure that your data transfer protocols won't leave this fast modem idling.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Motorola Codex 3260 Fast	$1395	53.4	38.4	90	115.2	24
RUNNER-UP	AT&T Paradyne Comsphere 3830	$795	43.4	40.3	98	115.2	19.2
RUNNER-UP	Telebit WorldBlazer	$1099	38.5	23.1	97	115.2	23
RUNNER-UP	Zyxel U-1496Plus	$989	40.6	39.2	97	76.8	19.2
RUNNER-UP	Zyxel U-1496EPlus	$649	40.6	39.2	94	76.8	19.2

Looking for full-duplex speed leader?

TWO WAY — AT&T Paradyne Comsphere 3830

The AT&T Paradyne Comsphere 3830 combines top-notch two-way communication performance with excellent usability. Its ability to handle DTE rates of 115.2 Kbps gives it the performance edge over the second- and third-place Zyxel modems. It also handled impaired lines well, as shown by its score of 98 percent. The Comsphere autobauds all the way to its top speed of 115.2 Kbps, and its menus are easy to configure. The Comsphere is designed to be easy to upgrade; we upgraded it from a V.32bis modem to a V.32terbo modem with a phone call.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	AT&T Paradyne Comsphere 3830	$795	43.4	40.3	98	115.2	19.2
RUNNER-UP	Zyxel U-1496Plus	$989	40.6	39.2	97	76.8	19.2
RUNNER-UP	Zyxel U-1496EPlus	$649	40.6	39.2	94	76.8	19.2
RUNNER-UP	Motorola Codex 3260 Fast	$1395	53.4	38.4	90	115.2	24
RUNNER-UP	Zyxel U-1496E	$469	36.6	33.3	95	76.8	16.8

Balancing high speed and low cost?

LOW COST — Zyxel U-1496EPlus

At $649, the Zyxel U-1496EPlus is less expensive than many of the V.32bis modems (all of which it outperforms handily). It has the best-case performance of the more expensive U-1496Plus and all of its features except leased-line support. We experienced poorer performance on impaired lines with the U-1496EPlus than with the U-1496Plus, but performance was still very good. (Zyxel was puzzled that the impaired-line performance differed from the U-1496Plus's, but the issue was unresolved at the time of writing this report.)

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	Zyxel U-1496EPlus	$649	40.6	39.2	94	76.8	19.2
RUNNER-UP	Zyxel U-1496E	$469	36.6	33.3	95	76.8	16.8

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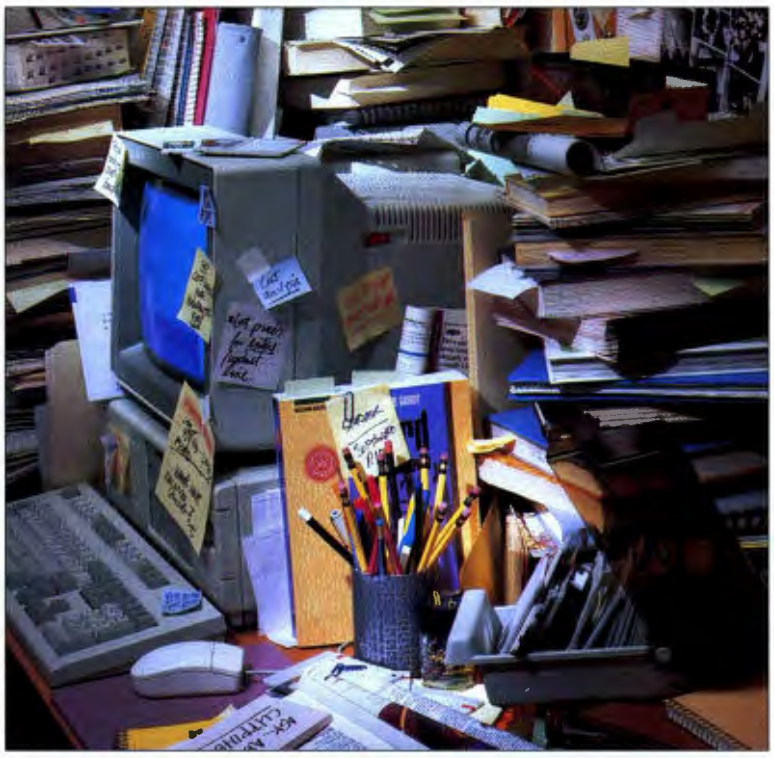

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BYTE BEST

DATA-ONLY APPLICATIONS

When you need to communicate with an installed base of network modems or use a modem for terminal emulation with a mainframe, data throughput and speed standards are your main concerns. Often, an installed base of corporate modems limits you to less than cutting-edge speeds. The modems in this category are the fastest devices supporting standard modulations, and we didn't factor in fax support.

When choosing modems for these applications, dispense with the fax and go all out for speed and performance. Modems without fax now tend to cost more than modems with fax. This may seem anomalous, but modems without fax capabilities are designed for mission-critical data-only applications. In this market, features like leased-line support and the ability to handle every probable kind of telephone-line impairment matter more than fax capabilities, which would simply go unused. This is not to say that modems that include fax can't compete here: In fact, our low-cost pick includes solid fax-modem capabilities. However, fax support is more of a nice bonus than a selection maker.

For these applications, we judged modems only on their data capabilities and limited our tests to modems running at V.32bis speeds. Throughput is important for network bridges and terminal-emulation applications. We averaged two-way and one-way speeds. We then factored in results from the impaired-line tests.

We found that most V.32bis modems can maintain high throughput in one direction, but relatively few can maintain high throughput in two directions simultaneously. Most file transfer protocols transfer in only one direction at a time, so you may not care if your modem can handle more than that. You should care, however, if you want to use the modem as a network bridge.

We counted remote configuration abilities highly. For example, if you're attempting to send sales results from a cash register to the corporate network, you won't have access to a PC to configure the modems for optimum transmissions. Modems that let you change speeds, flow control, or other options easily from their display panels are a must for these installations. Likewise, a modem's ability to autobaud at its highest rate is essential for network communications. Other important features are time windows, so you can determine when to do your backups; leased-line support; and dial backup, in case the leased line fails.

The AT&T Comsphere is our pick for best data-only modem. Its DSP-based design makes it extremely flexible. The unit we tested was a V.32bis modem upgraded to V.32terbo. The Comsphere achieves top performance and a perfect score on impaired-line tests.

Want the fastest in V.32bis?

BEST OVERALL — **AT&T Paradyne Comsphere 3830**

The Comsphere combines top-notch performance with excellent usability. Its ability to handle DTE rates of 115.2 Kbps gives it the performance edge over the Zyxel modems. Usability is excellent. The Comsphere autobauds all the way to its top speed of 115.2 Kbps. Its menus make configuration easy, but you will probably do fine with the defaults. The Comsphere is designed to be easy to upgrade; we upgraded it from a V.32bis modem to a V.32terbo modem by downloading software over the phone. Its impaired-line performance was a perfect 100 percent, and its best-case throughput was near the top.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	AT&T Paradyne Comsphere 3830	$795	31.3	30.7	100	115.2	19.2[1]
RUNNER-UP	Zyxel U-1496Plus	$989	32.0	31.3	99	76.8	19.2[1]
RUNNER-UP	Zyxel U-1496E	$469	31.8	31.2	99	76.8	16.8[1]
RUNNER-UP	Zyxel U-1496EPlus	$649	31.8	31.2	99	76.8	19.2[1]
RUNNER-UP	Motorola Codex 3260	$1095	29.3	30.5	99	57.6	14.4
RUNNER-UP	GVC FM144/144V	$399	31.7	30.6	99	57.6	14.4
RUNNER-UP	The Complete PC Turbo Modem Plus	$399	31.7	30.6	99	57.6	14.4
RUNNER-UP	Motorola Codex 3260 Fast	$1395	29.7	28.6	99	115.2	24[1]

Need top V.32bis speed at a low price?

LOW COST — **GVC FM144/144V**

The GVC FM144/144V is a low-cost alternative to the Comsphere. Its khaki paint job won't win any design awards, but its blazing two-way throughput might. While most under-$400 V.32bis modems are underpowered for two-way applications, the GVC modem clearly has enough horsepower for the job; it has nearly the speed of the Comsphere and the top Zyxels for V.32bis communication. It is light on backbone features, however (e.g., it has leased-line but not automatic dial backup). It provides fast fax with V.17 speeds and Class 1 support.

		PRICE	1-WAY THROUGHPUT (KBPS)	2-WAY THROUGHPUT (KBPS)	IMPAIRED-LINE TEST (% OF THROUGHPUT)	DTE RATE (KBPS)	DCE RATE (KBPS)
BEST	GVC FM144/144V	$399	31.7	30.6	99	57.6	14.4
RUNNER-UP	The Complete PC Turbo Modem Plus	$399	31.7	30.6	100	57.6	14.4
RUNNER-UP	USRobotics Sportster 14,400 Fax	$299	30.3	25.5	99	57.6	14.4
RUNNER-UP	E-Tech UFOMate P1414MX	$429	30.8	29.0	95	115.2	14.4
RUNNER-UP	E-Tech UFOMate P1496MX	$379	30.8	29.1	95	57.6	14.4
RUNNER-UP	CMS Enhancements X14400 Ext. Fax	$399	31.6	30.6	85	57.6	14.4
RUNNER-UP	CXR Telcom Action Fax 1445-FXD	$435	31.0	24.5	95	115.2	14.4

[1] Maximum DCE rate; test scores reflect modem's performance at 14.4 Kbps.

HONORABLE MENTIONS

AT&T Paradyne's Comsphere 3830 is designed around a DSP, and its software resides in flash ROM. This gives it the distinction of being the only modem we tested that allows instant remote upgrades. If you need to upgrade, you just download new firmware directly off the data line. Other modems, like the Dove Fax Pro, the Multi-Tech modems, and the Intel Satisfaxtion/400e, let you upgrade using software, but you can't do anything as radical as turn a V.32bis modem into one that supports V.32terbo. For most modems, even bug fixes require pulling the modem apart and replacing an EPROM.

Telebit's WorldBlazer
combines excellent one-way throughput with unparalleled spoofing support. Its pioneering innovation in the area of spoofing has already made it a standard in Unix shops. Its support for heterogeneous environments is top-notch; you can pick your computing environment from one of more than a dozen sets of factory defaults.

Dubious Achievements

Our tests operate the modem in error-correction, data-compression mode, which is how most users will run them. So why do so many modems set the default to uncompressed, unreliable links? The Octocom Xpresso 8396A gets the prize for longest AT command string required to reach a regular configuration: AT&F&C1&I2&K2E1*E1%G3&D2

E-Tech proclaims that its UFOMate P1496MX modem supports 9600-bps fax/9600-bps data transmissions. Closer inspection reveals that this is a 2400-bps modem that achieves 9600-bps speeds in the unlikely event of constant 4-to-1 V.42bis compression.

A few manufacturers actually portrayed some modems as less than they are. Manuals for the Zyxel modems (U-1496E, U-1496EPlus, and U-1496Plus) failed to mention the proprietary high-speed modes of 16.8 Kbps and 19.2 Kbps. The Multi-Tech MT1432MU pocket modem's box mentions 9600-bps fax capabilities; in fact, it can support 14.4-Kbps fax.

Don't try to share a phone line with a Zoltrix 144/144e modem—it can cause problems with other modems on the same line even when it's turned off. The Zoltrix modem also creates an annoying clicking on the phone line after being used with communication packages that fail to reset it (e.g., anything that uses the Macintosh Communication Toolbox).

Many pocket modems have little in the way of informative call-progress indicators. The Megahertz P2144 dispenses with lights altogether, however, delivering the inconvenience of an internal modem in an external package.

What's wrong with this picture? Actually, the picture is correct: You must plug the line cord into the jack labeled "phone" and the phone into the jack labeled "line" to get the Best Data Products Smart One 1442 to work.

SO ADVANCED IT EVEN TURNS ITSELF OFF.

PC MAGAZINE EDITORS' CHOICE
June 30, 1992
FlexScan F550i

Nanao, the technical leader in monitors has done it again. In addition to being the top choice of today's graphics professionals and Windows users, Nanao's award-winning FlexScan F-Series monitors now have a remarkable energy-saving system — Power Save.

Built into Nanao's new 17-inch FlexScan F550*i*W and 21-inch F760*i*W, Power Save has been designed to work with all screen saver software, including Windows 3.1 and After Dark. Power Save activates when the blank screen of the screen saver appears, cutting operating power to less than 8% of total consumption. It can also automatically power the monitor down to a stand-by mode when the computer is turned off. These innovations add up to energy savings and longer monitor life, and have placed Nanao at the forefront of the Environmental Protection Agency's EnergyStar Program.

Both the F550*i*W and F760*i*W exhibit their superiority in many other ways, as well. Each Invar Shadow Mask CRT has a new anti-reflective coating that eliminates reflection of ambient illumination, without sacrificing the focus level and brightness. Ultra-high resolutions with large screens plus other features make them ideal for CAD/CAM, DTP and Windows applications. On top of that, they can power down. So when you're not working, neither are they.

Nanao FlexScan monitors. Intelligently designed. Incredibly useful. And now, built to help protect our environment by reducing energy consumption.

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AMT International Industries	Star 1442I	$399	31.7	30.5	100	14.4	57.6	Hayes
Archtek America	SmartLink 9614AV	$399	29.1	16.0	97	14.4	57.6	Hayes
AT&T Paradyne	Dataport 14.4 Data Fax	$339	29.6	17.7	97	14.4	57.6	Hayes
ATI Technologies	9600ETC/E	$389	20.3	11.5	100	9.6	57.6	TIES
Best Data Products	Smart One 1442FX	$319	31.7	22.0	95	14.4	57.6	Hayes
BYTE Boca Research	14.4K External BocaModem	$395	32.0	26.0	100	14.4	57.6	Hayes
Cambridge Telecom	Datasystem 1414XE	$269	29.4	16.4	97	14.4	57.6	Hayes
Cambridge Telecom	Datasystem 1414XP	$349	22.7	12.1	97	14.4	57.6	Hayes
Cambridge Telecom	Discovery 9632AX	$495	—[4]	—[4]	—[4]	14.4	57.6	Hayes
Cardinal Technologies	14400V32bis	$399	31.7	22.1	92	14.4	57.6	Hayes
Cardinal Technologies	9600V42	$349	22.1	21.1	100	9.6	38.4	Hayes
CMS Enhancements	X14400 Ext. Fax	$399	31.6	30.6	85	14.4	57.6	TIES
CXR Telcom	Action Fax 1445-FXD	$435	31.0	24.5	95	14.4	115.2	Hayes
Digicom Systems	Scout Plus	$289	30.0	24.2	85	14.4	57.6	TIES
Dove Computer Corp.	Dove Fax Pro	$449	31.7	22.1	97	14.4	57.6	Hayes
Global Village Communications	Teleport Gold	$499	29.5	16.8	97	14.4	57.6	Hayes
Global Village Communications	Teleport Silver	$499	29.5	16.8	97	9.6	38.4	Hayes
GVC Technologies, Inc.	FM144/144V	$399	31.7	30.6	99	14.4	57.6	Hayes
Hayes Microcomputer Products	Accura 144/Fax 144	$339	31.2	18.3	95	14.4	57.6	Hayes
Hayes Microcomputer Products	Optima 144	$499	31.2	18.3	95	14.4	57.6	Hayes
Hayes Microcomputer Products	Optima 96 + Fax 96	$479	19.8	19.1	95	9.6	38.4	Hayes
Hayes Microcomputer Products	Ultra 144	$999	26.7	13.9	97	14.4	38.4	Hayes
Hayes Microcomputer Products	Ultra 96	$899	20.4	13.7	99	9.6	38.4	Hayes
Intel Corp.	Satisfaxtion/400e	$499	31.4	24.6	92	14.4	57.6	Hayes
Microcom	DeskPorte	$499	31.3	19.5	95	14.4	57.6	Hayes
Microcom	QX/4232bis	$699	31.7	19.9	99	14.4	57.6	Hayes
Microcom	QX/4232bis+	$899	32.4	20.4	84	9.6	57.6	Hayes
Motorola Codex	3220 Plus	$795	29.6	16.7	100	14.4	38.4	Hayes
Motorola Codex	3260	$1095	29.3	30.5	99	14.4	57.6	Hayes
Motorola UDS	FasTalk Fax32bx	$845	32.2	29.5	100	9.6	57.6	Hayes
Multi-Tech Systems	MT1432BA	$799	31.4	21.4	99	14.4	57.6	TIES
Multi-Tech Systems	MT932BA	$749	21.2	16.7	100	9.6	38.4	TIES
NEC	N9635E Plus	$1199	29.7	27.4	84	14.4	38.4	Hayes
Octocom Systems	Xpresso 8396A	$1095	27.3	14.5	100	14.4	38.4	Hayes
Penril DataCom Networks	DX144	$595	31.0	26.3	100	14.4	115.2	Hayes
Practical Peripherals	PM14400FXMT	$299	31.3	20.1	95	14.4	57.6	Hayes
Practical Peripherals	PM14400FXSA	$549	31.4	24.1	95	14.4	57.6	Hayes
Practical Peripherals	PM9600FXMT	$249	21.6	20.1	95	9.6	38.4	Hayes

[1] Results of tests are measured in Kbps.
[2] Maximum transfer rate in Kbps.
[3] Percentage of throughput.
[4] Unable to run our tests; problem was unresolved at press time.
BYTE = BYTE Best.

FAX SUPPORT			SOFTWARE	WARRANTY			
CLASS 1	CLASS 2	V.17	(DOS; WINDOWS; MAC)	(YEARS)	PHONE	TOLL-FREE NO.	INQUIRY NO.
Yes	No	Yes	QuickLink Fax; QuickLink Fax; QuickLink II	5	(714) 375-0306	None	1113
Yes	No	Yes	BitFax, ArchCom; ArchFax Plus, ArchCom; QuickLink II	2	(818) 912-9800	(800) 368-5465	1114
Yes	No	No	QuickLink II; QuickLink II; QuickLink II	Lifetime	(813) 530-2000	(800) 484-3333	1115
Yes	No	No	None; none; none	5	(416) 756-0718	None	1116
Yes	Yes	Yes	QuickLink II; WinFax; Microphone, STF	2	(818) 773-9600	(800) 632-2378	1117
Yes	Yes	Yes	Relay/PCLE, FaxWorks; Relay/PCLE, FaxWorks; QuickLink II, STF Fax	5	(407) 997-6227	None	1118
Yes	Yes	Yes	BitCom/BitFax; BitCom/BitFax; none	5	(408) 980-0885	None	1119
Yes	No	Yes	BitCom/BitFax; BitCom/BitFax; none	5	(408) 980-0885	None	1120
Yes	Yes	No	ABC Fax; BitCom/BitFax; none	5	(408) 980-0885	None	1121
Yes	Yes	Yes	QuickLink II Fax; QuickLink II Fax; QuickLink II	Limited lifetime	(717) 293-3000	None	1122
No	No	No	QuickLink II; QuickLink II; QuickLink II	Limited lifetime	(717) 293-3000	None	1123
No	Yes	No	QuickLink II; none; QuickLink II	1	(714) 222-6000	None	1124
Yes	Yes	Yes	FaxMaker, Comit; FaxMaker, Comit; none	5	(408) 435-8520	None	1125
Yes	No	No	DOSFax Lite; WinFax Lite; Microphone LC, STF Fax	5	(408) 262-1277	(800) 833-8900	1126
Yes	No	No	None; none; AppleTalk remote switching software, SFT Fax, Dove PhoneWare Lite	3	(919) 343-5600	(800) 849-3297	1127
Yes	No	Yes	None; none; Global Fax with OCR	5	(415) 390-8200	(800) 736-4821	1128
Yes	No	No	None; none; Global Fax	5	(415) 390-8200	(800) 736-4821	1129
No	Yes	Yes	QuickLink II; WinFax Lite; Microphone, STF	5	(201) 579-3630	(800) 289-4821	1130
Yes	No	Yes	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1346
Yes	No	Yes	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1349
Yes	No	Yes	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1350
No	No	No	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1347
No	No	No	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1348
Yes	No	Yes	CrossTalk, Satisfaxtion, Faxability Plus; CrossTalk, Satisfaxtion, Faxability Plus; none	3	(503) 696-8080	(800) 538-3373	1351
Yes	No	No	None; WinFax Lite; none	1	(617) 551-1000	(800) 822-8224	1354
No	No	No	None; none; none	1	(617) 551-1000	(800) 822-8224	1352
No	No	No	None; none; none	1	(617) 551-1000	(800) 822-8224	1353
No	No	No	None; none; none	2	(508) 261-4000	(800) 446-6336	1356
No	No	No	None; none; none	2	(508) 261-4000	(800) 446-6336	1355
Yes	No	Yes	None; none; none	2	(205) 430-8000	(800) 451-2369	1370
No	Yes	Yes	MultiExpress, MultiExpress-Fax; none; QuickLink II	5	(612) 785-3500	(800) 328-9717	1357
No	Yes	No	MultiExpress, MultiExpress-Fax; none; QuickLink II	5	(612) 785-3500	(800) 328-9717	1358
No	No	No	None; none; none	1	(214) 518-5000	(800) 222-4632	1359
No	No	No	None; none; none	2	(508) 441-2181	(800) 989-8888	1360
Yes	Yes	Yes	None; none; none	2	(301) 921-8600	(800) 473-6745	1361
Yes	Yes	Yes	QuickLink II Fax Win/DOS; QuickLink II Fax Win/DOS; QuickLink II Fax	Lifetime	(805) 497-4774	(800) 442-4774	1363
Yes	Yes	Yes	QuickLink II Fax Win/DOS; QuickLink II Fax Win/DOS; QuickLink II Fax	Lifetime	(805) 497-4774	(800) 442-4774	1362
Yes	Yes	No	QuickLink II Fax Win/DOS; QuickLink II Fax Win/DOS; QuickLink II Fax	Lifetime	(805) 497-4774	(800) 442-4774	1364

ROLL CALL OF MODEMS TESTED

MANUFACTURER	MODEM	PRICE	THROUGHPUT TEST RESULTS[1] 1-WAY	2-WAY	IMPAIRED LINES[3]	MAX SPEEDS[2] DCE	DTE	ESCAPES
Supra Corp.	Supra Fax Modem v.32	$380	22.1	21.0	100	9.6	57.6	Hayes
Supra Corp.	Supra Fax Modem v.32 bis	$380	31.7	21.8	92	14.4	57.6	Hayes
Telebit Corp.	T3000	$949	31.1	23.1	93	14.4	57.6	TIES
The Complete PC	Turbo Modem Plus	$399	31.7	30.6	100	14.4	57.6	Hayes
Twincom	14.4/DF	$399	31.7	22.1	89	14.4	57.6	Hayes
USRobotics	Courier V.32bis Fax	$795	30.2	25.6	99	14.4	57.6	TIES
USRobotics	Sportster 14,400 Fax	$299	30.3	25.5	99	14.4	57.6	TIES
USRobotics	Sportster 9600 Fax	$249	20.9	20.4	100	9.6	38.4	TIES
Ven-Tel	EC144Fax	$599	31.7	21.8	95	14.4	57.6	Hayes
Western Datacom	WorldCom V.32bis	$695	—[4]	—[4]	—[4]	14.4	115.2	Hayes
Xycomm Technologies	QuickComm Spirit II	$249	30.2	24.2	83	14.4	57.6	Hayes
Zoom Telephonics	VFXV32	$269	22.1	21.0	100	9.6	38.4	Hayes
Zoom Telephonics	VFXV32bis	$349	31.7	22.0	97	14.4	57.6	Hayes
E-Tech Research	UFOMate P1414MX	$429	30.8	29.0	95	14.4	115.2	TIES
E-Tech Research	UFOMate P1496MX	$379	30.8	29.1	95	14.4	57.6	TIES
Hayes Microcomputer Products	Optima 144 Pocket	$599	31.2	18.3	95	14.4	57.6	Hayes
Megahertz	P2144	$499	32.0	26.1	97	14.4	57.6	Hayes
Microcom	MicroPorte 4232bis Fax	$699	31.9	19.7	86	14.4	57.6	Hayes
Multi-Tech Systems	MT1432MU	$699	31.4	21.4	99	14.4	57.6	TIES
Practical Peripherals	**PM14400FX PKT**	**$499**	**31.3**	**20.3**	**95**	**14.4**	**57.6**	**Hayes**
Twincom	Voyager	$499	30.8	29.1	95	14.4	57.6	TIES
USRobotics	WorldPort14,400 Fax	$649	30.1	28.0	98	14.4	57.6	TIES
USRobotics	WorldPort 9696 Fax/Data	$549	20.1	19.7	99	9.6	57.6	TIES
Zoltrix	144/144e	$239	31.7	22.1	85	14.4	57.6	Hayes
AT&T Paradyne	**Comsphere 3830**	**$795**	**43.4**	**40.3**	**98**	**19.2**	**115.2**	**Hayes**
Motorola Codex	**3260 Fast**	**$1395**	**53.4**	**38.4**	**90**	**24**	**115.2**	**Hayes**
Telebit Corp.	WorldBlazer	$1099	38.5	23.1	97	23	115.2	TIES
USRobotics	Courier Dual Standard	$1295	32.1	25.6	92	16.8	57.6	TIES
Zyxel	U-1496E	$469	36.6	33.3	95	16.8	57.6	Proprietary
Zyxel	U-1496EPlus	$649	40.6	39.2	94	19.2	76.8	Proprietary
Zyxel	U-1496Plus	$989	40.6	39.2	97	19.2	76.8	Proprietary

[1] Results of tests are measured in Kbps.
[2] Maximum transfer rate in Kbps.
[3] Percentage of throughput.
[4] Unable to run our tests; problem was unresolved at press time.
BYTE = BYTE Best

FAX SUPPORT			SOFTWARE (DOS; WINDOWS; MAC)	WARRANTY (YEARS)	PHONE	TOLL-FREE NO.	INQUIRY NO.
CLASS 1	CLASS 2	V.17					
Yes	Yes	No	Comit DOS/Windows, FaxTalk; WinFax Lite; STF Fax, Microphone	5	(503) 967-2400	(800) 727-8772	1366
Yes	Yes	Yes	Comit DOS/Windows, FaxTalk; WinFax Lite; STF Fax, Microphone	5	(503) 967-2400	(800) 727-8772	1365
No	Yes	No	None; none; none	2	(408) 734-4333	(800) 835-3248	1367
No	Yes	Yes	CrossTalk, RapidFax; RapidFax; BitFax, Microphone	7	(408) 434-0145	(800) 229-1753	1368
Yes	Yes	Yes	QuickLink II; QuickLink II with OCR; QuickLink II or QuickLink Data and STF Fax	2	(919) 395-6100	(800) 666-2496	1369
Yes	No	No	Blast Fax; WinFax Lite; Apple Talk scripts on BBS	2	(708) 982-5010	(800) 342-5877	1371
Yes	No	Yes	Blast Fax; WinFax Lite; AppleTalk scripts on BBS	5	(708) 982-5010	(800) 342-5877	1372
Yes	No	No	Blast Fax; WinFax Lite; AppleTalk scripts on BBS	5	(708) 982-5010	(800) 342-5877	1373
Yes	Yes	Yes	QuickLink II Fax; none; QuickLink II Fax	5	(408) 436-7400	(800) 538-5121	1374
Yes	Yes	Yes	QuickLink II Fax; QuickLink II; none	1	(216) 835-1510	(800) 262-3311	1375
Yes	No	No	QModem Lite, DOS Fax Lite; WinFax Lite; none	Lifetime	(214) 732-0255	(800) 551-6166	1376
Yes	Yes	Yes	MTez with ExpressFax Protocols & Emulations; WinFax Lite; STF Fax, Microphone LT Data	7	(617) 423-1072	(800) 666-6191	1378
Yes	Yes	Yes	MTez with ExpressFax Protocols & Emulations; WinFax Lite; STF Fax, Microphone LT Data	7	(617) 423-1072	(800) 666-6191	1377
No	Yes	Yes	QuickLink II; QuickLink II; QuickLink II	2	(408) 730-1388	(800) 328-5538	1379
No	Yes	No	QuickLink II; QuickLink II; QuickLink II	2	(408) 730-1388	(800) 328-5538	1381
Yes	No	Yes	Smartcom EZ, EZ Fax; none; Smartcom, Fax	2	(404) 840-9200	None	1382
No	Yes	Yes	Eclipse Fax; WordPerfect MTEZ; none	5	(801) 272-6000	(800) 527-8677	1383
Yes	No	No	DOSFax Lite; WinFax Lite; none	1	(617) 551-1000	(800) 822-8224	1380
No	Yes	Yes	MultiExpress, MultiExpress-Fax; none; QuickLink II	5	(612) 785-3500	(800) 328-9717	1384
Yes	**Yes**	**Yes**	**QuickLink II Fax Win/DOS; QuickLink II Fax Win/DOS; QuickLink II Fax**	**Lifetime**	**(805) 497-4774**	**(800) 442-4774**	**1385**
No	Yes	No	QuickLink II; QuickLink II with OCR; QuickLink II or QuickLink Data and STF Fax	2	(919) 395-6100	(800) 666-2496	1386
Yes	No	Yes	Blast Fax; WinFax Lite; AppleTalk scripts on BBS	2	(708) 982-5010	(800) 342-5877	1387
Yes	No	No	Blast Fax; WinFax Lite; AppleTalk scripts on BBS	2	(708) 982-5010	(800) 342-5877	1388
Yes	Yes	Yes	BitFax for DOS, BitCom for DOS; BitFax for Windows, BitCom for DOS; none	5	(510) 657-1188	None	1389
No	**No**	**No**	**None; none; none**	**2**	**(813) 530-2000**	**(800) 484-3333**	**1105**
No	**No**	**No**	**None; none; none**	**2**	**(508) 261-4000**	**(800) 446-6336**	**1106**
No	Yes	No	None; none; none	2	(408) 734-4333	(800) 835-3248	1108
Yes	No	No	Blast Fax; WinFax Lite; AppleTalk scripts on BBS	2	(708) 982-5010	(800) 342-5877	1109
No	Yes	Yes	ZVoice/Fax; ZVoice/Fax; ZVoice/Fax	5	(714) 693-0808	(800) 255-4101	1110
No	Yes	Yes	ZVoice/Fax; ZVoice/Fax; ZVoice/Fax	5	(714) 693-0808	(800) 255-4101	1111
No	Yes	Yes	ZVoice/Fax; ZVoice/Fax; ZVoice/Fax	5	(714) 693-0808	(800) 255-4101	1112

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Inside MS-DOS 6

The developers of MS-DOS 6 describe the operating system's memory optimization and disk-compression technology

BENJAMIN W. SLIVKA, ERIC STRAUB, AND RICHARD FREEDMAN

The two most interesting features of the newly released MS-DOS 6 Upgrade are Microsoft's new MemMaker memory optimization and DoubleSpace on-the-fly disk-compression technology.

MemMaker automatically scans all device drivers and TSR programs in your AUTOEXEC.BAT and CONFIG.SYS files, scans the upper-memory area, and determines the most efficient way to load these files into available UMBs (upper-memory blocks). A new EMM386 allows MemMaker to recover up to 100 KB of additional UMB space.

DoubleSpace effectively doubles your available disk space by compressing the contents of your hard disk. DoubleSpace works in the background, decompressing files as applications request them and then compressing the files when they are saved to disk.

Both technologies mark an advance in MS-DOS by integrating memory management and file compression tightly into the core operating system.

MemMaker

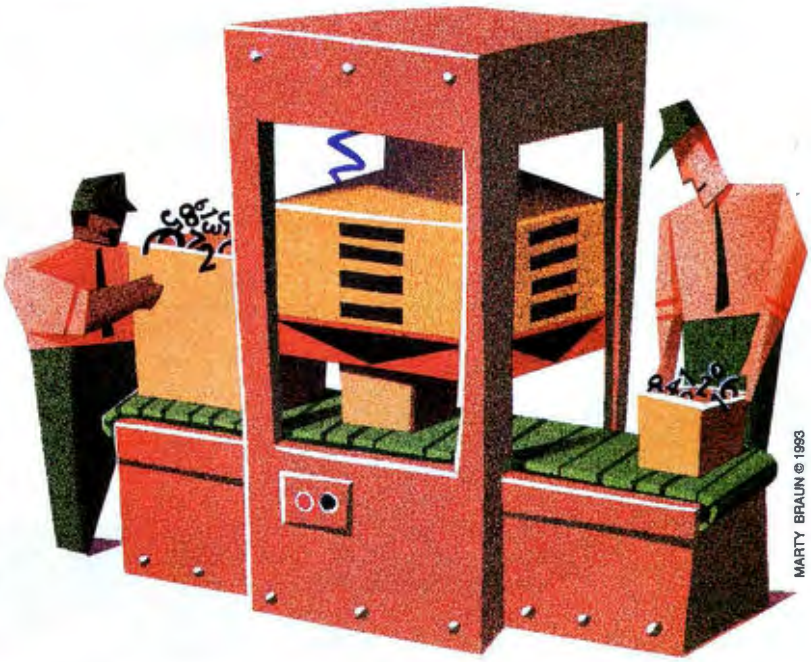
We designed MemMaker with three goals in mind: safety (i.e., reliability), ease of use, and optimum use of memory resources. When we had to make trade-offs, we gave safety and ease of use higher priority than optimization.

During memory optimization, MemMaker reboots the system twice. The first pass is for detecting the size of all device drivers and programs in CONFIG.SYS and AUTOEXEC.BAT (it does this by adding the SIZER command to each line containing a device driver or program). The second pass is for loading these drivers and programs in the optimal upper-memory configuration. Our primary goal was safety, yet we think it's impossible to design a memory optimizer that will never hang, since certain device drivers and programs do not function properly when loaded into upper memory. Our solution was to implement a *state model* that tracks the optimization process and lets MemMaker recover gracefully should the system hang during the optimization process.

If MemMaker incorrectly maps over a critical piece of memory used by adapter ROM, the system may hang while restarting. MemMaker's state model automatically detects this situation when the system restarts, and it lets you undo all changes or try a more conservative mapping algorithm that creates less upper memory but may avoid the conflict. MemMaker recovers in a similar way if a device driver or program hangs when loaded into upper memory (or if it hangs as a result of another driver's or program's attempt to load into upper memory).

Each time it runs, MemMaker creates a MEMMAKER.STS file to hold the information it gathers during optimization, such as driver size information. The STATE= line in MEMMAKER.STS tracks the current state of the optimization process. MemMaker modifies this line many times during optimization as it passes certain milestones, such as completing the first reboot pass.

Before each reboot, MemMaker inserts the statement DEVICE=C:\DOS\CHKSTATE.SYS /S:STATEARG as the first line in CONFIG.SYS. STATEARG defines the state that appears in MEMMAKER.STS when CHKSTATE.SYS loads and all is well. If CHKSTATE.SYS detects a mismatch between STATEARG and the state in MEMMAKER.STS when loading, MemMaker halts optimization and takes action. Since CHKSTATE.SYS is the first driver loaded in CONFIG.SYS, it can load and take appropriate action when you reboot after a system hang. MemMaker removes the CHKSTATE.SYS line from CONFIG.SYS after it completes the optimization.

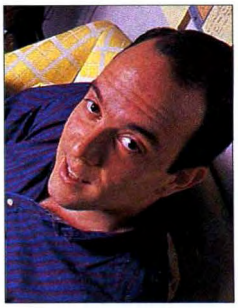


MARTY BRAUN © 1993

continued

Optimum Balance

MemMaker's optimization process does not automatically configure the 32-KB upper-memory area from B000–B7FF for two reasons: Super VGA boards use this space, and MemMaker can't always detect the presence of a Super VGA board.



Benjamin W. Slivka

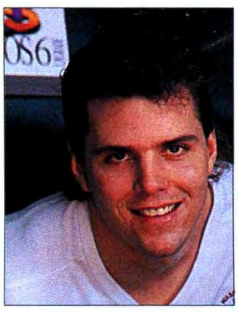
We also did not implement the FlexFrame/Stealth feature that some other memory managers offer. This feature enables a 386 memory manager to load a device driver or TSR into a UMB that would otherwise not be large enough to hold the device driver. This feature takes advantage of the fact that the initial size of most device drivers and TSRs is larger than the final size.

The difference between these two sizes is usually due to initialization code that can be discarded after the driver or TSR has been initialized. The trick is to detect a region of ROM or device adapter RAM adjacent to a target UMB that is not used while the particular device driver is loading. If the memory manager can find such an adjacent region, it maps this region with RAM temporarily, loads the device driver, and initializes it. Once the driver or TSR shrinks down to a size that can fit in the UMB space, the memory manager restores the original ROM or adapter RAM mapping.

The drawback here is that you may later add a driver, TSR, or board to the computer that invalidates the adjacent memory region selected. Unless you reoptimized at that point, the system would probably hang, and the problem would be difficult to diagnose.

DoubleSpace

DoubleSpace uses an on-the-fly LZ (Lempel-Ziv) compression algorithm that doubles—or nearly doubles—available disk space on a typical hard drive. DoubleSpace provides this increased disk capacity in a manner that is as compatible, easy to use, and safe as possible. Since disk compression is a file-system technology, we focused on integrating DoubleSpace into the MS-DOS file system.



Eric Straub

LZ compression lies at the heart of DoubleSpace. Lempel and Ziv wrote a landmark paper, LZ77, on lossless data compression (see "A Universal Algorithm for Sequential Data Compression" in *IEEE Transactions on Information Theory*, vol. IT-23, no. 3, May 1977) and proved that you can achieve nearly optimal compression without any knowledge of the type of data being handled. Quite simply, if a repetition is found, it is represented by referring back to any early occurrence in the data block of the same data.

For example, consider the following string.

```
123456789012345678901234567890123456789012345678901234
The rain in Spain falls mainly on the plain.
```

According to LZ77, you can represent this in a compressed form by writing out a combination of explicit bytes and *matches* that refer back to a previous portion of the input. For this example, you would produce the following:

```
The rain <3,3>Sp<9,4>falls m<11,3>ly on
t<34,3>pl<15,3>.
```

Here, <offset,length> indicates that you should move back *offset* bytes in the input string and copy *length* bytes. As another example, given the compressed data 0<1,200>1<1,100>2<1,50>, the uncompressed data would be 0...01...12...2 (i.e., 201 0's, followed by 101 1's, followed by 51 2's).

To create an LZ77 scheme suitable for DoubleSpace, we constructed an algorithm that found good matches quickly and used very little data space. Since DoubleSpace is a part of every disk read and write on a compressed drive, it must be fast. And since it's resident in memory at all times, it must be small. We also needed to choose an encoding scheme that produced good compression but was easy to both encode and decode.

"Safety and ease of use were the top priorities in MemMaker's design."

—Richard Freedman

The final result is a good compromise. The performance impact of DoubleSpace is, on average, in the range of 5 percent to 15 percent slower than the performance of an uncompressed drive. But few users notice any change in performance. DoubleSpace requires 43 KB of memory and can be loaded high. The compression ratio ranges from about 1.4 to 1 for executable files, to 2 to 1 for spreadsheet and word processing files, to more than 3 to 1 for bit maps and other redundant files.

The CVF Approach

Like many commercial third-party on-the-fly data-compression programs, DoubleSpace stores all compressed data in a single file—what we call a CVF (compressed volume file)—that appears to be a separate logical drive. A normal FAT (file allocation table) drive can be converted into a DoubleSpace drive, and the conversion process occurs in place without any disk reformatting or repartitioning. A system can have up to 255 CVFs; a CVF can hold up to 512 MB of data (that's the uncompressed value).

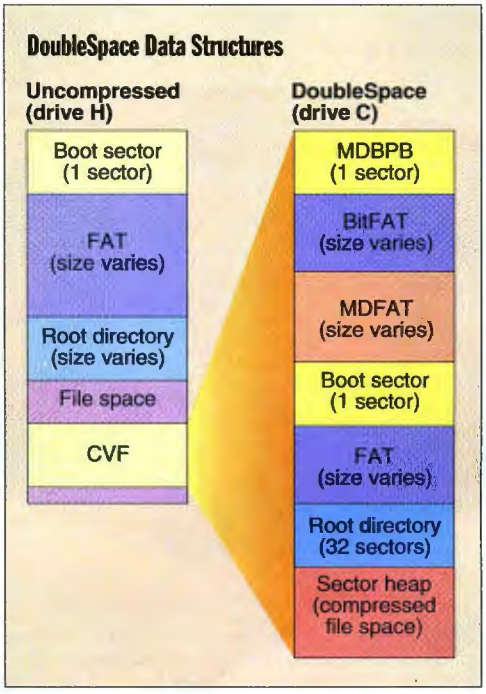
A CVF implementation has several advantages over automatic file-by-file compression. Since it stores compressed data at the cluster level, MS-DOS doesn't have to decompress the entire file to randomly read or write to it. The CVF approach also doubles the reported size of the hard disk while reporting the uncompressed sizes of individual files. The file-by-file approach, by contrast, reports the same total disk size as before, while reporting the compressed size of individual files.

Since files, unlike hard disks, travel between systems, changes in their reported sizes as they are decompressed and copied to another location can create knotty compatibility problems. And since DoubleSpace effectively simulates a standard FAT drive structure, existing disk tools work with a DoubleSpace drive. Finally, since DoubleSpace stores clusters on a sector basis, the CVF approach solves the problem of cluster slack: Small files, even if they are not compressible, are stored in as few 512-byte sectors as possible, rather than taking a full cluster as they would

on a normal FAT drive.

Some users worry that a CVF might be less safe than the normal FAT file system, because it puts everything in one file. Actually, a CVF is no more susceptible to damage than a normal FAT drive. Both contain a FAT, a root directory, subdirectories, and sectors that store actual file data; the CVF also has an additional data structure (called the MDFAT) that allows for optimal space allocation.

As with a FAT drive, one bad sector in a CVF means that you lose just the file (or a portion of it) that contains the bad sector. A damaged FAT, root directory, or subdirectory sector is a more serious problem, but these risks exist for both FAT drives and DoubleSpace drives.



DoubleSpace *uses the same data structures as an uncompressed hard drive but adds several new structures that allow data to be stored at the sector level, rather than by cluster.*

Inside the CVF

A DoubleSpace CVF uses the naming convention DBLSPACE.*nnn*, where *nnn* is a number between 000 and 254 that represents the CVF's sequence number. DoubleSpace uses sequence number 000 when the CVF is created by compressing the contents of an existing drive (as opposed to creating an empty CVF from free space). When DoubleSpace mounts a DBLSPACE.000 CVF, it refers to the CVF using the drive letter of the host drive—which is most often C—and refers to the host drive using a new drive letter (the default is H).

The CVF's internal data structures include the MDBPB (Microsoft DoubleSpace BIOS parameter block), the BitFAT, MDFAT, boot sector, FAT, root directory, and sector heap (see the figure "DoubleSpace Data Structures"). The MDBPB contains an MS-DOS BPB as well as fields that describe the rest of the CVF.

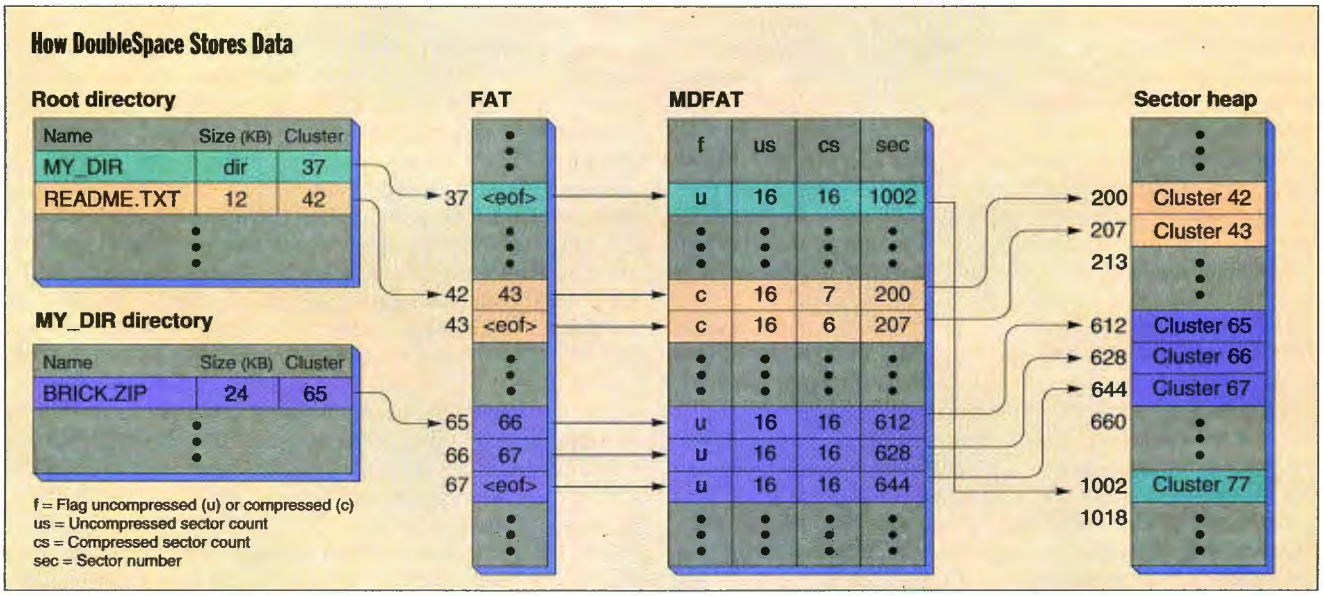
The BitFAT indicates which sectors in the sector heap are in use (1) or free (0). Its size depends on the maximum CVF size (which is stored in the MDBPB and chosen at the time the CVF is created). MS-DOS 6 rebuilds the BitFAT each time it mounts the CVF (including when the system restarts) by scanning the MDFAT. This process verifies the integrity of both the MDFAT and the BitFAT.

The MDFAT is a table of 4-byte entries that map each FAT cluster to sectors in the sector heap. Each entry points to the location in the sector heap that contains the data for the cluster, the compressed and uncompressed length of the cluster, whether the data is compressed, and whether the cluster is in use. If DoubleSpace can't compress a cluster, it stores the data uncompressed to avoid wasting space and to improve read speed.

The boot sector in the CVF is present for compatibility only; MS-DOS 6 does not use it to boot the system. However, this sector is returned when MS-DOS reads sector 0 from the compressed volume.

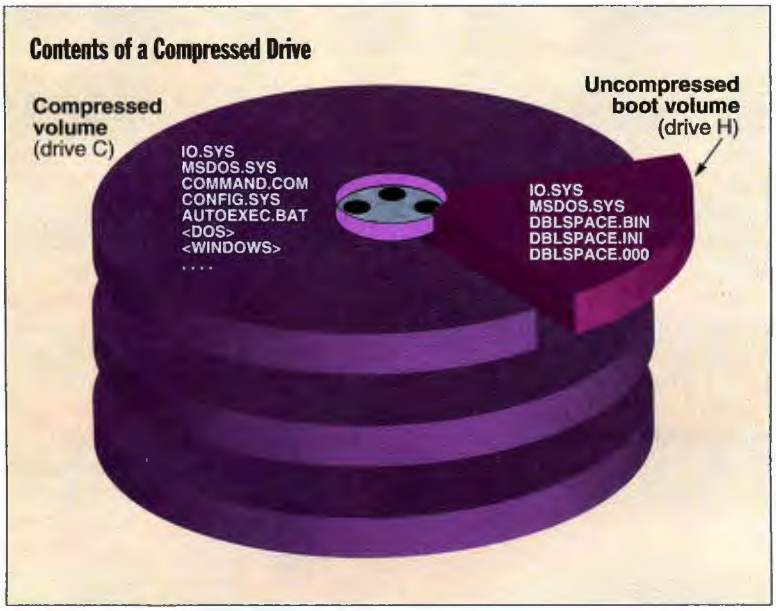
DoubleSpace uses a standard MS-DOS root directory (512 entries of 32 bytes each) and replaces the usual cluster file-space area of a normal FAT drive with a sector heap. Unlike a normal FAT drive, where file space is allocated in units of a cluster, DoubleSpace allocates sector-heap space in units of a sector.

continued



On a DoubleSpace drive, *files and subdirectories map through the FAT and MDFAT to the sector heap. DoubleSpace stores files by sector rather than by cluster, and the MDFAT provides the link between the uncompressed logical clusters in the FAT and the compressed data in the sector heap's physical sectors. README.TXT uses two clusters that compress from 32 to 13 sectors in the sector heap. BRICK.ZIP can't be compressed; it's flagged as uncompressed in the MDFAT and uses a full 16 sectors per cluster.*

When DoubleSpace requires disk space, it allocates one or more free sectors from the sector heap and sets the corresponding bits in the BitFAT to indicate that the sectors are in use.



The DBLSPACE.BIN *kernel file executes from the boot drive immediately after IO.SYS and MSDOS.SYS. Drive C then becomes the CVF, and the boot volume becomes drive H. The latter contains DoubleSpace's hidden files. Note that IO.SYS and MSDOS.SYS are duplicated on the CVF for application program compatibility.*

FAT-Compatible

A DoubleSpace drive appears to the MS-DOS file system as a normal FAT drive and has similar on-disk structures. The key difference is how DoubleSpace stores subdirectory data and data clusters (see the figure "How DoubleSpace Stores Data"). On a FAT drive, MS-DOS uses a simple multiplication formula to translate a FAT cluster number to a logical sector number on the drive containing the cluster's data. Using a DoubleSpace drive, MS-DOS 6 finds cluster data by looking at the MDFAT entry that corresponds to the requested FAT cluster.

Suppose an application calls MS-DOS to read file data. MS-DOS finds the FAT cluster containing the desired data—call it cluster X—and then calls DoubleSpace to read this cluster. DoubleSpace examines the MDFAT entry for cluster X, finds the sector heap location for cluster X's sectors, reads those sectors into an internal buffer, decompresses them (if necessary), and returns control to MS-DOS.

The cluster size varies on uncompressed hard drives, but a DoubleSpace drive always has 8-KB clusters. Therefore, the number of sectors read from the sector heap can range from one (if the cluster was compressed to a ratio of 16 to 1) to 16 (if the cluster was not compressed).

Operations such as creating a file, deleting a file, and searching the disk for a particular file work exactly the same way on a DoubleSpace drive as they would on a FAT drive. The only difference is that reading a subdirectory or data cluster requires a lookup in the MDFAT table, and probably decompression as well.

Disk utilities are another matter. Any program that uses normal MS-DOS INT 21h file I/O operations or INT 25h/26h direct-sector read and write operations will see a DoubleSpace drive as a normal FAT drive. However, the data for a contiguous range of clusters on a DoubleSpace disk is most likely not stored contiguously in the sector heap. That means that disk defragmenters that haven't been updated to support MS-DOS 6 will work safely but won't produce physically contiguous files. (Many such products have already been upgraded to support DoubleSpace.)

DoubleSpace's own disk utilities, CHKDSK and DEFRAG, operate in two phases when applied to a DoubleSpace drive. They first perform the same operations they would perform on a normal FAT drive—working with the root directory, the FAT, subdirectories, and data clusters—before operating on the CVF's unique internal structures (the MDBPB, BitFAT, MDFAT, and sector heap).

The Boot Process

We integrated DoubleSpace into MS-DOS by making the compression system, DBLSPACE.BIN, a kernel file. Because DoubleSpace doesn't load as a device driver from CONFIG.SYS, you don't need to have two copies of CONFIG.SYS and AUTOEXEC.BAT (one on the CVF and one on the uncompressed disk). You also don't need to maintain duplicate copies of all files that are referenced in CONFIG.SYS and AUTOEXEC.BAT (which are called *boot files*), synchronize changes to these files, or swap drive letters partway through processing CONFIG.SYS.

On a system without DoubleSpace, the boot process begins when the CPU executes the ROM BIOS and loads the MBR (master boot record). The MBR searches the partition table for the active partition and loads that partition's boot sector. The boot sector then loads IO.SYS and initializes MSDOS.SYS. Finally, CONFIG.SYS and AUTOEXEC.BAT execute.

In a DoubleSpace system, DBLSPACE.BIN loads right after MSDOS.SYS initializes. DBLSPACE.BIN then reads the initialization parameters from DBLSPACE.INI and mounts the CVFs indicated in the `ActivateDrive=X,Yn` line. At this point, the uncompressed drive C becomes drive H, and C becomes the CVF (see the figure "Contents of a Compressed Drive"). DBLSPACE.BIN looks for DBLSPACE.INI first on the boot drive and then on the CVF. If it doesn't find the file, DBLSPACE.BIN unloads itself from memory.

Since DBLSPACE.BIN does not load when DoubleSpace drives are absent, you can put DBLSPACE.BIN on every bootable MS-DOS 6 drive without fear of wasting valuable memory space. And since the configuration information remains in DBLSPACE.INI on the hard drive, you can boot an MS-DOS 6 system that uses DoubleSpace from a boot floppy disk that contains DBLSPACE.BIN, and the DoubleSpace drives will mount correctly.

The next step is to load DoubleSpace into a UMB. The kernel approach created its own problems here: DBLSPACE.BIN loads before the system's 386 memory manager loads in CONFIG.SYS, so no UMBs are available at load time. We solved this problem by writing a short program, DBLSPACE.SYS, and by adding code to DBLSPACE.BIN so that DoubleSpace can relocate itself into upper memory. DBLSPACE.SYS loads from CONFIG.SYS after EMM386.EXE and HIMEM.SYS and contains the line DEVICEHIGH=C:\DOS\DBLSPACE.SYS /MOVE. This line signals DBLSPACE.BIN to move itself from conventional memory to upper memory.

continued

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PC Week - May 10, 1993

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Circle 161 on Inquiry Card.

Hands On Under the Hood

Safety First

DoubleSpace operations can be classified as either *restartable* or *robust*. Restartable operations, such as compressing a FAT drive or resizing a DoubleSpace drive, *must* complete. If such an operation terminates before completion, the data on the hard drive will be in an inconsistent state, and the computer will become inoperable. A robust operation such as CHKDSK or DEFRAG, on the other hand, is designed so that it can be interrupted without consequence; it does not have to complete. For either type of operation, we engineered DoubleSpace so that the computer can be restarted at any time without losing data.

When DoubleSpace starts an operation that must be completed, it modifies AUTOEXEC.BAT so that it automatically regains control after an interruption. Also, DoubleSpace performs all operations on the hard drive in a careful order to ensure that at least one copy of all user data is on the drive at all times and that DoubleSpace knows at all times what operation is being performed. In this way, DoubleSpace can pick up where it left off after an interruption with no data loss. Robust operations like CHKDSK and DEFRAG move data around on the DoubleSpace drive in a specific order so that no data loss occurs if the system reboots unexpectedly.

Extending DoubleSpace

Disk-tool vendors can take advantage of the DoubleSpace system API and the CVF specification to write DoubleSpace-aware disk defragmenter and repair utilities. And software and hardware developers can take advantage of the MRCI (Microsoft Real-Time Compression Interface), a client/server software interface that allows a compression client (be it DoubleSpace, a backup program, or a network protocol transport) to use compression without depending on the particular compression-server implementation. This approach requires only a single copy of the compression server (a boon in the RAM-starved arena of MS-DOS) and allows compression-server improvements to occur without requiring corresponding revisions to the clients.

The most obvious improvement would be to implement an MRCI server in hardware. This would have several benefits. The RAM occupied by the software server would no longer be needed and would be available to other programs (the present MRCI server occupies 14 KB). A hardware server is faster and can achieve better compression by performing more exhaustive searching for matches. And in a multitasking environment, the hardware server can free the CPU for other functions.

MRCI-compliant hardware will have the greatest speed if it is implemented on a local-bus architecture. In the future, MRCI compression could even be built into CPUs. By contrast, an ISA-bus compression card would be at a distinct disadvantage, since the 8-MHz speed of the bus limits the amount of data that can be transmitted to and from the card. MRCI is currently limited to real-mode operation but will soon support enhanced-mode Windows.

We focused on safety and ease of use in our design of MemMaker and DoubleSpace in the hope that a much broader audience will reap the benefits of increased conventional memory and disk space. Up to now, these benefits have been limited to a much smaller group of advanced users. ■

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Confessions of a DDK Developer

The OS/2 Device Driver Development Kit falls short, but it's a start

STEVE MASTRIANNI

One cold February afternoon, after a long wait, I received a letter from IBM announcing the beta OS/2 2.0 Device Driver Development Kit. I eagerly signed and returned the form with a check for $15, and less than one week later, I finally had the elusive OS/2 DDK. I'd been hearing rumors about it for several months. IBM kept promising to deliver it, but delays dragged the process out, and IBM had to repeatedly ask developers to have patience. Sources close to IBM say that the problem was not the availability of the driver code. Instead, no one was given the responsibility to gather the code and produce the DDK. Rumors of legal problems with Microsoft also circulated. At last, the problems were resolved.

A Dubious Beginning

The DDK came on one CD-ROM, and the Win-OS2 drivers came on two floppy disks. I was eager to find out what took up all the space, so I began to install it immediately on a machine that was running the December 2.1 beta code. The installation process asked for 50 MB of disk space. I had 52 MB free, so I figured I'd just make it.

I was wrong.

About 95 percent of the way through the installation, I got a general protection fault and that feared message "the system is stopped." Judging by the address of the fault, it appeared to be in a device driver, and my worst fears were realized when I found that the first several tracks of my disk were rewritten with data. The disk was no longer bootable. The FAT (file allocation table) was gone, as was all my data. Fortunately, this was a spare system that didn't contain any critical information. (I later found out that this was a known bug with the 2.1 beta code. The device-driver code, I later discovered, requires 54 MB of disk space.)

I reformatted the hard disk and reinstalled DOS and the 2.1 beta code. I reinstalled much of my previous software, but I left approximately 100 MB free. This time the installation went perfectly, duly placing a gob of driver source code on my disk. All the drivers were installed: printer, SCSI, display, virtual, and physical. The installation program lets you select only the drivers you want. That helps conserve disk space, but locating a particular driver is a tedious job.

What You Get

The DDK includes the previously unreleased Microsoft CL386, a 32-bit C compiler that was used internally to create the 32-bit code for OS/2 2.0. IBM also used CL386 to build all the VDDs (virtual device drivers) for OS/2 2.x. Also included is a copy of MASM (Microsoft Macro Assembler) 5.1, although some examples require MASM 6.0. I was annoyed by this. Why couldn't the examples all use the same tools?

A better question yet: Why does IBM develop OS/2 with different compilers and assemblers? This requires device-driver developers to install Microsoft C 5.1, Microsoft C 6.0, CL386, IBM's C Set/2, MASM 5.1, and MASM 6.0. In its defense, IBM says that it is working to correct this problem in a subsequent release of the DDK. Also, some simple tools are included with the DDK, such as a program that lets you quickly change a file's extended attributes, a hardware palette-display program, a display test tool, a printer test tool, TOUCH, SED, MAPSYM, LIB, and the resource compiler, RCPP.

DAVE CUTLER © 1993

As for drivers, the DDK includes dozens. In the category of video-display drivers, the DDK includes a 16-bit

VGA driver, a 16-bit 8514/A driver, a 32-bit VGA driver, a 32-bit Super VGA driver, and a 32-bit device-independent driver. The virtual video counterparts are also included. Base video handlers for VGA, 8514/A, CGA, XGA (Extended Graphics Array), and EGA top off the list of video drivers. The two floppy disks contain the source code for two seamless video drivers based on a Windows 3.0 and Windows 3.1 VGA driver.

In the printer category, IBM supplies only two drivers: a PostScript driver and a plotter driver, which appear to be OS/2 1.3 source code. This makes sense, because IBM still supports these drivers on OS/2 1.3. You must compile the PostScript driver with CL386. For disk drives, the DDK includes the source code for the floppy driver, ASPI (advanced SCSI programming interface) driver, IDE driver, PS/2 SCSI driver, PS/2 floppy driver, and PS/2 DASD (Direct Access Storage Device) driver. For CD-ROM drives, the DDK includes the source code for the Hitachi, Toshiba, NEC, and Sony SCSI CD-ROM drives, as well as CD-ROM Device Manager. Drivers for the Mouse Systems mouse, PC Mouse/Logitech mouse, and VisiOn mouse are also included, although a virtual mouse driver is missing.

Hunting Around

The first place I looked was the PDD (physical device driver) section, since these are my favorite OS/2 device drivers. I've long been an advocate of writing PDDs in C. I supply a C-callable library that allows a PDD written in C to call the register-based OS/2 device helpers, and I was curious to see what IBM offered.

IBM included a library with source code and make files, but absolutely no documentation. If you're a good MASM programmer, you can probably figure out the more-complex-than-necessary assembly language code and macros, and the way to call the functions by reading the assembly language include file—if you have the time.

Also, the library contained several undocumented device-helper function calls. The library needs to be fully documented, and the documentation file placed on the CD-ROM for reference. If the function calls are unsupported, IBM should make note of these so that developers won't use them in production code. But they should be documented nonetheless. I was pleased to see much of the driver code written in C. Since most driver operations are quick, it makes almost no sense to write them in assembly language. Drivers written in C can be written in half the time it takes to write one using MASM, and they're easier to debug and support.

I didn't find the PDD reference, which is the PDD writer's bible. Nor did I find the presentation driver and VDD references. What's confusing about these omissions is that IBM has already released these in the Professional Developer's Kit. Not all driver writers, however, have need for the PDK, so they're left with virtually no documentation. IBM says it intends to supply these documents on future releases of the DDK.

Trying to make sense of the DDK by wading through over 50 MB of code is extremely tedious. The DDK CD-ROM should include the necessary navigational information in INF format. I'd also like to see the *Control Program Reference* manual on the DDK CD-ROM, since most of the calls to the device driver are performed with these APIs. When testing my drivers, I always have to refer to *Control Program Reference* because I find it impossible to remember all the parameters and their ordering.

Also noticeably absent from the DDK is an example of a file-system driver. The information about OS/2's IFS (installable file system) is sketchy at best, and it can be obtained only with special permission. Although a small skeleton IFS is downloadable via CompuServe, IBM needs to do a better job in the IFS area by providing sample code and IFS documentation as a standard part of the DDK CD-ROM. There's just no excuse for not providing the code.

Other Improvements Needed

The DDK is a good start, but it's extremely difficult to use without good documentation. Because IBM has committed to regular releases of the DDK, it should take the time to make the product better. Many of the source code examples contain hundreds of lines of code with no documentation whatsoever, and some never even state what the function does. IBM must provide more documentation to let developers understand exactly what is on the CD and how to find it. Nobody has the time to fumble around the CD looking for something that may or may not be there.

A debugger such as ASDT32 should be provided on the CD. The DDK is also lacking in examples of character drivers, such as a serial or parallel driver, a data acquisition driver, or a simple memory-mapped driver. These "other" drivers make up over half of the devices that will require OS/2 device drivers. The DDK should also include a tutorial for building device drivers with sample code. All these documents, including the device-driver references, should be supplied in several formats (e.g., INF, Read/2, ASCII, and PostScript).

IBM must do a better job of supporting device-driver writers, especially since this has traditionally been OS/2's Achilles' heel. Currently, IBM operates a small BBS where device-driver writers can ask questions and download sample code. However, the BBS is a single-user system and lacks the benefit of ongoing message threads, like you find on CompuServe or BIX. Periodically, the questions and answers are merged into a file that can be downloaded, but this is not as helpful as a continuing message thread on CompuServe. IBM has announced that CompuServe is the official public support forum for OS/2 2.x. Therefore, IBM should support device drivers in the device-driver forum there, where a much wider audience of developers can benefit from the message traffic.

Waking Up?

IBM may finally be getting the message. A special group within the company has been formed to promote OS/2 device drivers—both publicly and internally. The DDK has become a product, and it now has a product manager assigned to it. IBM plans quarterly releases of the DDK, and each release should get better and better. Future releases will include drivers and tools for the following areas: pen computing, multimedia, XGA, 8514/A, SCSI, mice, keyboards, IFS, serial and parallel ports, touchscreens, and PCMCIA, as well as a large selection of tools and on-line documentation.

IBM has scheduled a three-day OS/2 DDK conference this month. The OS/2 2.x device-driver developers from the Boca Raton labs will attend to give talks and meet with developers. Perhaps the release of the DDK and the conference signal a turning point for OS/2 device-driver developers. Stay tuned. ■

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The Mac Extended

The Mac operating system's modular design lets savvy programmers add new features

ERIC SHAPIRO AND
TOM THOMPSON

Much of the Apple Macintosh's identity comes from its Toolbox code. Believe it or not, despite the fact that these routines are frozen in the Mac ROMs, you can still change the Mac's identity. Apple does it all the time. MultiFinder retroactively added cooperative multitasking to all existing Macs; QuickTime added time-based data manipulation to the Mac's repertoire. This was possible because the Mac OS's low-level structure was designed to be easily extensible. Such extensions take the form of code patches that alter a program's thread of execution out of the ROM and into new code located in RAM. It's this new code that adds extra features.

Easy Extensions

You can patch the Mac OS in various ways. For example, some word processors patch the Mac's text-handling routines so it can work with huge chunks of text. (These patches apply only to the application's environment, not to other running applications). The application applies these patches when it launches and removes them just before it quits. The exception is MultiFinder under System 6.0.x. This System application applies specific patches and runs in the background for as long as the Mac remains switched on.

You might, however, want to add a special feature that's present constantly, not just when a certain application runs. The QuickTime Extension, for example, supports all applications, and Steve Christensen's SuperClock Control Panel adds a permanent time display to the Mac's menu bar. The trick is to do what experts do to apply a permanent feature: patch the operating system at boot time. Fortunately, the Mac OS gives you a hand here. A special initialization mechanism scans the Control Panel, Extension, and System folders at boot time for files of type INIT, cdev, and RDEV. These file types signal the software to open the file, load initialization resources of type INIT into memory, and execute their code. This code applies the patches to the Mac OS.

These INITs are called Extensions in System 7 parlance, although INIT code can be found in Control Panels. They are powerful tools, but they're more complicated to write than applications. Apple doesn't officially approve of patching the Mac OS because it can create compatibility problems. Nevertheless, it has supplied some information. Tech Note number 256 discusses these issues, with a heavy bias toward using the MPW development tools. To add balance, we provide information on writing Extensions using Symantec's Think C compiler. Since we're tinkering with the Mac OS at a low level, a brief explanation of how the Mac OS operates is in order. Once you understand how it works, you'll know how and where to apply a patch safely.

The Trap Mechanism

The Mac OS gains its extensibility by leveraging off the 680x0 processor's exception handling. An *exception* is an error condition that the processor detects as it runs a program. Such errors include attempting to access a memory address outside of physical RAM, trying to use a privileged instruction, executing an unimplemented instruction, and other abnormal conditions.

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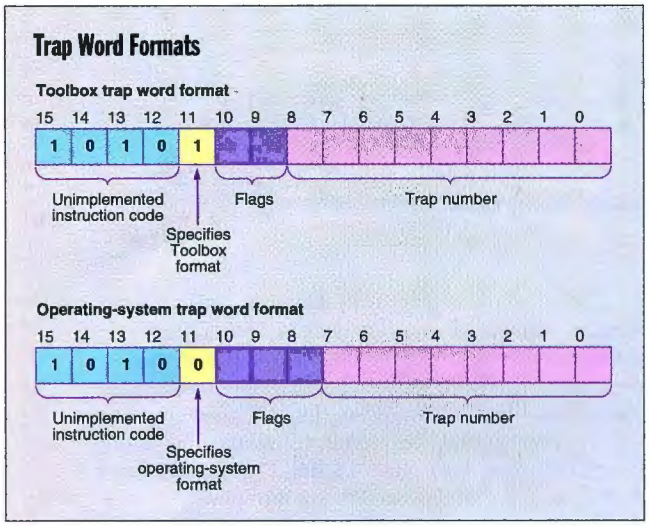
When the processor detects an exception, it switches to supervisor mode, calculates an exception vector (which is an address that contains a pointer to a handler routine), and saves its registers on the stack. The processor then loads the address stored in the exception vector and jumps to it. The handler code at this address deals (presumably) with



Format of the opcode *used to call Toolbox routines. Bit 11 is used to select the type of service requested.*

the error condition and returns execution to the program. As most Mac users know, the Error Manager fields some of these exceptions, displaying the much-beloved bomb box.

So far, this sounds no different from the way other processors handle exceptions. However, you can use a special unimplemented instruction to expand the features of the 680x0 processor. This unimplemented instruction word is called the *A-line opcode*, because bits 15 through 12 equal the bit pattern for the hexadecimal "A." Exception handling is the same when the processor encounters this instruction, but the system jumps to handler code that emulates new functions. The A-line trap therefore allows new operations to be added to the processor's instruction set.

Apple uses the A-line trap mechanism to implement its Toolbox and Mac OS routines. The figure above shows the format of this instruction word (commonly called a *trap word* or *trap*). Notice that bit 11 of the word (the "Toolbox bit") signifies whether the trap is a Toolbox routine or a Mac OS routine. Originally, Toolbox routines were stack-based (i.e., they took arguments off the stack), and the Mac OS routines were register-based (with a few exceptions).

Apple adds another level to this trap mechanism (see "Anatomy of a Trap" on page 207). When the processor hits an A-line trap during the execution of a Mac application, it jumps to a handler known as the Trap Dispatcher. The Trap Dispatcher first examines the trap word's Toolbox bit to determine the type of routine being called. Then it uses the 8 or 9 remaining bits in the trap word as an index into a dispatch table. The entries in this table contain pointers to routines, so the processor jumps to a routine that provides the services that the trap requests. Finally, the processor returns to the Mac application.

The Mac ROM contains a list of entries that get loaded when the Mac boots, and this is where the initial addresses in the dispatch table come from. The Trap Dispatcher must determine whether the trap is a Toolbox call or a Mac OS call, because it maintains a separate dispatch table for these two trap types.

While the Trap Dispatcher scheme adds some complexity to trap handling, it also provides great flexibility. Since every call to the Toolbox or Mac OS is controlled by the dispatch tables, changing an entry in the table changes which routine services a trap. To add a new routine to the Toolbox (perhaps a QuickDraw GX trap), Apple loads the new trap code into RAM at boot time, locks it (so it can't move around in memory), and then plugs the code's start address into an empty slot in the dispatch table.

Once you understand the workings of the Trap Dispatcher, you can patch a trap to add custom features to the Mac OS by modifying a dispatch table entry to point to your code. Instead of replacing a particular trap's routine, use the Trap Dispatcher to call your code to perform a task, and then call the original trap routine.

This sounds simple, but it's a bit tricky. Remember, you're performing surgery as the Mac starts up, and your code can't rely on many of the resources made available to an application. Since it's on its own to access global variables or allocate memory, such code is called *stand-alone code*.

Global Issues

When you launch an application, the Process Manager creates a memory partition, loads the application code into it, and sets up its heap, stack, and *A5 world*. The A5 world uses the A5 register to point to the application's global variables, QuickDraw globals, and jump table. The application code starts running once the Process Manager sets up this environment.

With a few exceptions, extension code runs in another application's heap. Because the Process Manager didn't launch the application, the value in register A5 is meaningless. And you can't change A5 to correct the problem because the application already uses it for its own global variables. Fortunately, when Think C builds a code resource, the generated code uses register A4 as its globals pointer. This solves the problem of interfering with an application, but you still need a valid address in A4.

Think C stores the program's globals inside the code segment itself, just past the actual machine code. References to these globals are just offsets from the start of the code, so you can make A4 point to the first byte of the code segment. A supplied Think C macro, `RememberA0()`, saves a copy of register A0 (which points to the code segment) within the code itself, where another macro can find it. This macro, `SetupA4()`, loads the stored A0 value into register A4. A `RestoreA4()` macro restores the previous value of A4.

`RememberA0()` smacks of self-modifying code, and while programs we've written using these macros have worked reliably on even 68040-based Macs, we consider this technique tacky. Instead, we select the Custom headers option when building the code segment. We then use Think C's built-in assembly language feature to write a macro that copies the segment's start address into A4. When our code finishes, another macro restores A4's original value. (See `GET_GLOBALS()` in the useful-macros listing on page 207.)

We also needed to initialize QuickDraw because we use it to show our Extension icon on-screen when the code loads at boot time. In addition, your Extension might use QuickDraw traps at some point. In a Mac application, you do this by calling `InitGraf(&qd.thePort)` to initialize QuickDraw. In fact, `qd.thePort` is the last field in a 206-byte structure allocated for us by our development systems. When the Process Manager sets up the A5 world, it loads the QuickDraw globals into this structure. Since Think C places its globals within code resources, we just allocate an identical data structure in our global space and pass the last field's address, `thePort`, to `InitGraf()`. Be sure to use the fields in this structure instead of the globals `qd.thePort`,

screenBits, black, and so on. This scheme works well as long as the combination of code and data doesn't exceed 32 KB. Think C has the ability to build multisegmented code resources (larger than 32K), but we haven't tried these techniques in such a situation.

Permanent Residence

Most of a Mac's memory is a temporary heap region that the Process Manager slices and dices as it partitions and then loads or unloads applications. You don't want your code hanging around here. The safest place for it in the Mac OS is the system heap. The system heap is built at boot time and is off-limits to applications. This haven is where drivers, system code resources, patches, and extension code hang out, and this is where we place our home-brew Extension.

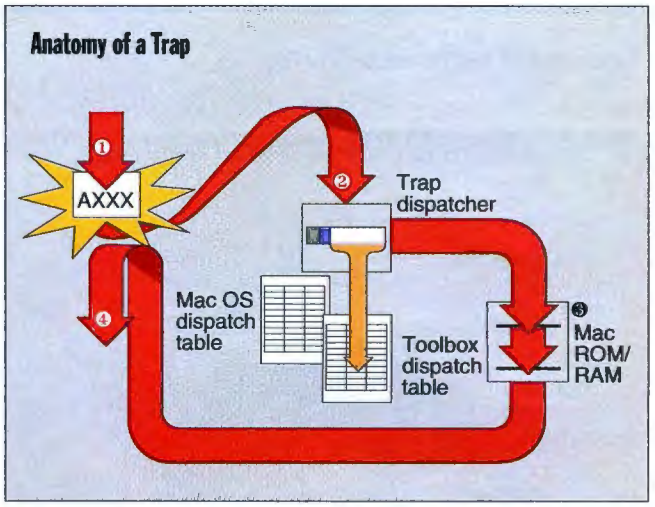
There are several ways to place code in the system heap. You can allocate a block of nonrelocatable and nonpurgeable memory in the system heap using NewSysPtr() and then use BlockMove() to copy the code from the file into this block. Think C has a feature that lets you set a code resource's attribute bits when you build it. By setting the System and Locked bits on the code segment, you can coerce the Resource Manager into loading it as a nonpurgeable block in the system heap. But when the Mac OS closes your INIT file, the Resource Manager releases the code resource, thinking that you are finished with it. To avoid this problem, call DetachResource() on the block immediately in your setup routine so the Resource Manager "forgets" about it when the file closes. The macro LOCK_SELF() in the useful-macros listing shows how this is done.

Useful macros for writing Mac Extensions.

```
/* Note: Main() must be the very
        first function in the
        file for this to work. */
#define LOCK_SELF()
asm {                          \
 lea     main, A0              \
 dc.w    _RecoverHandle        \
 move.l  A0, -(SP)             \
 dc.w    _HLock                \
 dc.w    _DetachResource       \
}

#define GET_GLOBALS()
asm {                          \
 move.l  A4, -(SP)             \
 lea     main, A4              \
}

#define UNGET_GLOBALS()
asm {                          \
 move.l  (SP)+, A4             \
}

#define PATCH_SETUP()
asm {                          \
movem.l a0-a5/d0-d7, -(SP)
lea     main, A4               \
}

/* Note: Save any global result
        into local variable
        before calling this
        macro. Then use local
        variable to return
        result. */
#define PATCH_CLEANUP()
asm {                          \
movem.l (SP)+, a0-a5/d0-d7
    }
```

Patching Traps

Once you have stowed the code segment safely away in memory and have your global variables set up, you must make the Mac aware of it by modifying a dispatch table entry. Begin by seeing if the desired trap exists. Remember that your neat hack might be running on all sorts of Macs, some of which may not have QuickTime, QuickDraw GX, or other nifty features. Also, since Extension files load in alphabetical order, it's possible that your QuickTime-patching Extension might load before the QuickTime Extension does.



When an exception *occurs* ❶, *program flow jumps to the Trap Dispatcher* ❷, *which uses the Toolbox bit in the trap word to select a dispatch table address. This address is used to locate and execute a routine in ROM or RAM* ❸. *The thread of execution then returns to the next instruction in the Mac program* ❹.

The Apple-approved way is to call the Gestalt Manager to obtain this information. However, the Gestalt Manager might be absent (definitely the case if the Mac is running an operating system lower than System 7). Or the Gestalt Manager might not be aware of the really new Mac OS features you want to patch.

The functions listing on page 208 shows how to check for a desired trap's existence. You start by passing the target trap word to the IsTrapAvailable() function, and if the word exists, the program returns TRUE.

Now you're ready to change the dispatch table entry. Apple provides two traps, NGetTrapAddress() and NSetTrapAddress(), that facilitate this operation. The first function, given a trap number, provides the address of its handler from the dispatch table. The second function, given a trap number and the address of our own handler, plugs this address into the dispatch table.

Even at this level, most of the low-level workings of the Mac remain hidden. All that's required is a trap number and the address of your routine. This setup also lets you add patches on top of patches. As long as everyone writes well-behaved code, a single trap might invoke several custom handlers before calling the actual trap code.

Patch with Caution

You'll want your code to be robust and reliable. Since the code might be called from anywhere, you'll want to save the current environment carefully and restore it when you're done. The macros PATCH_SETUP() and PATCH_CLEANUP in the useful-macros listing help here. Since the Toolbox calls use Pascal calling conventions rather than C, you must set up your patch routines as Pascal routines. You do this in Think C by adding the pascal prefix to your routine declaration.

If the routine returns a result, its value must be the correct size or it will corrupt the stack. Similarly, examine how the trap accepts arguments. Some traps take values that are pushed onto the stack, while others require that one or more arguments be

Functions that test for and patch a trap.

```
/* Global for original routine address. */
static void *gOldKeyTrap;
/* Our custom routine, which gets substituted. */
extern void OurKey(void);

Boolean ChangeTrap(void)
{
Boolean patchFlag;
#define kMenuKeyTrap 0xA93E
. patchFlag = FALSE;       /* Assume the worst. */
  if (IsTrapAvailable(kMenuKeyTrap))
    {    /* Trap exists; patch it. */
    gOldKeyTrap = PatchTrap( kMenuKeyTrap, OurKey );
    patchFlag = TRUE;  /* Flip flag to OK state. */
    } /* end if */
    return patchFlag;
} /* end ChangeTrap() */

/* PatchTrap : Modifies the dispatch table. */
/* StripAddress() required because an app can */
   switch to 32-bit mode and call a patched trap. */

void *PatchTrap(short trapNum, void *codeAddress)
{
void    *oldAddress;
TrapType          tType;

  tType = GetTrapType(trapNum);
  oldAddress = (void *)NGetTrapAddress(trapNum, tType);
  NSetTrapAddress((long)StripAddress(codeAddress),
                  trapNum, tType );
  return((void *)StripAddress(oldAddress));
} /* end PatchTrap() */

/* Determine if trap is Toolbox or Mac OS trap. */
TrapType GetTrapType( short trapNum )
{
TrapType tType;

  /* Look at the Toolbox bit. */
  tType = (trapNum & 0x0800) ? ToolTrap : OSTrap;
  return( tType );
} /* end GetTrapType() */

/*  This function is based on Inside Mac VI 3-8. */
Boolean IsTrapAvailable(short trapNum)
{
TrapType tType;
short   numToolboxTraps;
#define kInitGrafTrap 0xA86E
#define kUnimplementedTrap 0xA89F

  tType = (trapNum & 0x0800) ? ToolTrap : OSTrap;
  if (tType == ToolTrap)
        {
        trapNum &= 0x07FF; /* Largest # of traps
        possible. */
/* Is _InitGraf at address of 0xAA6E? */
        if (NGetTrapAddress(kInitGrafTrap,ToolTrap) ==
          NGetTrapAddress(0xAA6E, ToolTrap))
          numToolboxTraps = 0x0200;          /* Yes */
        else               /* No, table is larger. */
          numToolboxTraps = 0x0400;
          if (trapNum > numToolboxTraps)
          / Valid trap #? */
         return(FALSE); /* Trap # larger than table. */
        } /* end if */

  /* Return trap address if != unimplemented trap. */
     return( NGetTrapAddress(trapNum, tType) !=
        NGetTrapAddress(kUnimplementedTrap, ToolTrap)
  );
  } /* end IsTrapAvailable()*/
```

placed into certain registers. For the latter traps, you'll have to write some in-line assembly language code to process the arguments. Note that some Managers (such as the Hierarchal File System Manager and the Slot Manager) use one trap word as an entry point. A value in register D0 acts as a selector that determines the routine actually called when the trap fires.

Examine the Toolbox descriptions in the *Inside Macintosh* series (Addison-Wesley) to see what size arguments the trap uses and how it's set up. Or write a small routine that calls the trap, and use Think C's Disassemble menu command to create an assembly language code dump. Finally, check to see if the routine moves or purges memory. If the original routine didn't move memory, neither should your patch code.

Patches fall into two categories. A *head patch* performs some preprocessing before calling the original trap code. Put another way, when your trap gets called, it first performs some preliminary operations and then calls the actual trap routine. An example of this is when a keyboard event calls your code. You might scan for a certain combination of keys (perhaps an option key held down) to determine whether or not to process the character. We created `KeyTest.sea` to demonstrate a head patch. (This program patches the Mac OS so that the system beeps when you hold down the Shift key.)

In a *tail patch*, your code does postprocessing; it hands off execution to the trap first and then acts on the results that the trap passes back. You might call `MenuSelect()` to see which menu and which menu item were chosen. Eric Shapiro has created an Oscar the Grouch Extension that works this way. (In this extension, the Sesame Street character pops out of the Trashcan when you pick Empty Trash from the Finder's Special menu.) `BellTest.sea` demonstrates a tail patch. It patches the "About" item in the Apple menu so that the Mac beeps when you select it.

Apple deems tail patches a bad thing because they can interact with the System Software patches that Apple uses to fix Toolbox bugs. These patches often rely on the return address on the stack to determine what trap called them, and a tail patch can defeat these checks. But obtaining menu choices or other situations make tail patches unavoidable. Don't say we didn't warn you.

Code with Honor

With a good understanding of the Mac's trap mechanism, it's possible to add permanent features to the Mac OS. Just remember that Extension code operates outside the benign environment that the Process Manager sets up for an application, so you have little margin for error. ■

Editor's note: *The complete listings for programs mentioned in this article are available electronically. See page 5 for details.*

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6 ❑ Other

B. What is your level of management responsibility?
7 ❑ Senior-level 9 ❑ Professional
8 ❑ Middle-level

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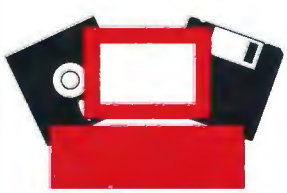

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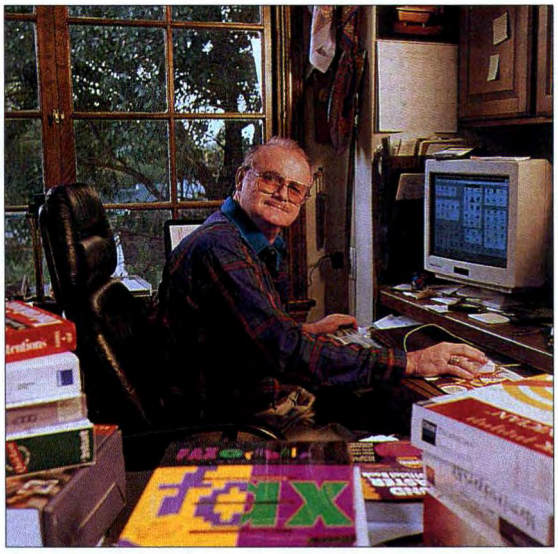
The DOS 6 Question



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I'm sure DOS 6 will eventually catch on. But until I have some applications that need it, I'll use DOS 5.0, QEMM, and caching controllers.

About the time you read this, they should be doing flight tests on the DC/X out at White Sands. DC/X, which stands for *Delta Clipper X*, is a flying scale model of the SSX spaceship that General Graham, Max Hunter, and I have been involved with. The goal is to have a ship that will fly into orbit without dropping off stages (and thus will be able to take off from any location, not just rocket ranges), return, refuel, and fly into orbit again without refurbishing. It should also have the capability of surviving an engine failure on takeoff. DC/X won't do that—it has only four engines, and you need at least eight—and it won't make orbit, but it does test many of the concepts needed for a proper spaceship.

We went down to the rollout at the McDonnell Douglas plant in Huntington Beach, and it was a pretty impressive thing to see a spaceship—even a model—rolled out like we used to roll out airplanes. We won't have access to space for the rest of us until we have spacecraft that operate like airplanes, and DC/X gets us one step closer to that.

At the rollout, DC/X program manager Paul Klevatt said that this was the first project he'd ever seen in which the software development wasn't the long pole in the tent. DC/X is controlled entirely by computers—they're using a 32-bit, 4.5-MIPS computer with off-the-shelf flight-control hardware such as the F-15 inertial navigation system—and the programs, being part of a Department of Defense project, are written in Ada.

Originally there were plans for them to develop software from scratch, but there wasn't enough money for that; which, I suspect, may have been a blessing in disguise, because it led them to off-the-shelf CASE tools. One of those was Matrix X from Integrated Systems. This starts with a graphical representation and develops actual Ada code. According to Klevatt, "Our coding error rates are much lower than on previous projects, and debugging times have been much shorter."

Anyway, she's a beautiful ship, and I'll sure be glad to see her flying.

Everyone runs out of disk space, and it doesn't matter how much you have. Ezekial, my original Z80 system, had twin 64-KB floppy disks to hold both programs and data, and I can recall thinking how luxurious double-density 8-inch floppy disks would be. Now, even with twin 330-MB hard drives, plus network access to the Pioneer read/write optical drive, I sometimes find I have to stop and shift things around to install a new program. I can imagine what it must be like for people who don't have the hardware assets I do.

One answer to the disk-space problem is compression systems, and the latest of these is DOS 6, which includes both file compression and memory management. While Microsoft's special introductory offer will be over before you read this, I suspect DOS 6 will still be far and away the lowest-cost way to get those goodies.

DOS 6 works, or at least I had no great problems with it; but for some reason, I don't get a warm feeling about it. I'm not sure why, since most of the reports I get are positive. I think it

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may be a case of "be not the first by whom the new is tried."

There's also some confusion about just what kind of compression system Microsoft put into DOS 6. Microsoft has a lot of experience with DOS, but I'm not so sure they have all that much in integrating file-compression programs.

If you're a big fan of DOS 6, I won't fight with you. But if you have an IDE hard drive—as nearly all the Gateway 2000 systems do—I think there's a better way to get file compression: Perceptive Solutions' WinStore caching controller.

It works only with IDE drives (not SCSI), but WinStore incorporates the Stacker file-compression chip right on the controller. The controller has its own processor and memory. Thus, you get both file compression and disk caching without using up system memory. That's a great advantage, because memory is likely to be in shorter supply than disk space.

Do note that while WinStore has the file-compression chip on the controller card, it isn't really integrated into the operating system. Your increased disk space looks to the outside world as if it were a new hard drive, but in fact it's an enormous hidden file. That means there's a small but real chance that a glitch in the compressed file system will make it impossible to access any of that data. Of course, that can happen with DOS 6, too.

The Stacker system for file compression and management has been in use long enough to be trustworthy, and certainly Perceptive Solutions makes reliable caching controllers: two of my major systems use them. (Another system uses a Distributed Processing Technology controller.)

All major compression systems maintain special FATs (file allocation tables) that are supposed to make it impossible for you to lose all the compressed data. However, I have enough disaster reports from readers that I'm very pleased that Norton Utilities 7.0 understands DOS 6 compressed files and file systems. Whatever compression system you decide to use, get and learn Norton Utilities 7.0 *before* you embark on it.

The DOS 6 MemMaker memory optimizer and revised EMM386 are a hands-down improvement over DOS 5.0's EMM386.SYS, and for many these will probably be good enough. However, MemMaker is not as efficient as Quarterdeck's QEMM-386 6.0. When I replaced a DOS 5.0/QEMM system with DOS 6 and used MemMaker, I found I had 28 KB less DOS memory, largely because MemMaker isn't as aggressive about allocating unused memory. It also doesn't seem to be as good as QEMM in working with fully reentrant programs that understand how to use memory in small noncontiguous chunks.

MemMaker isn't as simple to use as QEMM's Optimize. On the other hand, if you really need to play around to cadge memory, you'll have to go to QEMM's analysis tools. That takes some hard study, but it's also the most efficient memory recovery system I know of.

In general, QEMM works well with DOS 6. There are some load-high switches in DOS 6 that Optimize currently doesn't understand, but that just means you have to do some things manually. QEMM/DOS 6 is a good combination; but then so is QEMM/DOS 5.0.

We're all running out of UMBs (upper memory blocks), especially those of us who use networks. I'm already having

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memory trouble. Thus my recommendation: where money is a primary factor, DOS 6 may be the right choice. In my judgment, however, it's worth the extra cost to use QEMM for memory management and, if you have an IDE drive, WinStore for file caching and compression. Obviously WinStore will cost more than DOS 6, but given a choice between hardware and software solutions, I'll take hardware just about every time.

I'm sure DOS 6 will eventually catch on. But until I have applications that need it, I'll stay with DOS 5.0, QEMM, and caching controllers.

I keep promising to change my network over to NetWare, and when I do, I'll install a Procomp Pro-Val network controller in the server. Procomp makes network-aware controllers tested and approved by Novell, and it will be interesting to compare the Pro-Val with the Distributed Processing Technology controller that's in the Cheetah 386 now. For the moment, though, I'm still wringing out Windows for Workgroups.

That's partly a matter of time—I have never had so many things to do—but it's also a matter of "good enough." W4WG can't do all the things a full-featured network operating system can, but it sure makes it easy to share files and gives me access to assets like the Pioneer CD-ROM drive and read/write optical drive. W4WG also works well with Traveling Software's LapLink V. I can attach a parallel cable to any system on the network, plug the other end into a laptop, and run LapLink V, and I have access to *every* network drive. That is useful enough that I don't need any fancier way to service my portables.

Indeed, LapLink V has so many wonderful features—such as synchronizing directories so that both have all and only the latest files—that I'd be hard pressed to do without it. I only wish W4WG itself had some of the features.

I've had astonishingly few problems with W4WG, but there have been some glitches. It is the easiest network software to install that I've ever worked with, so it's surprising that one of my worst panics came when I tried to install the Gateway 4DX2-66V with local-bus video. Previously, all I'd done with the Gateway 4DX2-50V was to put in the Intel EtherExpress 16 card, connect it to the network, and do an upgrade installation of W4WG over the Windows 3.1 that the machine came with. When it came time to add the 4DX2-66V, I expected no difficulties.

At first all went well. I selected the Express installation and let things run. When I got to the third floppy disk, it all came apart. Up popped "ATI Flexdesk Windows Driver Error. The ATI Flexdesk Windows driver requires Windows to be run in 386 enhanced mode. Select the 8514/A driver to use your ATI 68800 video board with a 286-based processor to use Windows standard mode." Then the installation aborted.

To make it worse, I'd foolishly done this without making a full backup. There's no real excuse for that, but in my defense, I'll say that I'd installed W4WG in the other Gateway without problems; and if the system isn't on the network, backups aren't so easy to do. Indeed, that was one reason I wanted to add it to the network. Anyway, Setup had gone far enough that I couldn't get into Windows 3.1 either. Worse than that, attempts to install Windows 3.1 from the original Gateway disks ran into other problems, with various error messages about not being able to find needed device files I'd never heard of. I was dead in the water.

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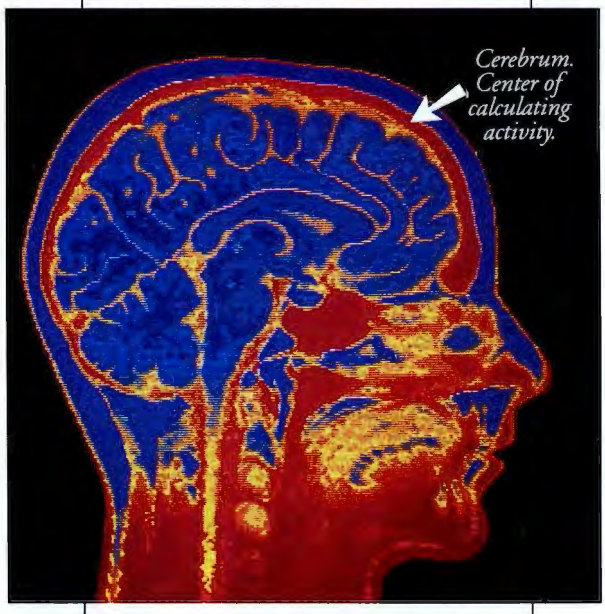

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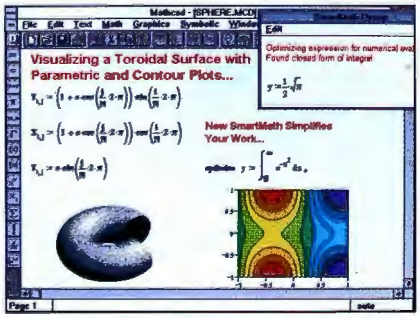

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from Lex in Microsoft technical support within an hour; a result that you probably can't get, but after you read this, you may not need to. Fixing things was relatively easy, if tedious.

First, I was told to edit SYSTEM.INI and remove the line that says `Setupstate=1`. This line tells Setup that there was a failed attempt to install and gets in the way of things. Second, I logged on to C:\WINDOWS and ran Setup to select VGA 3.0 (standard VGA) as the video mode. This is necessary because Setup launches Windows in standard mode, and standard mode doesn't understand ATI's Flexdesk. Setup asked for several floppy disks and eventually announced that it was finished.

Now to install W4WG again. I put in the first floppy disk, fired it up—and the system hung up fairly early in the procedure, well before I got to the third disk. OK, turn the machine off—it was hung good—and start over, this time with a bare-bones CONFIG.SYS and AUTOEXEC.BAT. Same result.

OK, maybe it's the floppy disks. I'd been using 5¼-inch; change to 3½-inch.

Same result. The machine hung to hardware reset quite early in the process. By now I was ready to panic, but Lex wasn't. Apparently this happens more often than you'd think, and there's a trick that will get you around it.

Here it is. Reboot the machine and create a directory called C:\FOO (or whatever strikes your fancy). Copy the first three W4WG installation disks into that directory, log on to it, and launch Setup from within it. When Setup asks what kind of installation you want, say Custom rather than Express. Now follow instructions. After a while, it will run out of stuff from the hard disk and ask where to find the rest. Tell it which floppy drive, put the disk it wants in there, and Bob's your uncle.

When Setup is done, it restarts Windows, this time in 386 enhanced mode, and configures your network, including your network card. When it asks which IRQ (interrupt request) you want to use, the default is 3, which probably isn't what you want; 5 is usually free, and that's the one I chose. The EtherExpress card is configured in software: no jumpers to set, just drop in the card. You'll also be asked to name your machine: since Gateway machines come in cow-spotted boxes, the 4DX2-66V became SuperCow.

I had one more glitch, but it was my fault. My network is called JERRY ONE, but I forgot and told the new machine to be on JERRYONE; so it couldn't find any other machines on the network. However, when I told it to go look for LITTLE CAT C (my name for the C drive on the Cheetah 386/25), it informed me that I could find that machine on JERRY ONE, so I didn't even have to retype to get logged on.

No one seems to know why Setup sometimes has problems with floppy drives. It's a bit like the Sound Blaster Pro problem I sometimes have. I launch a program that needs the Sound Blaster Pro card, the system informs me it can't do that because something else is using the card, and it iconizes the program. I double-click on that icon, the program launches, and there's sound. This, it turns out, is a known bug. Creative Labs may have a new driver on their BBS by the time you read this. But I do notice that as these machines get faster and their programs get more complex, we find more odd things that we just have to live with. Oh, well.

I've been fighting to install Norton Speedcache+ on my network server. This program works very well with DOS and Windows. It speeds up CD-ROM operations something wonderful and appears to work well with the Pioneer CD-ROM drive and read/write optical drive. It likes Windows 3.1 just fine and speeds up normal disk operations at least as much as Smartdrive. Of course, it doesn't have much effect if you have a good caching controller. When it comes to speeding up a system, hardware generally beats software every time. The controllers from Perceptive Solutions and Distributed Processing Technology have cache memory on the controller card, and thus don't use up your main system memory.

My major systems now use controllers from those two companies, and I've yet to see the software that will improve their performance. The Gateway 4DX2-66V doesn't come with a caching controller, so I installed Speedcache+ on that. It installs just fine without the manual. Once you have it going, there are some optimizations you can try, but the default installation is painless. On the Gateway machine, it works fine in both DOS and W4WG, but more on that in a minute. The bottom line is that Speedcache+ works very well indeed on vanilla systems.

How it works isn't so easy to figure out. Speedcache+ comes with a Disk Processing Test program that you can run under

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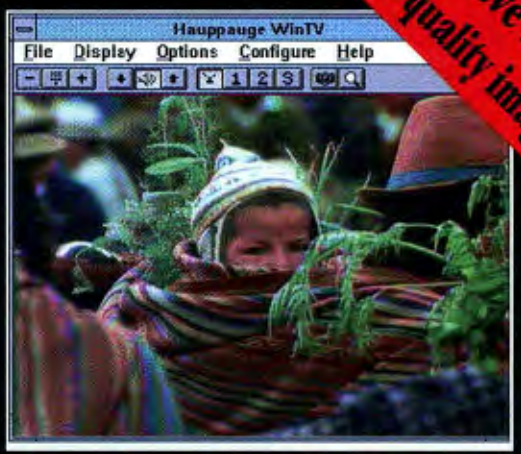

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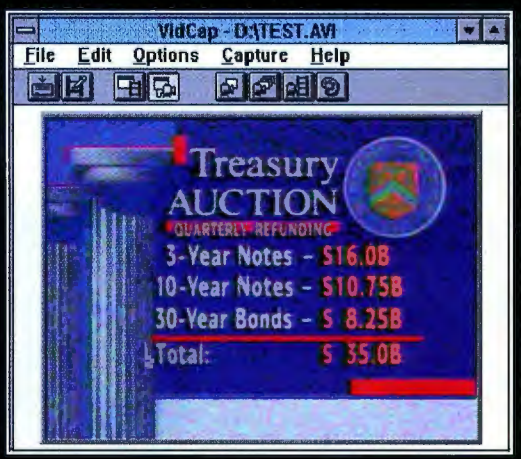

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Windows, but there's no printed documentation except for a reference to the online help system, and the help for the test has no instructions for use. I'm sure that given time I could figure it out, but I wasn't willing to put that much time into it; and since there were no examples, I soon got discouraged. Symantec says that Speedcache+ will work better than Smartdrive, and I'm willing to believe that.

Where I really need Speedcache+ is on my network server, because I don't have a caching controller for the Pioneer CD-ROM and read/write optical drives, and those are the very things that need caching most. I got it installed on the server, and the performance improvement of my optical drive was startling. It really has to be seen to be appreciated.

Fair warning: if you use caching systems, *get a UPS (uninterruptible power supply)*. When I copy files to the optical drive through Speedcache+, it all happens at blinding speed; but the optical drive's disk activity light shows that it may be half a minute before those files are written onto the glass disk. If I had a power failure before the files were completely written, the consequences would be severe. I recommend that anyone whose work is valuable get a UPS, but it's particularly important if you use caching systems.

Anyway, Speedcache+ works fine with Windows and CD-ROMs, and with W4WG with a single CD-ROM; what I haven't been able to do so far is get it to work with my W4WG file server, which has the two Pioneer drives. On that machine, when I load Speedcache+ and then run Net Start (which you have to get going before you launch W4WG), the system goes out to the land of lost bits. I'm working with Symantec's technical-support people on finding out why, and I have no doubt the problem will be solved, probably well before you read this.

Until then, Speedcache+ installs easily and intuitively, seems to work just fine with Windows and the various CD-ROM and optical drives we've got here at Chaos Manor, and gives noticeable speed improvements for every drive we've tried it with (except, as noted, those that have caching controllers). If you use Smartdrive, you will *love* Speedcache+. Recommended, but do be careful if you've got complex systems.

There are some problems Stabilant 22 won't solve, but I'm astonished at how many it does take care of. The Pioneer CD-ROM drive resides back in the cable room (a horrible place infested with monsters), where it runs off the Cheetah 386/25 we use as the server for the W4WG network. When I had problems installing Speedcache+, I found I needed to get a telephone back into that room, which meant stringing together phone lines using those wonderful little Radio Shack connector gizmos that let you do that. You expect that if you have seven different telephone wires connected end to end you'll get a noisy line, and indeed that happened, so I used Stabilant 22 on each connection. The result was blessed silence. I periodically use Stabilant 22 on *all* my phone connections, including modem phone lines.

In case you don't know about Stabilant 22, it's a contact enhancer. It comes in a little bottle that isn't cheap, but don't worry

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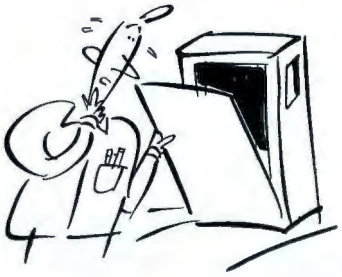
about that. A little goes a long way.

It helps eliminate noise in telephone lines, but for me the most important use of this stuff is inside my computers. I have a lot of fairly old equipment. My main machine is a Cheetah 486/33 with an Intel OverDrive CPU, which makes it in effect a 486/66. You may recall that the Cheetah 486 won my 1990 User's Choice Award as the most useful machine of the year. The previous year's winner was the Cheetah 386, which is useful as a network server.

Problems never come singly: when my attempts to install Speedcache+ crashed the Cheetah 386, recovery was complicated because the Cheetah 486 began to act flaky at reboot time. Sometimes it wouldn't boot at all—even from the "panic" boot floppy disk, and if you have not made yourself one for every machine you have, go do that now—sometimes it would tell me the hard drive wasn't properly formatted, and then it began telling me there were no hard drives at all.

"Don't panic," I kept telling myself, as I thought about all the deadlines I'm facing. I had everything backed up on DAT (digital audiotape) using the Palindrome backup system, so if worst came to worst, I could install Palindrome in a Gateway 486 and let it transfer over my whole working environment. It would cost a couple of hours, but it would be no disaster.

I didn't want to do that because I like this big Cheetah. It's not *quite* as fast as the Gateway 4DX2-66V because the latter has local-bus video, but unless I'm doing very complex video images, I can't tell the difference. That Cheetah has worked fine for years.



I don't like opening up computers without need, but it was clear I'd have to get inside this one, so I did. It was dusty in there, and cables were bunched up in a way that might have been blocking airflow. I moved the cables. I also reinstalled the CD-ROM drive. It's the one that comes with Creative Labs' Multimedia Upgrade Kit; a fast, reliable CD-ROM drive, highly recommended. Alas, when I first installed it, I hadn't any proper rails for the hard disk cage, and I used a lash-up with gaffer's tape. This time I found some rails and did it right. Then I vacuumed things out and got a fan blowing into the open case while I tested things.

This time it booted from a floppy disk all right, and once booted that way, it could find the hard drives. But it wouldn't boot from the hard drive.

OK, that's progress, I thought; so let's see what else I can do. The machine was filthy in there, so I took all the boards out. Some of the boards—including the caching controller—had discolorations on the contacts. I got out the Stabilant 22 and used that to polish up every board contact; then for good measure I used it on all the cable contacts as well. This time when I fired up, everything worked fine. I confess that before I actually put the cover back on, I used the reset switch several times and powered the system on and off a few times. My lack of faith wasn't justified. It worked every time.

If it ain't broke, don't fix it; but next

time you have to do any troubleshooting, use Stabilant 22. If it doesn't fix things, you will at least *know* that the problem isn't dirty contacts, and that's always worth knowing. Highly recommended.

Of course, Stabilant 22 can't fix some problems. Once I had all my machines running again, I'd still get messages that some of the shared resources on the W4WG network weren't available. Naturally that caused another panic, but it shouldn't have, since there were plenty of clues as to what was wrong. The network was intact, but my big Cheetah 486/33 wasn't on it. That should have told me everything, but I wasn't thinking properly.

Whenever I have mysterious failures in my system, I suspect all kinds of things, including a virus. The latest version of Dr. Solomon's Anti-Virus Toolkit had just come in, and this seemed a good time to use it. When I check for viruses, I like to do it right: I booted up the machine with a floppy disk that has remained write-protected since I first formatted it. Then I ran Dr. Solomon's from its write-protected floppy disk.

As it was running, I figured out what was the real problem. I learned early on that if you have a problem with a computer, chances are good that it's a cable. That's even more true of networks. If your network stops working, cables are a more likely culprit than a virus. I thought about that, looked behind the Cheetah 486, and lo!, the T connector for the Ethernet had come loose. It took about a second to connect it back, after which the network worked fine. Meanwhile, Dr. Solomon's told me there were no viruses in my system, which I'd known all along, but it's good for one's peace of mind to be sure.

Indeed, peace of mind is the major value of a good virus detector. Really good protection like Dr. Solomon's (which includes 24-hour telephone advice if needed) isn't cheap; but a not-so-good virus detector that gives false alarms can induce you to do something stupid, like needlessly reformatting your hard disk in panic. Don't laugh: I know at least three people who have done it.

Reader Oscar Weingart reports that he has W4WG working with a 286 system. The 286 is a client only—it can get stuff off the network and send stuff to it, but others can't access it. At least one CPU in the system has to be a 386, and it can act as a network server. He reports that the networked Hearts game that comes with W4WG works fine. I've always thought that game was an insidious plot sneaked into W4WG by competitors.

He also finds he can use Radio Shack cable and the Radio Shack "push on" connectors (about $1.50 each). I've been tempted to try that because some of my Ethernet cables are just too darned long, but so far I haven't done it.

The CD-ROM scene continues to be complicated, with some CD-ROMs able to work across the network while others have to be installed on my local machine. Some companies are paranoid about letting their CD-ROMs be used on a network. One such company used to be World Library, whose Library of the Future won a User's Choice Award a few years ago. With 950 classical-literature titles on one disc, it's still a bargain. The good news is that they're updating it, and the next one will work on networks.

Meanwhile, I get a dozen CD-ROMs every month, some silly, some wonderful. I have Grolier's and Compton

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New Media encyclopedias, both excellent. There are CD-ROMs about animals and birds. There are the Timetables of History, which are extremely interesting.

The CD-ROM of the Month is the History of the World from the Bureau of Electronic Publishing. This is the kind of thing I envisioned CD-ROM publishing would produce.

The original team who started the Bureau of Electronic Publishing has parted company, and Barry Cinnamon, one of its founders, has a new idea: books on disk for Windows users.

Allegro New Media has published a whole raft of TurboBooks. They come compressed on disk. Installation is painless enough, and when you're done, you read the book with the Windows Viewer program. It reads fine. The books are organized in chapters, so you can jump to any one of them. You can also search the text.

Books published by Allegro in this format include *Fallen Angels* by Larry Niven and Jerry Pournelle; that one also incorporates two Falkenberg novels: *Go Tell the Spartans* and my latest, *Prince of Sparta*, both coauthored by Steve Stirling. Other books include two Anne McCaffrey collaborations, *The City Who Fought* and *The Ship Who Fought*.

I'd generally rather read novels on paper, but if you're carrying a laptop anyway, they sure take up less room in your luggage this way. There are also titles like Jim Seymour's *On the Road: The Portable Computing Bible*, a complete on-line manual to Windows 3.1, a career guide, and other technical books, where it makes sense to have search capabilities.

This is a new experiment in publishing, and one well worth watching.

We have a whole line of Mustek scanners, ranging from hand-held to a big flatbed. I'll have more on those when I do a major essay on image processing, but they install easily enough and work as advertised. We had no trouble setting the scanner to use IRQ 12, and QEMM's Optimize loads the software high. If you're in the market for a scanner, take a look at these.

I'm pleased to report that Micrografx's Picture Publisher 4.0 supports Photo CD, which is a Kodak standard. You take your film to be developed, and in addition to slides or prints, you get a CD. Of course, one roll of film won't fill that CD, but that's all right: Kodak can put more pictures on it.

That means you need a Photo CD–capable CD-ROM drive that is smart enough to look past the symbols that mark the end of each batch of pictures you've put on there. Many new CD-ROM drives support Photo CD. Some of those that don't may be expandable by inserting new ROMs. Others won't be.

In my judgment, it makes sense to get a CD-ROM drive that can handle the Photo CD standard, particularly if you have any professional use for graphic art. For example, suppose you use publicity or product photos. If you have your pictures delivered on a Photo CD, they'll be digitized better than you'll manage with any scanner. You can send digital copies over a network, paste them into desktop documents, and so forth.

Thus, even if Photo CD doesn't catch on as a consumer product—and I think it will, although that may take a bit of time—it's going to be professionally useful.

Meanwhile, for systems installation people, the Trantor T358 MiniSCSI EPP pocket SCSI and a portable CD-ROM drive have become essential equipment. It's sure easier to install CorelDraw from a CD than to spend half a day swapping floppy disks! Trantor has turned your parallel port into the world's new bus standard.

I have three, count them, three SCSI controller boards in my Cheetah 486. This seems like wretched excess. There's the Perceptive Solutions controller, the Palindrome Future Domain SCSI card to run the Palindrome DAT backup system, and the sort-of-SCSI built into the Creative Labs Sound Blaster Pro card. That latter runs the CD-ROM drive.

Macs have always been SCSI, and that's probably the way the world will go; the PC world went through MFM, RLL, ESDI, IDE/AT, and then to SCSI. IDE is cheap, but you can have only two devices, and they can be only disk drives, not CD-ROM or tape. SCSI lets you daisy chain up to seven devices, but the controller costs more. Meanwhile, what we have now is a zillion SCSI devices, each one slightly different. I sure wish people would get their acts together and put it all on one card.

The book of the month is by Charles J. Sykes, *A Nation of Victims* (St. Martin's Press, 1992). It's a readable but scholarly diatribe about the decline of individual responsibility, and it paints a fairly frightening picture. The computer book of the month is by Ralph Roberts, *A-Train Railroading* (Compute Books, 1993). If you have much interest in the Maxis game A-Train, then you definitely need this book.

There are two games of the month. The

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first, unsurprisingly, is A-Train. This is sort of a cross between Railroad Tycoon and SimCity. The train schedule and routing control are a bit odd, but it can be a lot of fun anyway. The other game of the month is Capitalist Pig, which is both fun and a serious business simulator. Mr. Heinlein once said that top management was like sex—until you'd done it you didn't know what it was—and while that's true enough, this game will give you some serious hints. If you know people who aspire to run a company, point them at this game.

Another CD-ROM of the month is DeLorme's Global Explorer, which advertises itself as "The most detailed world atlas ever" and pretty well lives up to that. I'm to be guest of honor at a convention in Stockholm this August, and I sure appreciated being able to look at a street map. Ever wonder about the street layout of Beijing? It's in there. Also geographical and cultural features, and a partridge in a pear tree. If you like maps, you'll love this thing.

Several readers have suggested that NetWare Lite is preferable to W4WG, particularly if you already have NetWare running. DR DOS 7 is supposed to include NetWare Lite. There have been major improvements to Artisoft's LANtastic. I'm accumulating both hardware and software for major network investigations, and I'll be looking at as many of those as I can get to. Meanwhile, despite major cleanups, there's a traffic jam of new software at Chaos Manor; stay tuned. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

For More Information

A-Train is a cross between Railroad Tycoon and SimCity. The train-schedule and routing-control simulation game is available in versions for DOS, the Mac, and the Amiga for $69.95.
Maxis, 2 Theatre Sq., Suite 230, Orinda, CA 94563, (510) 254-9700.
Circle 1146 on Inquiry Card.

Capitalist Pig is both fun and a serious business simulator. The DOS-only version has a list price of $59.95.
Pluma Software, 1116 East Greenway, Suite 200, Mesa, AZ 85203, (602) 969-9441.
Circle 1147.

Dr. Solomon's Anti-Virus Toolkit can find, identify, and remove a wide variety of viruses. Regular updates are available for both the Windows version 6.04 ($195.95) and the DOS version ($149.95).
Ontrack Computer Systems, 6321 Bury Dr., Suite 15-19, Eden Prairie, MN 55346, (612) 937-1107. In Europe, contact S&S International, Ltd., Berkley Court, Mill St., Berkhamsted, Hertfordshire HP4 2HB, U.K., +44 442 877877.
Circle 1148.

Global Explorer is a detailed world atlas on CD-ROM. It includes geographical maps, cultural details, and street maps for most major cities in the world. If you like maps, you'll love this; for DOS, $169.
DeLorme Mapping, Lower Main St., P.O. Box 298, Freeport, ME 04032, (207) 865-1234.
Circle 1149.

The **History of the World** CD-ROM is a compilation of books covering history from the dawn of civilization to the present. List price is $795, and annual updates are $125.
Bureau of Electronic Publishing, 141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700.
Circle 1150.

Mustek produces a variety of hand-held and desktop scanners. Models range from the black-and-white, hand-held **ImageArtist** to the **Color Artist II** flatbed scanner. List prices are from $149 to $1295.
Mustek, Inc., 15225 Alton Pkwy., Irvine, CA 92718, (800) 366-4620 or (714) 833-7740.
Circle 1151.

Traveling Software's latest file transfer program, **LapLink V** ($99.95), now features peer-to-peer file transfer across NetWare networks and automated file transfers. It operates in the background under Windows.
Traveling Software, 18702 North Creek Pkwy., Bothell, WA 98011, (206) 483-8088.
Circle 1152.

Library of the Future, 2nd Edition contains the complete text of over 2000 classical literary works from over 950 titles. The DOS-based CD-ROM, listing for $299, is an entire home library on one disc.
World Library, Inc., 12914 Haster St., Garden Grove, CA 92640, (800) 443-0238 or (714) 748-7197.
Circle 1153.

The latest operating system for PCs, **MS-DOS 6**, incorporates on-the-fly data compression, an improved memory manager, and antivirus software. The suggested list price is $129.
Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080.
Circle 1154.

Norton Speedcache+ is a caching program that works on CD-ROM drives and removable-medium drives, as well as on your hard drive. The list price is $99. **Norton Utilities 7.0** ($179) is the latest incarnation of this famous package. Version 7.0 works with MS-DOS 6 and can recover files from a compressed drive.
Symantec Corp., 10201 Torre Ave., Cupertino, CA 95014, (408) 253-9600.
Circle 1155.

Micrografx's **Picture Publisher 4.0** ($595) image-editing package for Windows features Object Layers technology that gives you complete control over the placement, transparency, size, rotation, and order of bit-map objects.
Micrografx, 1303 Arapaho, Richardson, TX 75081, (800) 733-3729 or (214) 234-1769.
Circle 1156.

The **Pro-Val** intelligent SCSI controller ($199) works with any SCSI-1 or SCSI-2 storage device, including optical, CD-ROM, and WORM drives.
Procomp USA, Inc., 6777 Engle Rd., Cleveland, OH 44130, (216) 234-6387.
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Circle 1158.

With data transfer rates as high as 1 MBps, the **Trantor T358 MiniSCSI EPP** is a high-performance parallel-port-to-SCSI adapter ($269). Parallel printer signals pass through the SCSI adapter, so you can use both your SCSI devices and printer.
Trantor Systems, Ltd., 5415 Randall Place, Fremont, CA 94538, (510) 770-1400.
Circle 1159.

TurboBooks are books on floppy disks that can be read via Windows. Titles include several works of fiction and nonfiction, such as *Prince of Sparta* ($29.95) by Pournelle and Stirling and *Winn L. Rosch Hardware Bible* ($35.95).
Allegro New Media, 387 Passaic Ave., Fairfield, NJ 07004, (201) 808-1992.
Circle 1160.

The **WinStore** IDE caching controller ($499) incorporates the Stacker file-compression chip right on-board. The controller has its own processor and memory. You get both file compression and disk caching without using up system memory.
Perceptive Solutions, Inc., 2700 Flora St., Dallas, TX 75201, (214) 954-1774.
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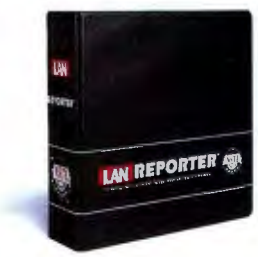

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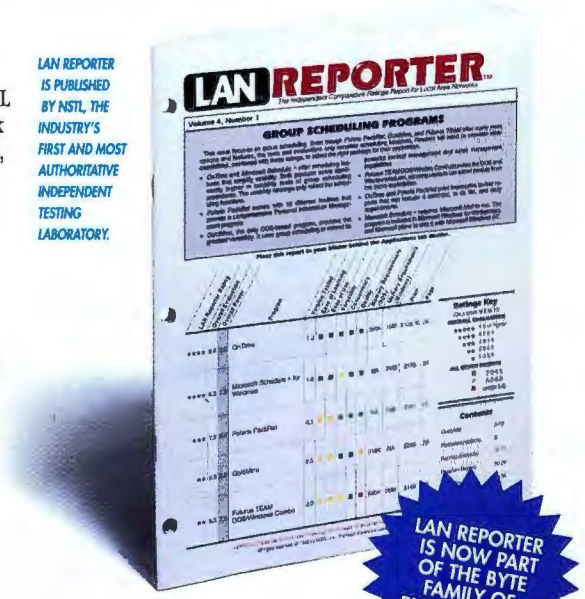

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The AVR 8800/CLX (from $1700) 24-bit flatbed scanner scans in color and gray scales. The TWAIN-compatible device from AVR Technology (San Jose, CA) can reach a vertical resolution of 800 dpi and an optical resolution of up to 1600 dpi.

Phone: (800) 544-6243 or (408) 434-1115.

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DEC'S QUIET DOT-MATRIX PRINTER

Able to automatically switch between its resident Epson LQ 570 and IBM Proprinter X24e emulations, the DECwriter 95 ($319) is a 24-wire narrow-carriage PC printer. The 360-dpi printer from DEC (Maynard, MA) prints at speeds of up to 300 cps at a noise level of only 43 dBa. It includes two resident scalable fonts, a Windows 3.1 printer driver, and a two-year warranty. The printer handles fanfold or cut-sheet paper, labels, envelopes, and up to four-part forms. An optional user-installed color kit ($55) lets you print in seven colors on each medium.

Phone: (800) 344-4825 or (508) 493-7161.

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PHOTOGRAPHIC-QUALITY COLOR PRINTING

Tektronix says its newest dye-sublimation printer processes color images in just over 3 minutes. The new Phaser IISDX ($9995) also supports Adobe PostScript Level 2. The networkable printer uses proprietary Tek-Color color-matching algorithms suitable for color proofing in graphic arts applications and scientific and engineering printing. A Phaser Print plug-in device for Adobe Photoshop increases the speed of printing Photoshop files by bypassing the Mac printer driver, Tektronix says. A driver for Windows 3.1 compresses scanned images such as photographs that are in Windows documents.

Contact: Tektronix, Inc., Wilsonville, OR, (800) 835-6100 or (503) 682-7377.

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PCMCIA TO SCSI

SlimSCSI ($349) from Trantor Systems (Fremont, CA) is a 16-bit PCMCIA-to-SCSI host adapter that features Trantor's proprietary ASIC controller and configurable I/O-mapped address settings. The adapter's two-piece design lets you remove the external connector and cable, leaving the card in place when carrying your portable computer.

Phone: (510) 770-1400.

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MICRO CHANNEL EXPANSION

Arco-Electronics' (Hollywood, FL) AC-1079MC Slim Drive Adapter ($395) expands storage on Micro Channel–based computers. The adapter, which lets you mount one or two 2½-inch hard drives on it, supports drives from Seagate, Maxtor, and Connor. The Arco BIOS on the card allows disk mirroring via hardware. The redundant write mode protects data by writing it to the primary and secondary drives; if a drive fails, Arco provides a recovery routine that allows data to be remirrored.

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Circle 1306 on Inquiry Card.

PORTABLE DATA FAX MODEMS

PCMCIA Type 2–compatible, the RediCard V.32bis data fax modems ($595) from Data Race (San Antonio, TX) include MNP level 4 and V.42 error protection as well as MNP level 5 and V.42bis data compression. They support Group 3 fax protocols and have EIA-578/Class 1 fax commands. The RediCard modems ship with Windows-based fax software.

Phone: (210) 558-1900.

Circle 1305 on Inquiry Card.

DAT DRIVE RUNS FAST ▼

Cristie Electronics (Gloucestershire, U.K.) claims that its TS5450 DAT drive ($3108; £1999) reaches operational speeds of more than 14 KB per minute over standard PC parallel printer ports. Without data compression, the drive has a capacity of 2 GB; with data compression, the drive can achieve capacities of up to 8 GB. The TS5450 is available with a SCSI connection in lieu of the parallel port and comes with software for DOS, Windows, OS/2, Unix, Xenix, and NetWare.

Phone: +44 453 823611.

Circle 1309 on Inquiry Card.

PALMTOP PERIPHERALS

The S2P-95LX converter ($125) lets you connect the HP 95LX palmtop PC to any printer with a parallel port. From Imaging Supplies Express (Torrance, CA), the 5-ounce converter connects directly to the palmtop's four-pin serial connector and the printer's 36-pin connector.

Phone: (800) 462-4309 or (310) 370-6882.

Circle 1323 on Inquiry Card.

The Flashdrive (from $599) 1½-pound battery-powered external hard drive provides additional storage for your palmtop. From BSE (Flagstaff, AZ), the 1½-inch-tall drive interfaces to any parallel printer port, letting you access your stored data from a variety of PCs. The internal batteries are rechargeable.

Phone: (602) 527-8843.

Circle 1324 on Inquiry Card.

Hardware

SCSI STORAGE

An intelligent multitasking SCSI bus–to–ISA bus host adapter, SCSI Cache ($315; £199) from Western Systems (Ruislip, Middlesex, U.K.) supports as many as four adapters that in turn each support up to seven SCSI devices. With 2 MB of RAM, SCSI Cache also provides hardware disk mirroring for all operating systems.

Phone: +44 81 845 8383.

Circle 1315 on Inquiry Card.

POWERBOOK CABLE ADAPTER

A palm-size 25- to 30-pin SCSI adapter, SCSI Boy ($29) from APS Technologies (Kansas City, MO) turns a standard 25- to 50-pin SCSI cable into a PowerBook-compatible cable. The lightweight cable's shell is made of anodized aircraft aluminum.

Phone: (800) 235-2753 or (816) 373-5800.

Circle 1318 on Inquiry Card.

CROSS-PLATFORM COLOR PRINTING

The CrayonFX Color Printer ($1495) is a thermal-wax-transfer printer that prints from Mac QuickDraw and Windows applications. From LaserMaster (Eden Prairie, MN), the 203-dpi printer includes Apple's ColorSync technology for color matching and 50 TrueType fonts that automatically scale on-screen and in the printer. You can use the LocalTalk and parallel-port interfaces simultaneously and connect to a network via AppleTalk and Windows for Workgroups.

Phone: (800) 477-7714 or (612) 944-9330.

Circle 1310 on Inquiry Card.

VOLTAGE REGULATION

From Upsonic (Tustin, CA), the VR Series of UPS systems (from $279) includes voltage regulation to protect LANs, host computers, and file servers from brownouts. In addition, these UPSes provide surge protection and up to 10 minutes of battery backup power.

Phone: (800) 877-6642 or (714) 258-0808.

Circle 1320 on Inquiry Card.

SEEING IS COMMUNICATING

From Datapoint (San Antonio, TX) comes the Minx Link Point-to-Point System ($16,500), a desktop video workstation with integrated camera, monitor, speaker, and microphone that provides two people with direct video communication. Expansion capabilities let you build a video network for multiple users. The system includes a codec and Minx control software.

Phone: (800) 334-9968 or (210) 593-7910.

Circle 1313 on Inquiry Card.

▼ ERGONOMICS ON A KEYBOARD

An ergonomic PC keyboard, the MiniErgo ($179) from Marquardt Switches (Cazenovia, NY) is designed for people who use their computers for extensive word processing or data-entry work. Developed in Germany by Marquardt's parent company, the MiniErgo features a sloping V-shaped configuration with a large resting area for hand and palm. Sculptured key caps are in the standard QWERTY pattern. Numerical keys are embedded and are also available as an optional number pad.

Phone: (800) 282-3746 or (315) 655-8050.

Circle 1311 on Inquiry Card.

WIRELESS LAN ADAPTER

Designed for peer-to-peer or client/server communications, the RadioPort/Parallel Wireless LAN Adapter ($599) lets you quickly set up, add, remove, or relocate workstations without disrupting the rest of the network. Able to communicate at distances as far as 800 feet, the adapter plugs into your computer's parallel port; it supports LANtastic and NetWare.

Contact: Alps Electric (USA), Inc., San Jose, CA, (800) 825-2577 or (408) 432-6000.

Circle 1300 on Inquiry Card.

REMOVABLE CARTRIDGE DRIVES

The Puma 105 ($1119) external 3½-inch cartridge drive provides 105 MB of removable storage for DOS- or Windows-based PCs. The SyDOS (Boca Raton, FL) drive has an average seek time of 14.5 ms and a 64-KB buffer. A parallel-port adapter that comes with the drive includes a printer pass-through that lets you simultaneously use the drive and your printer. An optional battery pack provides up to 5 hours of continuous use.

Phone: (407) 998-5400.

Circle 1326 on Inquiry Card.

From Mirror Technologies (Roseville, MN), the Mirror 105MB Syquest Removable Drive ($699) for the Mac offers an average seek time of 14.5 ms and a sustained data transfer rate of 1.7 MBps. The drive includes an embedded SCSI-2 controller.

Phone: (612) 633-4450.

Circle 1327 on Inquiry Card.

NOTEBOOK VIDEO ENHANCEMENT

Designed for Toshiba notebooks, Phoenix Graphics' (San Diego, CA) VideoPak-1024 ($649) high-resolution accelerated video adapter enhances video capabilities in such areas as CAD, spreadsheets, and word processing. Resolution-switcher software for Windows automatically configures Windows drivers for LCD and high-resolution modes. A PS/2-compatible keyboard port lets you connect a full-size keyboard.

Phone: (619) 283-9375.

Circle 1308 on Inquiry Card.

FLOPTICAL STORAGE

Adambyte's (Mountain View, CA) Powerbox mobile storage system is now available in two floptical versions. As is the original Powerbox, the 200-f ($1449) and 500-f ($2399) are complete systems for use with the PowerBook. Features include a 200- or 500-MB on-line hard drive and an additional PowerBook battery.

Phone: (415) 988-1415.

Circle 1312 on Inquiry Card.

PS/2 UPGRADE

Designed to interface with industry-standard IDE hard drives, the MC70 Upgrade Kit ($394; £249) lets you add storage to the IBM PS/2. It plugs into the IBM hard drive adapter slot, replacing the adapter. From CDL (Woking, Surrey, U.K.), the MC70 supports up to two hard drives, which can be installed in the B drive bay.

Phone: +44 483 756813.

Circle 1314 on Inquiry Card.

What's New Hardware

KEYBOARD KIT FOR VISUALLY IMPAIRED

Adhesive labels ($21.95) that adhere directly to the top of your keyboard's keys feature the keytop legends of a 101-style keyboard in a combination of raised braille characters and high-contrast large print. The size, spacing, and height of the braille dots comply with ADA specifications. From Hooleon (Cottonwood, AZ).

Phone: (800) 937-1337 or (602) 634-4503.

Circle 1317 on Inquiry Card.

PORTABLE ETHERNET ADAPTER

Featuring 10Base-2 and 10Base-T interfaces, the Dual Interface Pocket Ethernet Adapter ($295) from Kingston Technology (Fountain Valley, CA) connects to any portable or desktop PC via the parallel port. The adapter supports the enhanced parallel port and is the latest in Kingston's EtheRx line of Ethernet LAN products.

Phone: (714) 435-2600.

Circle 1333 on Inquiry Card.

SINGLE-BOARD VOICE COMPUTER

The MA590 ($240; $A333) single-height Eurocard intelligent voice-output card has on-board memory sockets for several minutes of tape recorder–quality recording and playback at 10-kHz audio bandwidth. The Microcontrol (Pymble, Australia) card includes multitasking voice-processing monitor firmware.

Phone: +61 2 449 1546.

Circle 1316 on Inquiry Card.

PANASONIC'S COLORFUL NOTEBOOK

An active-matrix TFT color display and a 120-MB hard drive are major features of the CF-580C ($4499) 486 notebook from Panasonic (Secaucus, NJ). The 25-MHz computer includes a built-in numeric coprocessor, 8 KB of internal cache memory, 3.3-V nickel-metal-hydride batteries, SuperStor disk-compression software, and a minitrackball.

Phone: (800) 742-8086 or (817) 685-1210.

Circle 1321 on Inquiry Card.

SCANNER DIGITIZES COLOR ▼

The Pro Imager 7650C color flatbed scanner ($11,495) from PixelCraft (Oakland, CA) digitizes color and gray-scale reflective images in sizes of up to 11 by 17 inches. The scanner has variable resolutions of up to 1200 dpi and ships with QuickScan and ColorAccess software. The scanner/software combination is designed to offer a desktop color-separation solution that rivals more expensive systems.

Phone: (800) 933-0330 or (510) 562-2480.

Circle 1319 on Inquiry Card.

SUPER SERVER

Tatung's Super COMPserver 10 Series (from $15,990) desktop servers are compatible with Sun Microsystems' Sparcstation 10. The entry-level model 10/30 features 32 MB of RAM, a 36-MHz SuperSparc chip, a 1-GB hard drive, built-in ISDN capabilities, graphics accelerator cards, and CD-quality 16-bit audio. Configurable with up to 10 storage devices, the unit includes Open Windows 3 and the Solaris 1.1 or 2.1 operating environment.

Contact: Tatung Science & Technology, Inc., San Jose, CA, (408) 435-0140.

Circle 1301 on Inquiry Card.

REMOVABLE STORAGE

The IncreMeg 6000 ($19,500) hard disk storage subsystem from MountainGate Data Systems (Orange, CA) provides up to 7.2 GB of formatted on-line capacity via up to six 3½-inch removable drives. Designed for secure storage, exchange, and transport of data for applications such as video/audio editing, mission planning, simulation, and data acquisition, the IncreMeg 6000 supports DOS, OS/2, Unix, Mac, and Sun platforms.

Phone: (800) 556-0222 or (714) 998-6900.

Circle 1322 on Inquiry Card.

TURN YOUR PC INTO AN OSCILLOSCOPE

A 12-bit, PC-based oscilloscope card from Gage Applied Sciences (Montreal, Quebec, Canada), the CompuScope 1012 (US $4995) provides a 10-mega-sample-per-second sampling rate on two simultaneous channels. Other features include a 65-dB dynamic range, 384 KB of memory depth per channel, programmable input gain, internal or external trigger capability, and programmable input coupling. GageScope software ships with the card, so you don't have to write any programming code.

Phone: (514) 337-6893.

Circle 1328 on Inquiry Card.

DOUBLE THE VIEWING

The Nth Double Edge ($1295) graphics board from Nth Graphics (Austin, TX) lets you run two color-graphics screens at once on two side-by-side monitors. You can see a large overview of a single application or view two full-screen applications and switch between them. The board includes 2 MB of VRAM and lets you pan, scroll, drag, and redraw screens.

Phone: (800) 624-7552 or (512) 832-1944.

Circle 1329 on Inquiry Card.

Decisions, decisions, decisions.

Decider, decider, decider.

Down-sizing, upgrading, multi-platform environments. Today's computer hardware issues are more numerous, more difficult, more critical than ever. So how do companies make decisions?

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BYTE reader Robert N. Barrett, Vice President Management Information Systems, M/A-COM, Inc.

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What's New Hardware

MAKE VIDEOTAPES ON YOUR MAC ▶

Designed for making high-quality presentations and videotapes on your Mac, the L-TV Pro LC ($449) and L-TV Pro NuBus ($499) support NTSC and PAL video standards. The interface cards support up to 16-bit video, which is optimized for Quicktime movies and photographic-quality pictures. From Lapis Technologies (Alameda, CA), the cards' four modes of operation are video recording, presentation, dual display, and TV only. Composite video and S-Video connections are standard.

Phone: (800) 435-2747 or (510) 748-1600.

Circle 1335 on Inquiry Card.

VIEW COMPUTER IMAGES ON TV

The pocket-size Presenter Plus 2 ($429) from Consumer Technology Northwest (Beaverton, OR) lets you present images generated in DOS or Windows applications on your TV screen. The device connects a computer's VGA port to a TV's video input port. Output is in NTSC, S-Video, and VGA formats.

Phone: (800) 356-3983 or (503) 643-1662.

Circle 1337 on Inquiry Card.

PRINT MULTIPART FORMS

From the Facit division of Ahearn and Soper (Manchester, NH), the D4000 ($2299) 80-column multipart forms and label printer handles up to six-part forms and pressure-sensitive labels. A straight paper path, front-mounted heavy-duty tractors, and the capability to print on paper from 3½ to 9½ inches wide are features of the 300-dpi printer. Facit's FormStore software lets you store up to six forms settings in the printer's memory. Serial and parallel interfaces and a keypad panel are built in.

Phone: (603) 647-2700.

Circle 1336 on Inquiry Card.

MULTIPLE-RESOLUTION SCANNER

A floor-standing scanner with a small footprint, the Visionscan VS-1250 ($9428; £5990) scans at speeds of up to 36 A4 portrait pages per minute at 200 dpi. You can also select resolutions of 240, 300, and 400 dpi. From Advanced Recognition (Windsor, Berkshire, U.K.), the scanner has a built-in 100-sheet page feeder and a manual paper-thickness adjustment.

Phone: +44 753 855442.

Circle 1332 on Inquiry Card.

STACKABLE HUB

Standard Microsystems Corp. (SMC, Hauppauge, NY) lets you stack up to eight of its Elite 3812TP ($995) 10Base-T hubs to form a 112-port logical repeater. When you add field-upgradable Network Management Modules ($1695 each), the hub allows in-band and out-of-band management and is compatible with any SNMP manager.

Phone: (800) 762-4968 or (516) 435-6255.

Circle 1334 on Inquiry Card.

NOTEBOOK HAS LONG BATTERY LIFE

With power management based on PicoPower Technology's Evergreen chip set, the CompuAdd 425TX notebook ($1895) runs on battery power for up to 5 hours under normal operation and 3 hours under heavy operation, the vendor says. The CompuAdd (Austin, TX) machine features 4 MB of RAM (expandable to 8 MB), a PCMCIA slot, a 120-MB hard drive, an internal fax modem slot, and a built-in trackball. Simulscan capability allows simultaneous display on the monochrome LCD and on an optional external color Super VGA monitor.

Phone: (800) 627-1967 or (512) 250-1489.

Circle 1330 on Inquiry Card.

VERSATILE IDE HARD DRIVE

The palmDrive 210i ($999) from ProTégé (Laguna Hills, CA), an external IDE drive, interfaces with your PC through the company's Stealth controller and device management software. The drive has access times of 12 ms, data transfer rates of 2.25 MBps, and drive buffer-to-host transfer speeds of 10 MBps. It coexists with IDE, SCSI, ESDI, RLL, and MFM controllers without changes to the PC BIOS.

Phone: (800) 995-4453 or (714) 586-8004.

Circle 1331 on Inquiry Card.

LIGHTWEIGHT NOTEBOOK

Epson America's (Torrance, CA) ActionNote 4SLC/25 notebook (from $1399) weighs 5½ pounds and has built-in power management features. The basic configuration includes 4 MB of RAM, an 80-MB hard drive, a backlit monochrome LCD, a dual display with an external monitor, and system and video BIOS RAM.

Phone: (800) 289-3776 or (305) 265-0092.

Circle 1338 on Inquiry Card.

MAKE THE CD-ROM CONNECTION

Future Domain's (Irvine, CA) SCSI CD-ROM kit ($69) lets you easily connect a CD-ROM drive to your PC. The kit includes a SCSI controller card, PowerSCSI universal application interface software, and NLM software for NetWare 3.11, 3.12, and 4.0 that lets file servers use a CD-ROM as a read-only volume. With PowerSCSI you can access several different SCSI peripherals, each connected through a different interface, simultaneously under Windows.

Phone: (714) 253-0400.

Circle 1325 on Inquiry Card.

LOCAL-BUS MULTIMEDIA

The Mega M46D2LM ($3895) local-bus multimedia system has 8 MB of RAM, 256 KB of cache RAM, 2 MB of VRAM, and 1 MB of DRAM. The MPC-compliant system includes a Pro Audio Spectrum 16 sound card, speakers, a microphone, and headphones. The medium-tower system can read multisession Photo CDs and includes Windows NT driver support.

Contact: Megamedia Computer Corp., San Jose, CA, (800) 634-2334 or (408) 428-9920.

Circle 1302 on Inquiry Card.

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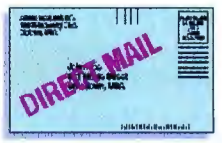

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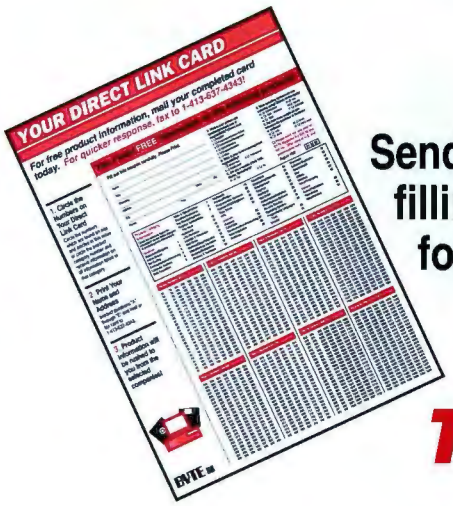

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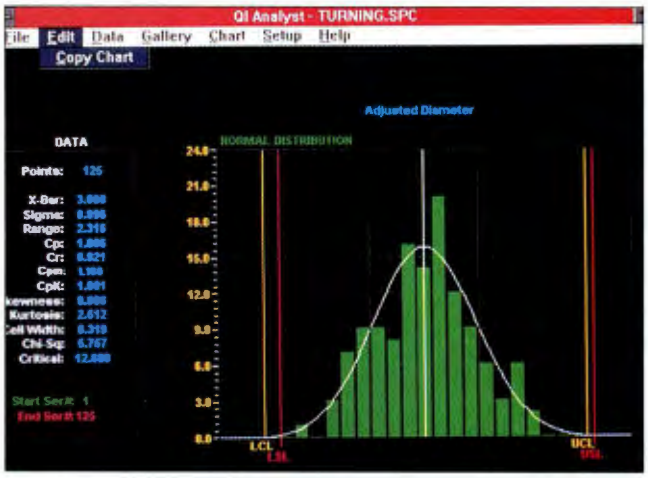
What's New Software



STATISTICAL SOFTWARE ▲

QI Analyst ($395 until September 30; $695 thereafter) SPC (statistical process control) software for quality improvement runs under Windows 3.1. From SPSS (Chicago, IL), QI Analyst is designed to help businesses improve processes, cut waste, and reduce nonconformance to quality improvement requirements. The package provides 23 SPC charts, capability statistics, Shewhart control tests, and reports.

Phone: (800) 543-2185 or (312) 329-2400.

Circle 1283 on Inquiry Card.

NO MORE MEMORY LEAKS

Bounds-Checker for Windows ($199) from Nu-Mega Technologies (Nashua, NH) can trap common bugs such as memory and heap-related corruption problems; library routine overruns of strings, arrays, and structures; resources that were not freed; and errant parameters that were passed to API routines.

Phone: (603) 889-2386.

Circle 1135 on Inquiry Card.

DATABASE MANAGEMENT MADE EASY

SQL Manager for SQL Base (US$795) from Nakiska Systems (Calgary, Alberta, Canada) combines database management, monitoring, and reporting for Windows users. Features include an intuitive interface, point-and-click commands, database maintenance, database trend information, server activity monitoring, and system catalog reporting.

Phone: (403) 945-7087.

Circle 1137 on Inquiry Card.

MODELING AND SIMULATION SOLUTION

A data analysis and numerics software package from MicroMath Scientific Software (Salt Lake City, UT), Scientist ($495) transparently processes standard and differential equations. The graphics editor supports annotation, editing, and grouping.

Phone: (800) 942-6284 or (801) 943-0290.

Circle 1136 on Inquiry Card.

TALK, DON'T TYPE

A speech-recognition command-and-control tool that works in Windows, IBM VoiceType 2 ($2195) lets you vocally enter text and control applications into programs such as WordPerfect, 1-2-3, and dBase. With a base vocabulary of 7000 words, the program accepts replacement words that you define or draw from a backup list. The Dragon Systems' (Newton, MA) program adapts to individual voice patterns.

Phone: (617) 965-5200.

Circle 1273 on Inquiry Card.

VIRTUAL REALITY DESIGN TOOL

Continuous, DSP-based (digital signal processor) operation in Real-Time Convolver ($1895) lets you design a virtual reality system in real time. The program supports impulse responses up to 25,000 points and sampling rates up to 100 kHz for mono or binaural real-time audible simulation. This Signalogic (Dallas, TX) software is compatible with the company's Hypersignal-Acoustic audio signal analysis environment.

Phone: (214) 343-0069.

Circle 1138 on Inquiry Card.

COLOR YOUR BUSINESS GRAPHICS

The Palette Chooser and the Explorer components of ColorUp ($99.95), an intuitive color software utility from Pantone (Carlstadt, NJ), provide professionally designed color palettes and an encyclopedia of color information and experiments. Colors are optimized for specific output media, and palettes are easily exported.

Phone: (201) 935-5500.

Circle 1140 on Inquiry Card.

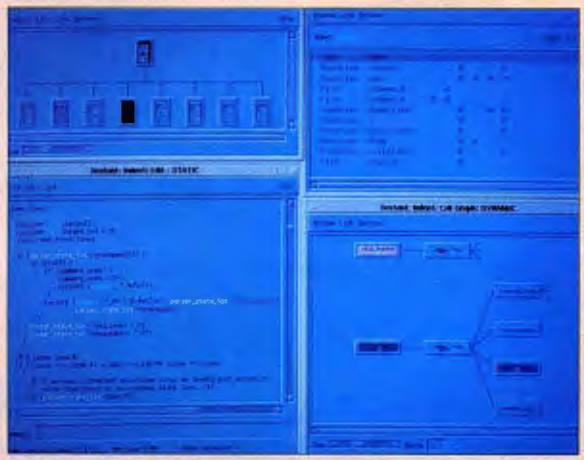
CREATE INTERACTIVE PRESENTATIONS

AniMage ($395) from Digital ChoreoGraphics (Costa Mesa, CA) lets you create interactive annotated animated graphical presentations. You can merge text, graphics, and animation into a single presentation and interact with it via the pan, zoom, replay, skip, and scroll options. You can then distribute the presentation and a presentation player on a floppy disk.

Phone: (714) 548-1969.

Circle 1142 on Inquiry Card.

DEVELOP AND MAINTAIN UNIX SOFTWARE



Sextant for C ($2500), an integrated hypertext environment for developing and maintaining Unix-based C applications, provides navigation and visualization capabilities that let programmers manage large and complex projects. The software assists in code reuse and reengineering and allows multiple views to be dynamically linked. You can configure the language-sensitive editor and fully integrate it into the environment. Features include color coding, filtering, and synchronization among specifications, code, and documents.

Contact: Sextant, Inc., Ann Arbor, MI, (313) 973-8888.

SMART COMMUNICATING

Communications software for Windows 3.0 and 3.1, Smartcom for Windows 1.0 ($49 through July; $149 thereafter) combines the GUI of a Windows application with the features and performance of a DOS program, according to Hayes. Smart Buttons let you access common commands and frequently used scripts with the click of a button, and the SCOPE scripting language allows you to automate tasks and to create interface-driven scripts for transparent operations. The Communications Editor includes ANSI.SYS functionality so that you can add color and graphics to text messages.

Contact: Hayes Microcomputer Products, Inc., Norcross, GA, (404) 441-1617.

Circle 1132 on Inquiry Card.

SAFE FILE TRANSFER

FileRunner ($99.95) for the Mac lets you network among your desktop computers and PowerBooks. The MBS Technologies (McMurray, PA) program synchronizes any number of Macs via its Tru-Sync feature, which automatically identifies and transfers updated and new files and folders. Overwrite Safeguard protects your data and warns you if the same file is changed on more than one computer. FileRunner creates a log of all transfers and compensates for changes in time zones.

Phone: (800) 860-8700 or (412) 941-9076.

Circle 1278 on Inquiry Card.

WINDOWS SOFTWARE FOR FINANCIAL ANALYSTS ▼

Leading Market Technologies (Cambridge, MA) has moved Expo to Windows 3.1 ($2995). Expo graphically monitors and analyzes market data, providing predefined analytics and letting you create custom analytics. A worksheet can contain up to 100 graphics windows; you can relate each window to others, spreadsheet-style, by formulas you define. Graphics, analyses, and decision rules from financial markets are automatically updated as you enter new data.

Phone: (617) 494-4747.

Circle 1282 on Inquiry Card.

SPEED UP WINDOWS WORK

When you power up your PC, Fantastic Recall ($49.95 until September 1; $79.95 thereafter) lets you start where you left off in Windows. With no special hardware required, this package from Binar Graphics (San Rafael, CA) automatically restores the application you were working in via a single keystroke.

Phone: (800) 228-0666 or (415) 491-1565.

Circle 1281 on Inquiry Card.

WINDOWS PAINTING

Color Wheel ($395), an image-processing program from Pacific Gold Coast (Glen Cove, NY), lets you quickly create designs using object-oriented procedures that let you change the shape, size, color scheme, and attributes of new or prefabricated objects. Major components of the software are object and overlay manipulation, color and palette management, special effects and editing, and OLE.

Phone: (516) 759-3011.

Circle 1271 on Inquiry Card.

NEURAL WINDOWS

DataSculptor ($495) shortens the time needed to solve data-analysis and manipulation problems. The NeuralWare (Pittsburgh, PA) data-translation, analysis, and transformation tools work in an object-oriented environment. You select tools and functions as you would building blocks; you connect the blocks to create reusable solutions to data-processing problems.

Phone: (412) 787-8222.

Circle 1272 on Inquiry Card.

Software Update

WinMaster 1.5 ($129.95), PC-Kwik (Beaverton, OR), adds new module KwikFind and enhancements to Toolbox, KwikInfo, PowerScope, and KwikVault.

Phone: (800) 759-5945 or (503) 644-5644.

Circle 1285 on Inquiry Card.

LANDesk Manager 1.5 ($995 per server), Intel (Santa Clara, CA), adds alert log, scripting, event manager, and Quick Windows screen control; enhances control panel with Network Device Table.

Phone: (800) 538-3373, (503) 629-7354, or +44 793 431 155.

Circle 1286 on Inquiry Card.

HiJaak Pro 2.0 ($169), Inset Systems (Brookfield, CT), adds improved user interface, new graphics formats, and support of the Aldus Graphics Import Filter specification, the WordPerfect for Windows API, and TWAIN.

Phone: (203) 740-2400.

Circle 1287 on Inquiry Card.

Linkage 3.1 (developer's kit, $20,000), Cimlinc (Itasca, IL), adds enhancements in computer graphics, data integration, floating licenses, and text handling.

Phone: (708) 250-0090.

Circle 1289 on Inquiry Card.

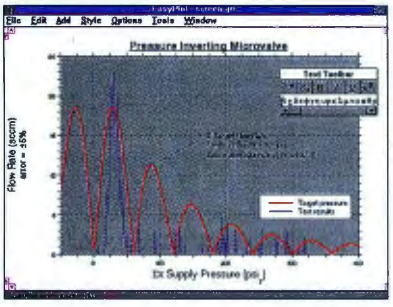
Golden Retriever 2.0b ($99), Above Software (Irvine, CA), adds File Save and File Open commands, version-control field in File Record, Uninstall option, and enhancements to Desk, File Manager, and ASCII file viewer.

Phone: (800) 344-0116 or (714) 851-2283.

Circle 1293 on Inquiry Card.

What's New Software

TECHNICAL GRAPHING IN WINDOWS ▶



EasyPlot for Windows ($399) technical graphing software lets you quickly analyze, manipulate, and plot large amounts of data. The Turbologic feature virtually eliminates delays normally associated with Windows screen rewrites by anticipating screen updates and storing key accelerator information, according to Spiral Software (Brookline, MA). Other features include the Text Toolbar, Clipboard Plotting, and the Data Editor.

Phone: (617) 739-1511.

Circle 1279 on Inquiry Card.

GUI DESIGN TOOL

XVT-Design++ 1.0 for PCs ($1395) and workstations ($3095) provides a GUI tool for creating C++ applications. From XVT Software (Boulder, CO), this interactive design tool for user interfaces incorporates a C++ code fragment editor and a C++ application framework that includes GUI objects.

Phone: (303) 443-4223.

Circle 1144 on Inquiry Card.

BASIC PROGRAMMING ON THE MAC

A visual interactive programming environment for BASIC on the Mac, VIP-BASIC ($295) provides precoded Procedures, integrated Resource Editors, and the Dispatcher for building applications in BASIC. From Mainstay (Agoura Hills, CA), VIP-BASIC lets you program from the bottom up.

Phone: (818) 991-6540.

Circle 1145 on Inquiry Card.

POINT-AND-CLICK BACKUP

Backup Exec for Windows ($149) introduces Connor Peripherals' (Lake Mary, FL) line of retail backup products. Conforming to Windows File Manager, the software lets you back up and restore your data by pointing and clicking on icons for drives, file servers, tapes, and logs. The software supports most standard SCSI tape devices that run under Windows.

Phone: (800) 541-2220 or (407) 262-8000.

Circle 1284 on Inquiry Card.

CONTROL ANIMATIONS

SoftVTR ($999), a software-based controller for use on PCs and Unix workstations, provides control of commercial and broadcast-quality VTRs (videotape recorders) and laser discs. From Moonlight Computer Products (San Diego, CA), the software puts the VTR control panel on your computer screen and lets you control in interactive or background modes. Features include frame-grabbing and rotoscoping.

Phone: (619) 625-0300.

Circle 1276 on Inquiry Card.

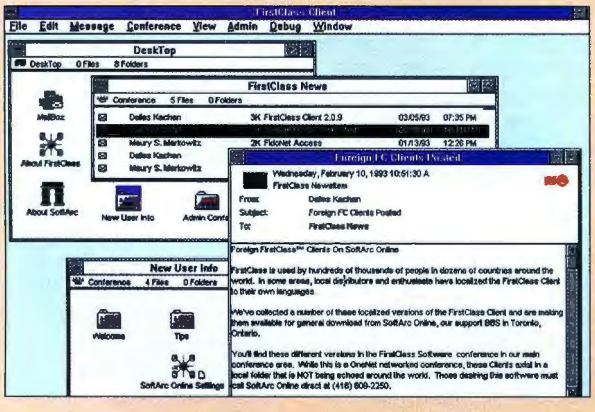
PC DIAGNOSTICS

CheckIt Pro: Tests & Tools ($149.95), a troubleshooting diagnostic utility, tests PC hardware with explicit interpretation of results to identify faulty components. You can use the custom test applets to build a variety of diagnostic suites and run them as part of your own custom batch file or menu. An advanced virus-scanning module can catch more than 2000 viruses, according to developer TouchStone Software (Huntington Beach, CA).

Phone: (800) 531-0450 or (714) 969-7746.

Circle 1143 on Inquiry Card.

MAC AND WINDOWS CONFERENCING



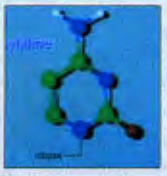
FirstClass Client for Windows (US$295), a front end for SoftArc's FirstClass E-mail conferencing system, lets clients use a Mac or Windows to access the same nondedicated FirstClass server without need of additional hardware. All connections are over the same Ethernet cable via log-ins over IPX, AppleTalk, and modems. The software accepts up to 250 users simultaneously, allowing Mac and Windows PC users to talk in real time.

Contact: SoftArc, Inc., Scarborough, Ontario, Canada, (416) 299-4723.

Circle 1133 on Inquiry Card.

Software Update

chemExhibit for Windows 2.0 ($595), Molecular Arts (Anaheim, CA), enables an unlimited number of diagram templates; adds Windows



common dialog boxes and hot keys, arrow tool palette in drawing tools, object stacking and grouping capabilities in object controls, additional query and identification capabilities in Select-3D, and additional molecule shading options in Visage-3D.

Phone: (714) 634-8100.

Circle 1288 on Inquiry Card.

PowerTools 1.1 ($895), Xionics (Peabody, MA), adds support for TWAIN and Xionics' Lightning cards, drivers for the Hewlett-Packard LaserJet 4 printer and Fujitsu M3097 scanner, document separators, new printing features, faster image panning, and multipage TIFF.

Phone: (508) 531-6666.

Circle 1291 on Inquiry Card.

Mathematica 2.2 (from $595), Wolfram Research (Champaign, IL), adds improved numeric functions and equation-solving capabilities, new interval arithmetic capabilities, more sophisticated symbolic capabilities, and enhanced solutions of symbolic differential equations.

Phone: (800) 441-6284 or (217) 398-0700.

Circle 1292 on Inquiry Card.

TapeWare 4.1 (from $299), Emeritus Technologies (Fresno, CA), adds file system agent for OS/2 and Unix; NetWare 3.x name space support for Mac, OS/2, and Unix files; NetWare user-level stratification; and enhanced file tracking.

Phone: (209) 292-8888.

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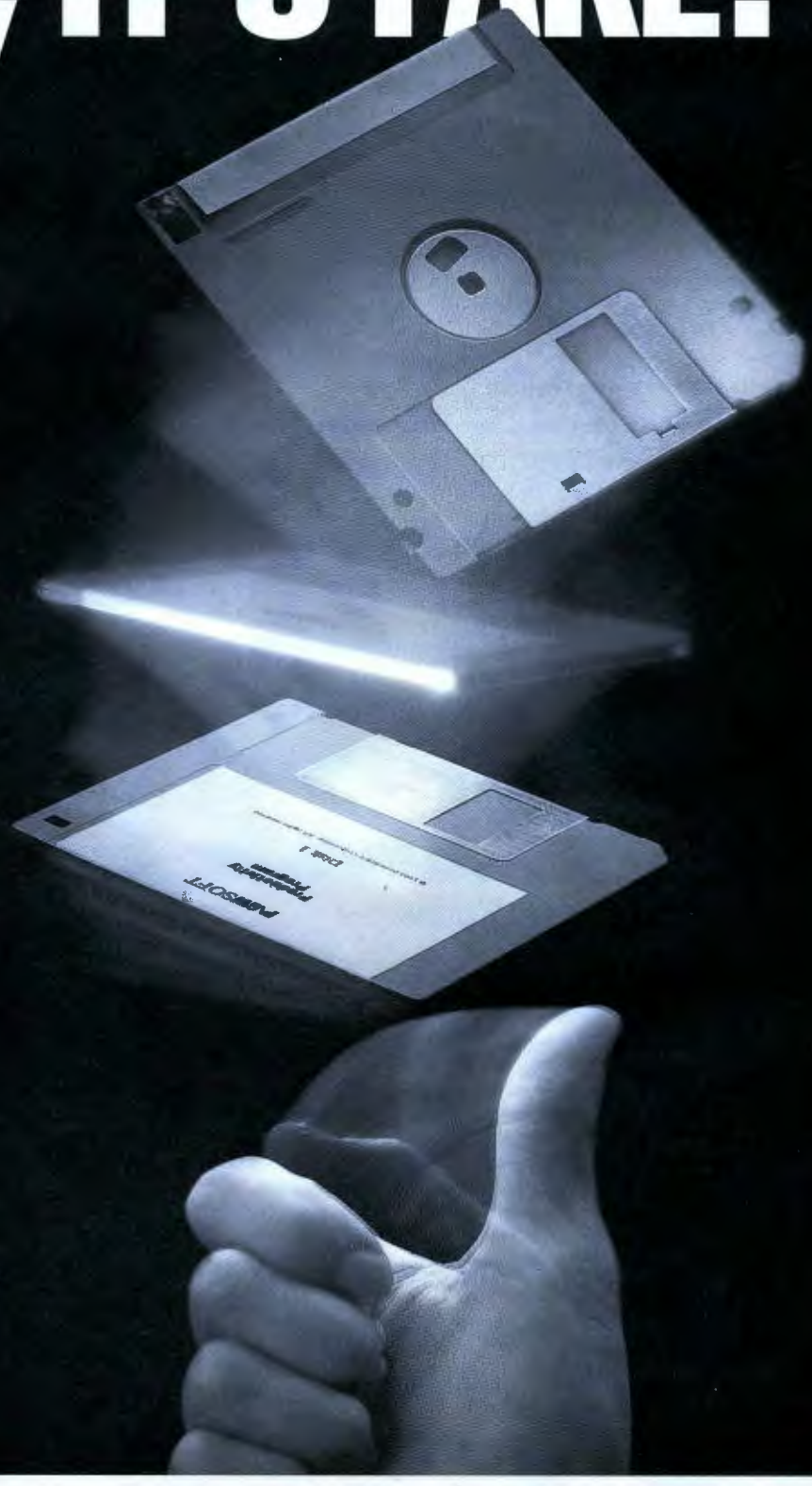
(800) 688-BSA1 (2721)



BSA Business Software Alliance

What's New Software

DATA-COMPRESSION HELP

A data-compression utility for DOS 6 DoubleSpace and Windows, SpaceManager ($89.95) from Vertisoft Systems (San Francisco, CA) augments DoubleSpace. Major features are SelectCompress, which provides additional compression; SuperMount, which negates the need for mount commands; SuperMonitor, which provides a graphical report of data compression; SuperExchange, which supports easy exchange of DoubleSpace-compressed disks; and FortuneTeller, which predicts the amount of remaining disk space available.

Phone: (800) 466-5875 or (803) 269-5311.

Circle 1139 on Inquiry Card.

ADD SERIAL I/O TO PC APPLICATIONS

The Software Wedge for Windows Professional Edition ($395) from T.A.L. Enterprises (Philadelphia, PA) lets you create sophisticated serial I/O interfaces between a device with a serial port and a Windows or OS/2 application. The software supports advanced data parsing and filtering capabilities, data formatting functions, and hexadecimal- or octal-to-decimal conversions. This edition lets you turn a spreadsheet cell into a serial input or output buffer and log data directly to a disk file in the background.

Phone: (800) 722-6004 or (215) 763-2620.

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DESIGN A BBS DATABASE

ModemBase Pro ($149) from Integrated Solutions (Riverside, CA) lets BBS system operators create custom-designed databases and incorporate them into the on-line services available on their BBSes. BBS callers can work with the database as they would with any other BBS conference.

Phone: (800) 633-6636 or (909) 780-8860.

Circle 1277 on Inquiry Card.

MORE THAN A DISK JACKET MAKER

The DirJacket System ($25) from The Flight House (Lake Forest, CA) lists the volume name and all files and directories, including hidden files, on a floppy disk, CD-ROM, tape, or fixed disk. MailJacket lets you print a disk mailer once you've entered the addressee and the return address into your computer.

Phone: (800) 795-4834 or (714) 768-3035.

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FAX FROM A PC IN WINDOWS

Any document you can print from a Windows application, you can fax from your PC with Open/image Fax for Windows ($995). From Wang Laboratories (Lowell, MA), the software includes APIs that let you fax an image window, screen, file, or document.

Phone: (508) 459-5000.

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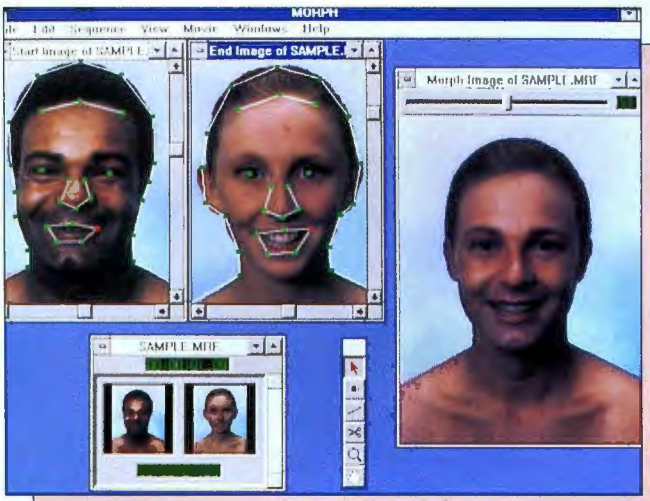


MORPH MIGRATES TO WINDOWS

Morph ($169) now works on PCs running Windows and lets them perform *morphing*, a 2-D special effect that transforms one still image into another. Able to use graphics generated from Windows-compatible painting or drawing programs or scanned images, Morph lets you place two images side by side on the computer screen. After matching key points on each image, you specify the number of intervening frames you want; Morph calculates the appearance of each frame and transforms one image into the other as an animation. You can save the resulting morph as a Video for Windows movie or as an animation on video tape or film. Single still images can be saved in file formats such as TIFF, GIF, and Targa.

Contact: Gryphon Software Corp., San Diego, CA, (619) 536-8815.

Circle 1134 on Inquiry Card.

Software Update

ZyIndex 4.0 for DOS (single user, $395; network, from $995), ZyLab (Buffalo Grove, IL), adds basic retrieval enhancements, unlimited index and file sizes, and new search capabilities.

Phone: (800) 544-6339 or (708) 459-8000.

Circle 1295 on Inquiry Card.

InterLend 2.0 ($495), TKM Software (Brandon, Manitoba, Canada), has enhanced functionality, especially in report generation.

Phone: (800) 565-6272 or (204) 727-3873.

Circle 1296 on Inquiry Card.

Windows Personal Librarian 3.0 ($995), Personal Library Software (Rockville, MD), adds native-mode document architecture, fuzzy-logic searching, PL-Admin in Windows, concurrent updating with transaction integrity, and simultaneous multiple database searches. PC or Mac.

Phone: (301) 990-1155.

Circle 1297 on Inquiry Card.

The Debt Analyzer 1.20 ($20), Insight Software Solutions (Bountiful, UT), adds the ability to select nine new debt priority payoff methods, print a summary report, view the sum of all debts and payments on-screen at all times, and use an effective-interest rate calculator.

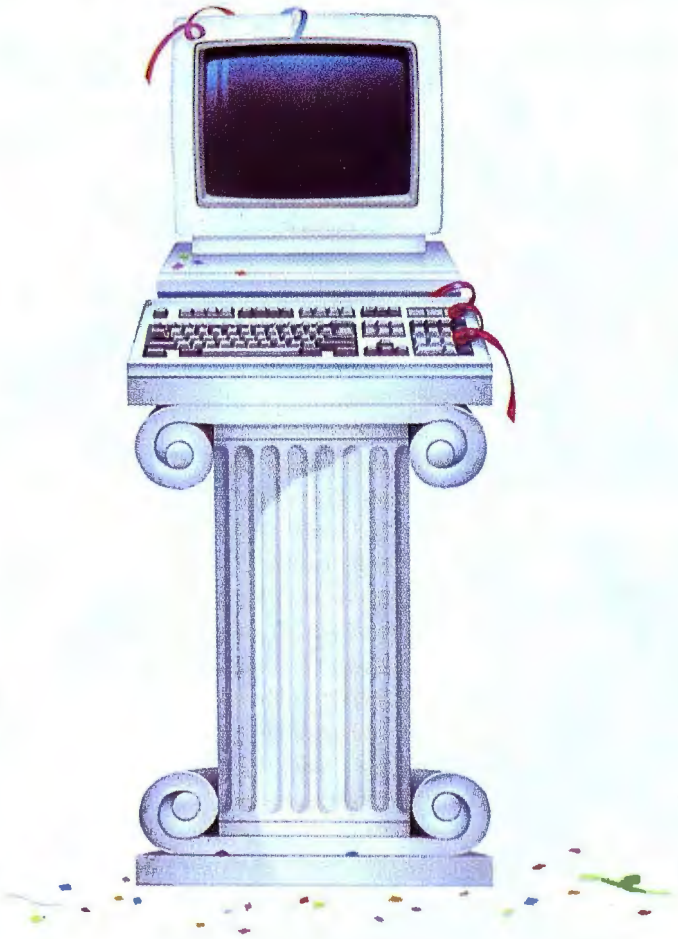
Phone: (801) 295-1890.

Circle 1298 on Inquiry Card.

HiQ 2.0 ($995), Bimillennium (Los Gatos, CA), adds a better GUI, new features in the Function Library, improved loop optimization, as well as easier data analysis and manipulation.

Phone: (800) 488-8662 or (408) 354-7511.

Circle 1290 on Inquiry Card.



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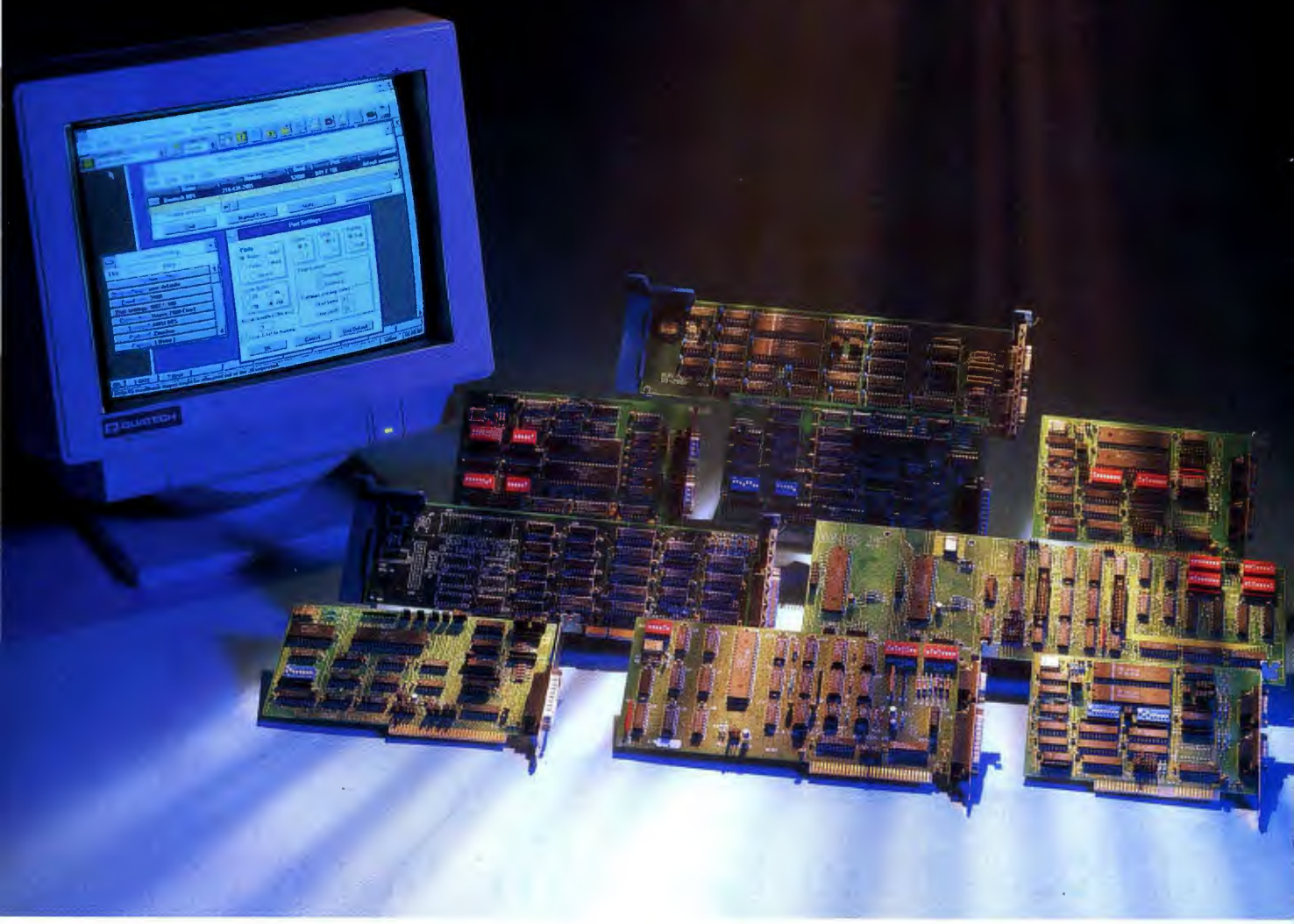

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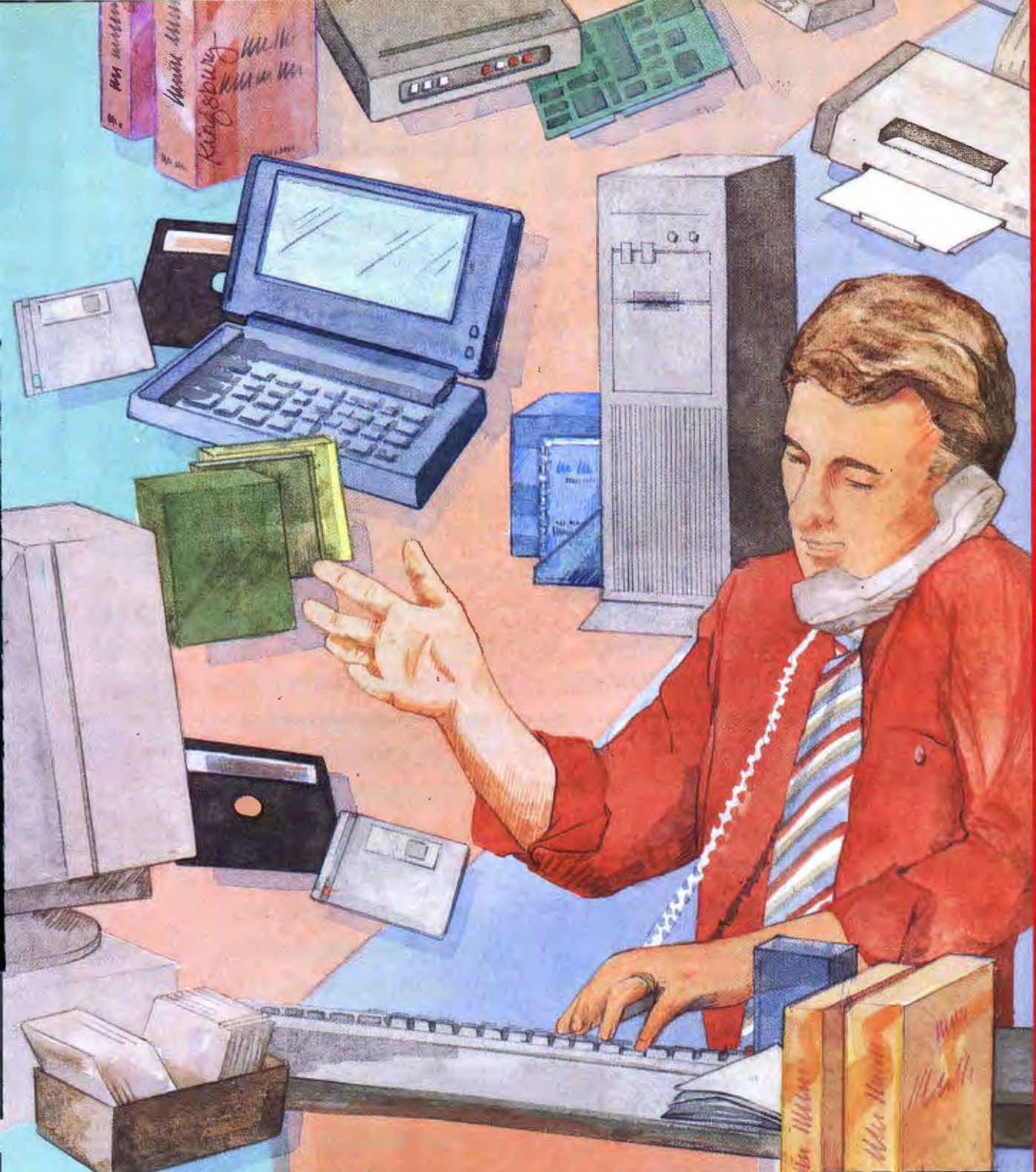

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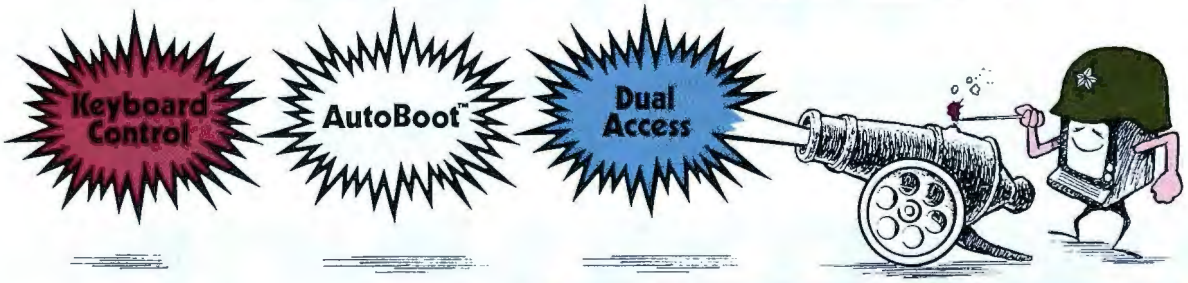

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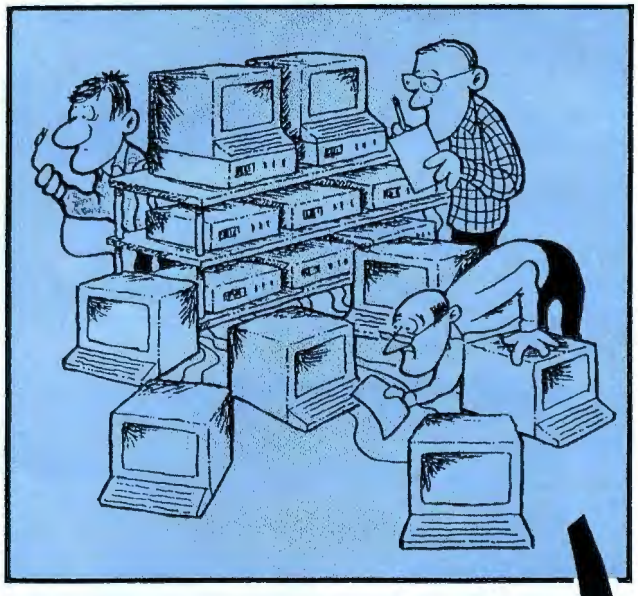

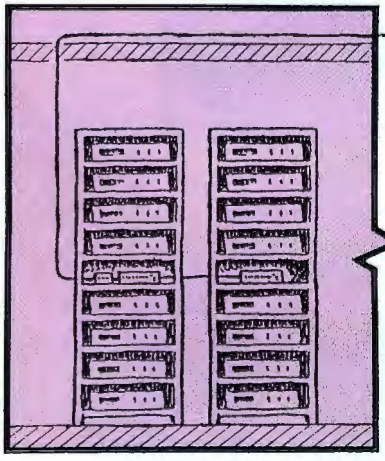

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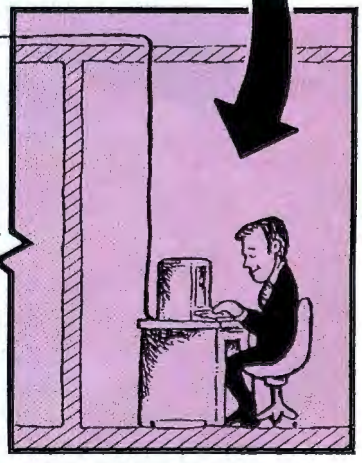

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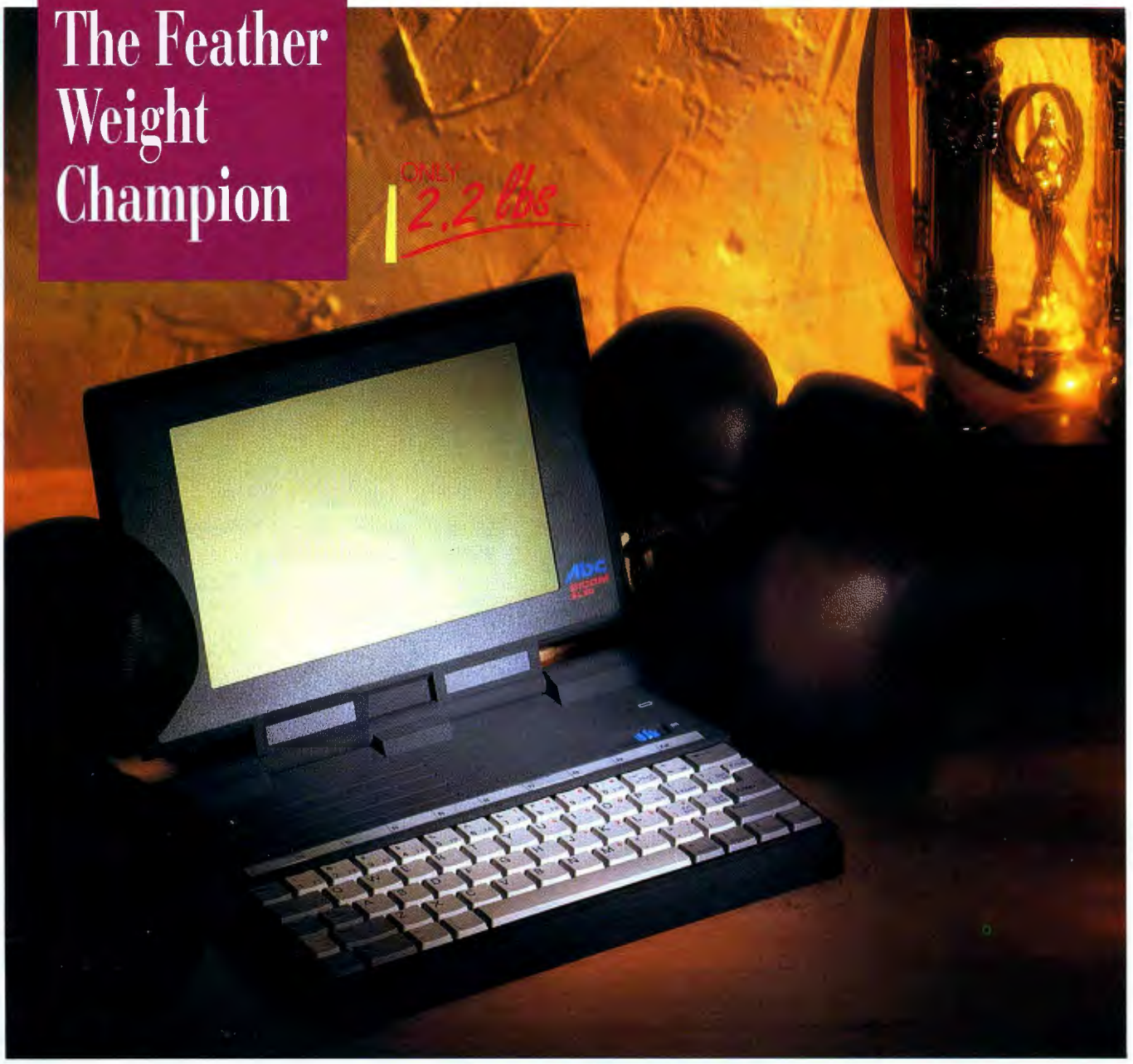

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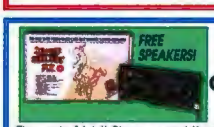

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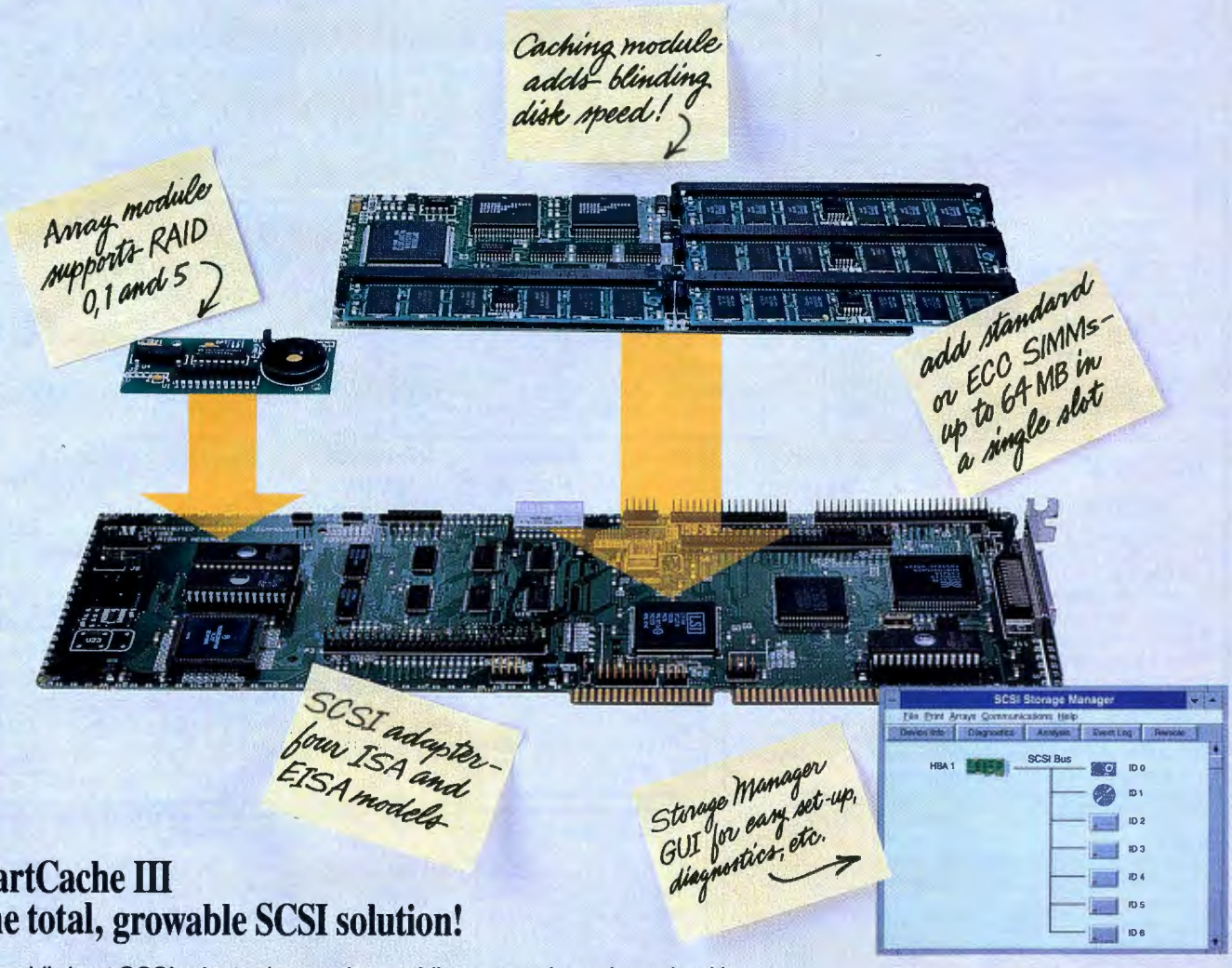

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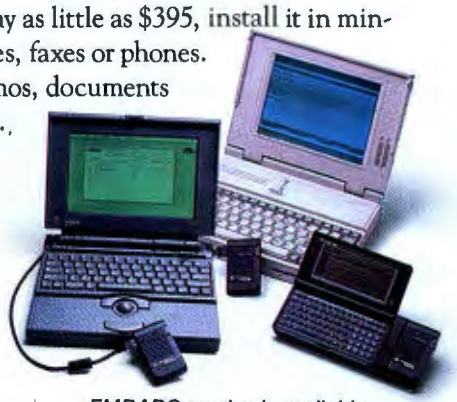

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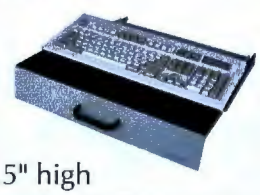

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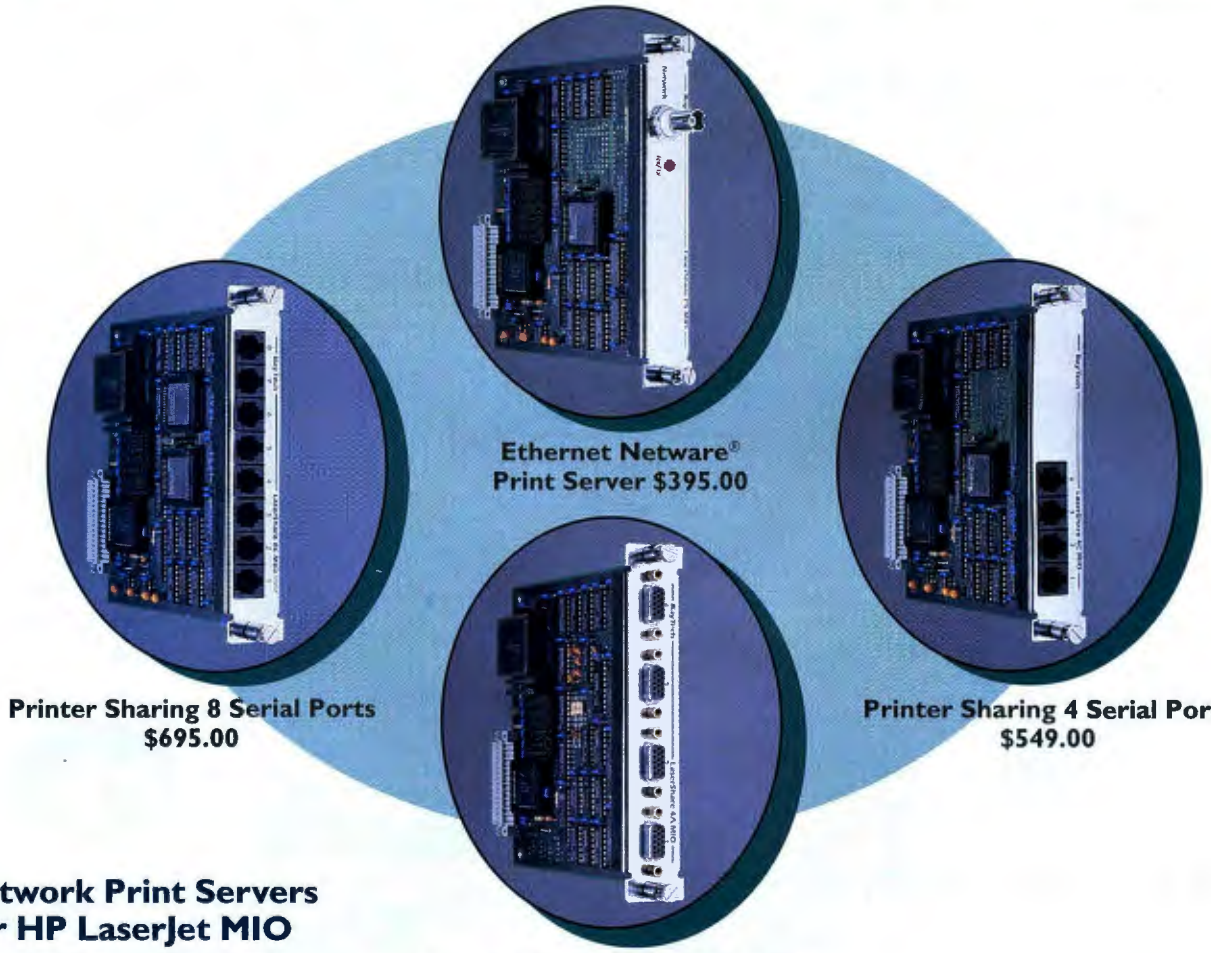

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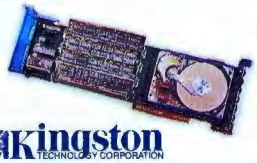

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T1600	2MB BOARD	PA8302U	$85
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	4MB CARD	PA2001U	$168
	8MB CARD	PA2002U	$328
T3100	2MB MOD	PA7135E	$199
T3100 E	2MB MOD	PA8341U	$88
T3100 SX	2MB BOARD	PA8308U	$88
	4MB BOARD	PA8310U	$158
T3200 SX	2MB MOD	PA8307U	$88
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T3200 SXC	2MB MOD	PA8318U	$88
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	4MB	113132-001	$178
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Deskpro 386-20E; 25E	4MB	113645-001	$239
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	2MB	118689-001	$85
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SLT386	1MEG MOD	118303-001	$79
	2MEG MOD	118304-001	$108
	4MEG MOD	118305-001	$199
Lte 286	1MEG BRD	117081-001	$79
	2MEG BRD	117081-002	$99
	4MEG BRD	117081-003	$218
Lte 386S/20	1MEG BRD	121125-001	$98
	4MEG BRD	121125-002	$179
Lte Lite/20, 25, 25C	2MEG BRD	129769-001	$138
	4MEG BRD	129769-002	$238
	8MEG BRD	129769-003	$398
	16MEG BRD		$1395
LTE Lite/20 & Lite/25,25C	16MB Card	N/A	$1045
Compaq Lte 486/25C	4MB Card	142337-002	$229
	8MB Card	142337-003	$378
	16MB Card	142337-004	$1198

Simm Modules

Prices change up and down call. Sipp modules, add $3.00 each

DESCRIPTION	100NS	80NS	70NS	60NS	53NS
256X9	$9	$11	$13	$18	
1MEGX3		$36	$37	$42	
1MEG X 9	$31	$39	$40	$44	$49
4MEG X 9		$144	$154	$179	
16MEG X 9			$699		
256X36 1MEG (72 Pin)		$50			
512X36 2MEG (72 Pin)		$85	$95		
1X36 4MEG (72 Pin)		$149	$159	$189	
2X36 8MEG (72 Pin)		$299	$318	$379	
4X36 16MEG (72 Pin)		$649	$699	$749	

D-Ram Chips

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64 X 4	$1.95	$2.25	$2.45	$2.95		
256X1 STATIC				$1.95	$2.25	
256 X 1	$1.05	$1.45	$1.90	$2.00	$2.05	$2.20
256 X 4			$4.45	$4.95	$5.45	$5.95
1MEG X 1			$3.95	$4.75	$5.45	$5.75
1MEGX1 STATIC				$4.95	$5.25	
1MEGX4				$17.00	$20.00	$24.00

CACHE MEMORY

	15ns	20ns	25ns
8X08	4.95	4.45	3.95
32X8	8.95	7.75	
64x1	9.95	8.45	
64x4	9.95	8.95	7.95
16x4	8.95	5.45	4.95
128x8		49.00	39.00

Laser Printer Memory

	1MEG	2MEG	3MEG	4MEG	5MEG	6MEG
Brother HL-8, 8E, 8D, 8V	$99	$149		$249		
Canon LBP4, 4 Lite & +	$118	$164				
Compaq Pagemark 15 & 20				$319		$638
Epson Action Laser II, 8000 ..	$95		$163		$229	
Epson + 6000 and many more		$98		$168		
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C and 550C	$59 (256K)					
HP2, 2D,	$89		$146			
3, 3D, 3P, 2P, 2P+	$103		$159			
HPIII SI	$50		$148			
HP Laser Jet 4, 111Si, XL300			$148			$289
IBM Laser 4019, 4019E (3.5MB)			$169			
IBM Laser 4029			$139			
NEC 90, 290	$118					
NEC 95	$128					
OKI 400	$99					
Packard Bell PB9500			$125		$178	
Panasonic 4410/4430			$119		$188	
Panasonic 4420/4450I	$89	$108			$178	
Panasonic 4450	$105					
Panasonic 4455	$139					
QMS 410	$129	$179			$249	
Star LS04	$129	$179			$269	
StarScript 4	$128	$178			$258	
Tosiba Page Laser 6		$119			$178	
TI XL/PS17/PS35	$48					

Major Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
AT&T Safari	2MB	37650	$128
	4MB	37651	$238
Bondwell B-310	1MB	23050-09100	$128
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$345
Dell Laptop 212, 320N; 320NT	1MB Mod	310-3203	$79
	2MB Mod	310-3204	$109
Dell 325N; NC; Notebook P.C.	2MB Mod	310-3210	$148
Dell NL20 & NL25 NITBK	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808501	$198
Epson NB-SL/20;25	2MB Mod	A808771	$138
25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$87
Everex Carrier	2MB	00263-00	$97
Grid 1500	4MB	52587	$198
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$88
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA165	$78
Samsung Notemaster 386S	2MB	SNM002	$195
	4MB	SNM004	$395
Sanyo 17N8; 18N8 & ZEOS	2MB	MBC-NBMEM2	$78
Sharp 6220	1MB	CE-6218	$98
Sharp 6640	2MB	N/A	$198
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$88
TI Travelmate 3000SX; WINSX	2MB	2566956-0001	$98
TI Travelmate 4000, WINDX/2S SX/16, SX25	4MB	2581265-001	$218

ZENITH MEMORY: CALL FOR ALL MODELS

AST COMPUTER Memory

MODEL#	MEMORY	PART#	PRICE
NOTEBOOK 286/12; 386SX/20	4MB MOD	500814-003	$168
NOTEBOOK EXEC SX/25; SX/25C	4MB MOD	500814-004	$168
POWER EXEC 3/25SL, 3/25SL-C	4MB MOD	500984-001	$168
	16MB MOD		$1298
AST POWER EXECL EL	2MB MOD	500984-004	$99
	4MB MOD	500984-001	$169
	8MB MOD	500984-002	$399
	16MB MOD	500984-003	$1245
POWER PREMIUM 486/50D	8MB EXP KIT	500780-001	$348
4/33; 3/33, 4/66D, PREMIUM II	16MB EXP KIT		$598
386/25, 33, 486/33; SX20	4-32 MB EXP BRD	500818-001	$348
AST PREMIUM 386C/386-16	4MB KIT	500510-008	$179
AST PREMIUM 386	4MB KIT	500510-004	$198
AST PREMIUM II, 386SX/16; 386SX/20, 486 37 & 33T	4MB MOD	500780-004	$198
BRAVO LC 425S, 4/33S, 4/50D, 4/66D	2MB KIT	500987-001	$98
	4MB MOD	500987-002	$168
	8MB KIT	500987-003	$348
	16MB		$649
	32MB		$1200

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Quantum

FACTORY NEW – 2 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
80MB	NOTEBOOK	16MS	2.5"	$259
120MB	NOTEBOOK	16MS	2.5"	329
160MB	NOTEBOOK	16MS	2.5"	489
42MB	ELS42A	19MS	3.5X1"	139
52MB	LPS52A	11MS	3.5X1"	149
85MB	ELS85A	17MS	3.5X1"	179
105MB	LPS105A	12MS	3.5X1"	199
120MB	LPS120A	FAST	3.5X1"	309
127MB	ELS127A	17MS	3.5X1"	229
170MB	ELS170A	17MS	3.5X1"	269
240MB	LPS240A	FAST	3.5X1"	339
425MB	PD425A	11	3.5"	895
525MB	LPS525AT	FAST	3.5X1"	899
SCSI				
42MB	ELS42S	19MS	3.5X1"	159
52MB	LPS52A	11MS	3.5X1"	199
85MB	ELS85S	17MS	3.5X1"	199
105MB	LPS105S	11MS	3.5X1"	249
120MB	LPS120S	FAST	3.5X1"	289
127MB	ELS127S	17MS	3.5X1"	269
170MB	ELS170S	17MS	3.5X1"	299
240MB	LPS240S	FAST	3.5X1"	379
425MB	PD425S	11MS	3.5"	879
525MB	LPS525	FAST	3.5X1"	899
700MB	PD700	10	3.5"	1199
2.1GB	P1225	10	3.5"	1399

FUJITSU

FACTORY NEW – 5 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
330MB	M2622T	12MS	3.5"	$599
425MB	M2623T	12MS	3.5"	790
520MB	M2624T	12MS	3.5"	819
SCSI				
425MB	M2623FA	11MS	3.5"	829
520MB	M2624FA	11MS	3.5"	919
1.2GB	M2694SA	10MS	3.5"	1499
1.2GB	M2266SA	14MS	FH	1199
2.0GB	M2652SA	11MS	FH	1999
2.4GB	M2654SA	12MS	FH	2249

Maxtor

FACTORY NEW – FULL WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
80MB	7080A	15MS	3.5X1"	$199
120MB	25120A	15MS	2.5"	329
130MB	7120A	15MS	3.5X1"	209
213MB	7213A	15MS	3.5X1"	299
245MB	7245A	15MS	3.5"	319
340MB	LXT340A	15MS	3.5"	589
535MB	LXT535A	12MS	3.5"	879
SCSI				
130MB	7120S	15MS	3.5X1"	239
213MB	7213S	15MS	3.5X1"	339
340MB	LXT340S	15MS	3.5"	549
535MB	LXT535S	12MS	3.5"	899
540MB	MAGIK540	8MS	3.5X1"	1049
1.2GB	MAGIK1240	8MS	3.5"	1599
1.2GB	PO12S	13MS	FH	1199
1.7GB	P117	13MS	FH	1459

TOSHIBA

CAPACITY	M/N	SPEED	SIZE	PRICE
SUPERFAST SCSI-2				
877MB	MK438FB	12MS	3.5"	$999
1.2GB	MK538FB	12MS	3.5"	1239

MICROPOLIS

FACTORY NEW – 5 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
SCSI				
340MB	MC1684	14MS	HH	$699
670MB	MC1624	14MS	HH	1069
1.2GB	MC2112	10MS	3.5"	1499
1.2GB	MC1598	15MS	FH	1299
1.5GB	MC1528	15MS	FH	1579
1.6GB	MC1908	11MS	FH	1749
2.0GB	MC1548	14MS	FH	1739
2.4GB	MC1924	11MS	FH	2379
3.6GB	MC1936	11MS	FH	3599

Seagate

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
42MB	ST351	19MS	3.5X1"	$139
107MB	ST3120	15MS	3.5X1"	209
130MB	ST3144A	16MS	3.5X1"	229
240MB	ST3283A	12MS	3.5X1"	399
SCSI				
240MB	ST3283N	12MS	3.5X1"	399
670MB	ST4766N	14MS	FH	1139
670MB	ST4767N	11MS	FH	1399
1.2GB	ST11200N	10MS	3.5"	1299
1.2GB	ST41200NK	14MS	FH	1199
1.6GB	ELITE-I	11MS	FH	1699
1.6GB	ST41651	14MS	FH	1749
2.1GB	ST42100N	14MS	FH	1999
2.4GB	ELITE-II	11MS	FH	2599
3.4GB	ELITE-III	11MS	FH	3699

HEWLETT PACKARD

FACTORY NEW – 5 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
SCSI				
1.2GB	C2247	10MS	3.5"	$1599
1.2GB	C97556	13MS	FH	1599
1.6GB	C3009	12MS	FH	2699
2.0GB	C3010	12MS	FH	2899

WESTERN DIGITAL

FACTORY NEW – 2 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
80MB	WD280	16MS	3.5X1"	$189
120MB	WD2120	14MS	3.5X1"	229
170MB	WD1170	15MS	3.5X1"	259
212MB	WD2200	12MS	3.5X1"	309
250MB	WD2250	14MS	3.5X1"	369
340MB	WD2340	12MS	3.5X1"	489

CONNER

FACTORY NEW – 1 YEAR WARRANTY

CAPACITY	M/N	SPEED	SIZE	PRICE
IDE				
40MB	CP3000	25MS	3.5X1"	$139
80MB	CP30084	19MS	3.5X1"	169
120MB	CP30104H	19MS	3.5X1"	215
170MB	CP30174E	17MS	3.5X1"	249
212MB	CP30204	12MS	3.5X1"	319
250MB	CP30254	14MS	3.5"	349
540MB	CP3544	12MS	3.5"	849
540MB	CP30544	17MS	3.5X1"	CALL
SCSI				
80MB	CP30080	19MS	3.5X1"	199
170MB	CP30170	17MS	3.5X1"	279
212MB	CP30200	12MS	3.5X1"	329
540MB	CP3540	12MS	3.5"	889

MATH CO-PROCESSORS

INTEL		CYRIX		IIT	
8087 5MHZ INTEL	49.00	83D87DX-16 16MHZ CYRIX	84.00	2C87-8 8MHZ IIT	54.00
8087-2 8MHZ INTEL	69.00	83D87DX-20 20MHZ CYRIX	84.00	2C87-10 10MHZ IIT	54.00
8087-1 10MHZ INTEL	89.00	83D87DX-25 25MHZ CYRIX	84.00	2C87-12 12MHZ IIT	60.00
80287-6 6MHZ INTEL	49.00	3D87DX-33 33MHZ CYRIX	84.00	2C87-20 20MHZ IIT	64.00
80287-8 8MHZ INTEL	49.00	83D87DX-40 40MHZ CYRIX	94.00	2C87-20 20MHZ IIT	84.00
80287-10 10MHZ INTEL	59.00	83S87SX16 16MHZ CYRIX	74.00	3C87-16 16MHZ IIT	84.00
80287XL 10MHZ INTEL	75.00	83S87SX20 20MHZ CYRIX	74.00	3C87-20 20MHZ IIT	84.00
80287XLT 12MHZ INTEL	75.00	83S87SX25 25MHZ CYRIX	74.00	3C87-25 25MHZ IIT	84.00
80387SX-16 16MHZ INTEL	85.00	82S87XL CYRIX	74.00	3C87-33 33MHZ IIT	84.00
80387SX-20 20 HZ INTEL	85.00			3C87-40 40MHZ IIT	94.00
80387DX-16 16MHZ INTEL	89.00	**WEITEK**		3S87SX-16 16MHZ IIT	70.00
80387DX-20 20MHZ INTEL	89.00	3167-20MHZ WEITEK	295.00	3S87SX-20 20MHZ IIT	70.00
80387DX-25 25MHZ INTEL	89.00	3167-25MHZ WEITEK	395.00	3S87SX-25 25MHZ IIT	70.00
80387DX-33 33MHZ INTEL	89.00	3167-33MHZ WEITEK	495.00	3S87SX-33 33MHZ ITT	80.00
80487SX-25 INTEL	479.00	4167-25MHZ WEITEK	445.00		
OVERDRIVE SX/DX33	749.00	4167-33MHZ WEITEK	695.00		
OVERDRIVE SX/DX25	599.00				
OVERDRIVE SX/DX20	499.00				
RAPID CAD	289.00				

SIMM-SIPP MODULES

4MB X 9-80NS SIMM-PC	135	256K X 9-100NS SIMM	10	1MB X 9-70NS SIPP	CALL
4MB X 9-70NS SIMM	145	256K X 9-80NS SIMM	12	1MB X 9-60NS SIPP	CALL
4MB X 9-60NS SIMM	165	256K X 9-70NS SIMM	12	256K X 9-100NS SIPP	CALL
1MB X 9-100NS 9 CHIP SIMM	33	256K X 9-60NS SIMM	13	256K X 9-80NS SIPP	CALL
1MB X 9-80NS 3 CHIP SIMM	32	1MB X 8-80NS SIMM	CALL	256K X 9-70NS SIPP	CALL
1MB X 9-80NS 9 CHIP SIMM	35	1MB X 8-70NS SIMM	CALL	256K X 9-60NS SIPP	CALL
1MB X 9-70NS 3 CHIP SIMM	33	4MB X 8-80NS SIMM	CALL	256 X 36 – 1MB	50
1MB X 9-70NS 9 CHIP SIMM	36	4MB X 8-70NS SIMM	CALL	512 X 36 – 2MB	85
1MB X 9-60NS 3 CHIP SIMM	35	1MB X 9-100NS SIPP	CALL	1 X 36 – 4MB	149
1MB X 9-60NS 9 CHIP SIMM	38	1MB X 9-80NS SIPP	CALL	2 X 36 – 8MB	299
1MB X 9-53NS 3 CHIP SIMM	50			4 X 36 – 16MB	675
1MB X 9-53NS 9 CHIP SIMM	54				
16MB X 9-70NS SIMM	675				

Apple

- POWERBOOK 100, 140, 145, 170
- 2MB MOD M1032LL A $ 99
- 4MB MOD M1033LL A 199
- 6MB MOD N A 284
- POWERBOOK 160, 180
- 2MB MOD N A 130
- 4MB MOD N A 200
- 6MB MOD N A 285
- 8MB MOD N A 380
- 10MB MOD N A 480
- POWERBOOK 210, 230
- NOTE: THERE ARE THREE TYPES OF MODULES FOR MODELS 210 & 230 "UPGRADABLE", "BASE" AND "CONVENTIONAL". BE SURE TO PURCHASE THE CORRECT ONE FOR YOUR NEEDS
- CONVENTIONAL (STANDARD)
- 2MB MOD N A 175
- 4MB MOD N A 280
- 6MB MOD N A 400
- 8MB MOD N A 500
- 10MB MOD N A 695
- 12MB MOD N A 795
- BASE - WILL ACCEPT 1 UPGRADE MODULE
- 4MB MOD N A 380
- 6MB MOD N A 580
- 12MB MOD N A 895
- 20MB MOD N A 2300
- UPGRADE MODULES - INSTALL ON THE BASE MODULES
- 4MB MOD N A 295
- 8MB MOD N A 595
- 16MB MOD N A 2300
- MAC PORTABLE
- 2MB MOD N A 339
- 3MB MOD N A 529
- 4MB MOD N A 662
- MAC PORTABLE BACKLIT
- 2MB MOD N A 232
- 3MB MOD N A 319
- 4MB MOD N A 395
- IIGS
- 1-4MB E-C N A 149
- MAC PLUS
- 2MB KIT MO219 88
- 4MB KIT MO2707 136
- MAC CLASSIC
- 1-3MB E-C M6361LL-A 88
- 2MB KIT MO219 88
- MAC CLASSIC II, LC, LCII
- 2MB KIT MO219 88
- 4MB KIT N A 136
- 8MB KIT N A 260
- MAC SE
- 2MB KIT MO219 88
- 4MB KIT MO27007 136
- MAC SE/30
- 4MB KIT MO2707 138
- 16MB KIT N A 610
- MAC II
- 4MB KIT MO2707 136
- MAC IIX
- 4MN KIT MO2707 136
- 16MB KIT N A 525
- MAC LC
- 2MB KIT MO219 88
- 4MB KIT N A 140
- 8MB KIT N A 280
- 512K VRAM 47
- MAC IISI IICI
- 2MB MOD M0514LL A 88
- 4MB KIT MO2707 138
- 16MB KIT N A 575
- 32MB KIT N A 1050
- 64MB KIT N A 1995
- MAC IIFX
- 4MB KIT M0378LL-A 185
- 16MB KIT N A 595
- 64MB KIT N A 1990
- MAC IICX
- 4MB KIT MO2707 136
- 16MB KIT N A 575
- 32MB KIT N A 1050
- MAC QUADRA 700, 900, 950
- 4MB KIT MO2707 136
- 16MB KIT N A 575
- 32MB KIT N A 1050
- 64MB KIT N A 1995
- QUADRA VIDEO 700, 900
- 512K KIT M5951LLA 82
- QUADRA VIDEO 950
- 512K KIT M593LLA 70
- PERSONAL LASER WRITER LS
- 512K KIT 3340114 35
- PERSONAL LASER WRITER NT
- 2MB KIT MO219 88
- 8MB KIT N A 299
- LASERWRITER IINTX (INTL)
- 1MB KIT M6005 87
- 3MB KIT M6006 143
- LASERWRITER IIF/IIG
- 4MB KIT MO2727 136
- 16MB KIT N A 575
- LASER WRITER IINTR
- 2MB 110
- MAC IIVX
- 4MB KIT MO292LLA 138
- 16MB KIT N A 575
- 32MB KIT N A 1050
- 64MB KIT N A 1995
- MAXIMA MEMORY MGR 58

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ALR

- ALR BUSINESS VEISA
- ALR BUSINESS VEISA ARRAY
- ALR MPS
- 4MB KIT 12904000 156
- 16MB KIT 12916000 625
- 0-32MB E C 12407480 182
- ALR BUSINESS STATION
- ALR POWER PRO
- ALR POWER PRO ARRAY
- ALR POWER PRO/MC
- ALR POWER FLEX FLYER 20CX
- 4MB KIT 12904000 156
- 16MB KIT 12916000 625
- ALR POWER CACHE 486-486E
- ALR MICROFLEX 3600
- 2MB KIT 12902000 80
- 4MB KIT 12904000 156
- 16MB KIT N A 625
- 32MB KIT N A 1250
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- 1MB 32LCT ONLY 53
- 4MB 17901804 155
- 16MB 17904816 695
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- 4MB MOD 12928010 340
- 8MB MOD 12928016 649
- 16MB MOD N A 1949
- VENTURA NOTEBOOK 16 & 20
- 1MB MOD 12407980 109
- 4MB MOD 12407970 390

AST

- AST PREMIUM EXEC 286 12 386SX 20
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- 4MB MOD 500814003 140
- AST PREMIUM EXEC 386SX 25 25C, 25SL, 25SLC
- 4MB MOD 500814004 140
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- 4MB KIT 500510008 170
- BRAVO 486 25, 4-23
- 2MB KIT 500718004 88
- 8MB KIT 500780001 312
- BRAVO 3-25S
- 2MBN KIT 500710004 95
- 8MB KIT 500824002 280
- BRAVO 3-33LC
- 2MB KIT 500962001 90
- 8MB KIT 500962002 280
- BRAVO 386SX
- 2MB KIT 500510002 85
- 4MB KIT 500510008 170
- BRAVO 386SX20
- 2MB KIT 500710003 86
- 8MB KIT 500824001 270
- BRAVO 425S 433LC, 450D, 466D
- 2MB KIT 500987001 100
- 4MB MOD 500987002 150
- 8MB KIT 500987003 290
- 16MB MOD 500987004 525
- 32MB KIT 500987005 1250
- PREMIUM II 386/25, 33, 386SX/20, 486/33, 486SX/20, PREMIUM 386SX 16, 486/33E, PREMIUM 386/33TE, 486/33TE
- 1MB MOD 500780003 43
- 2MB KIT 500780005 86
- 4MB MOD 500780004 140
- 8MB KIT 500780001 312
- 0-32MB E-C 500816001 279
- OFFICE ADVANTAGE 386SX/20, 486SX 20
- 2MB KIT 500891001 88
- 8MB KIT 500891007 290
- PREMIUM 386
- 4MB 500510004 214
- POWER PREMIUM 3/33, 4/33 & 4/50
- 2MB KIT 500780005 88
- 8MB KIT 500780001 312
- PREMIUM WEST 286, 386SX
- 2MB KIT 500510002 78
- 4MB KIT 500510008 170
- PREMIUM 386/16,C
- 4MB KIT 500510008 170
- PREMIUM SE 4/33
- 2MB KIT 500780005 88
- 8MB KIT 500780001 312
- PREMIUM SE 4/50
- 16MB KIT 500928001 690
- 32MB KIT 500928002 1300

HP

- HP VECTRA 286 12, ES12PC
- 2MB KIT D1354A 78
- 0-16MB E C 129
- 386 16N, 20N
- 2MB KIT D2406A 79
- 8MB KIT D2404A 295
- QS 16S, RS25PC 20PC, 20C
- 2MB KIT D1354A 84
- 386-25PC, 486UPC
- 2MB MOD D2381A 84
- 8MB MOD D2152A 299
- 486-20PC, 486PC, 486/25T, 486/33T
- 1MB MOD D2150A 47
- 2MB MOD D2381A 84
- 4MB MOD D2156A 163
- 8MB MOD D2152A 299
- 9000/375, 380, 345, 400DL, 400S, 400T, 425S
- 8MB KIT H98229B 480
- 16MB KIT H98229D 852
- 32MB KIT H98229E 1480
- 9000/425T
- 4MB KIT H98229C 275
- 8MB KIT H98229B 450
- 16MB KIT H98229D 850
- 9000 433S
- 4MB KIT H9229C 275
- 9000 425E
- 4MB KIT A2200A 275
- 8MB KIT A2201A 450
- 16MB KIT A2202A 850
- 9000 720, 730
- 16MB KIT A1979A 875
- 32MBN KIT A2512A 1625
- 9000 750
- 16MB KIT A1979A 875
- 32MB KIT A1987A 1585
- 9000 705, 710
- 8MB KIT A2216A 395
- 16MB KIT A2217A 790
- 32MB KIT A2218A 1385
- X-STATION 700RX
- 1MB MOD C2320A 50
- 2NBN MOD C2321A 90
- 4MB MOD C2322A 153
- 8MB MOD D2152A 299
- DESKJET 500C, 500 PLUS, 550C
- 256KB MOD H2270?B 64
- LASERJET II, IID
- 2-4 E C H33444B 102
- 4MB E-C H33445B 160
- LASERJET IIP, III, IIID, IIIP
- 2-4MB E C H33475B 98
- 3-4MB E-C H33476B 125
- 4MB E C H33477B 150
- LASERJET IIISI
- 4MB MOD C2065A 140
- 8MB MOD N A 299
- HP-4
- 4MB MOD N A 149
- 8MB MOD N A 299
- HP LASERJET FAX
- 1MB 80
- PAINTJET XL300
- 0K EXP BD 88

ALR

- ALR POWERFLEX
- ALR FLEX CACHE 386SX
- 2MB KIT 12902000 $ 80
- 4MB KIT 12904000 156

TOSHIBA

- T1000SE
- 1MB C C PCPA8311U $ 75
- 2MB C C PCPA8312U 100
- T1000LE
- 1MB C C [illegible] 75
- 2MB C C [illegible] 100
- 4MB C C [illegible] 160
- 8MB C C [illegible] 300
- T1000XE
- 1MB C C PCPA8311U 75
- 2MB C C PCPA8312U 100
- T2000
- 1MB C C PC18PA8316U 95
- 2MB C C PC18PA8317U 100
- 4MB C C PC1XPA8314U 160
- 8MB C C PC1XPA8315U 300
- T2000SX
- 4MB C-C PC14PA8314U 172
- 8MB C-C PC14PA8315U 300
- T2000SXE, T2200SX, T1600, T1850, T1850C
- 2MB C C PCPA2000U 109
- 4MB C C PCPA2001U 169
- 8MB C C PCPA2002U 300
- T3300SL
- 2MB C-C PCPA2006U 130
- 4MB C C PCPA2007U 174
- 6MB C-C PCPA2008U 246
- 8MB C-C PCPA2009U 375
- 16MB C C PCPA2010U 750
- T4400SX, T4400SXC, T4400-C
- 2MB C C PCPA2003U 120
- 4MB C-C PCPA2004U 220
- 8MB C-C PCPA2005U 375
- 16MB C C PCPA2010U 725
- 32MB C C N A 3050
- T1200XE
- 2MB MOD PC13PA8306U 95
- T1600
- 2MB MOD PC8PA8307U 95
- T3100
- 2MB MOD PC3PA7135E 204
- T3100E
- 2MB KIT PC9PA8341U 95
- T3100SX
- 2MB MOD PC15PA8308U 98
- 4MB MOD PC15PA8310U 144
- T3200
- 3MB MOD PC6PA7132U 170
- T3200SX
- 2MB KIT PC12PA8307U 95
- 4MB KIT PC12PA8309U 170
- T3200SXC
- 2MB KIT PC19PA8318U 95
- 4MB KIT PC19PA8319U 170
- T5100, T5100C
- 2MB MOD PC7PA8301U 99
- T5200, T5200C, T8500
- 2MB KIT PCPA8304U 90
- 8MB KIT PCPA8311U 310
- T4500, T4500C
- 4MB C C PCPA416U 250
- 8MB C C PCPA2011U 445
- 16MB C C N A TBA
- PAGELASER 6
- 2-4MB E C NB009G 114
- 4MB E C NB0100 174

brother

- HL-4, 4V, 4PS
- 1MB E C MB410 $ 125
- 2MB E C MB420 185
- 4MB E C MB440 245
- HL-8, -8E, -8D, -8V
- 1MB E C MB810 88
- 2MB E C MB820 125
- BROL1-410, BROL2-420
- 1MB KIT N A 49
- HL10DV, 10PS
- 2MB E-C N A 185
- 4MB E C N A 245

NEC

- ULTRALITE 286F
- 1MB MOD PC2221 $ 90
- 4MB MOD PC2222 199
- ULTRALITE SX/20
- 2MB MOD PC4421 157
- 8MB MOD PC4422 430
- ULTRALITE SL/20, SL/20P
- 6MB MOD PC4921 299
- ULTALITE III, SL25C
- 2MB MOD PC4721 164
- 4MB MOD PC4722 299
- 8MB MOD PC4723 525
- PROSPEED 286
- 1MB MOD PC2121 68
- 2MB MOD PC2126 150
- 4MB MOD PC2122 225
- PROSPEED 386
- 2MB MOD PC3121 150
- 8MB MOD PC3122 429
- PROSPEED 386SX
- 1MB MOD PC2121 98
- 2MB MOD PC2126 150
- 4MB MOD PC2122 225
- PROSPEED 386SX/20
- 1MB MOD PC4321 80
- 4MB MOD PC4322 199
- PROSPEED 486SX, 486SX/C
- 1MB MOD OP4106204 42
- 4MB MOD OP4106205 165
- POWERMATE PORTABLE SX
- 2MB E-C APCH751X 199
- 8MB E-C APCH753-754 695
- POWERMATE PORTABLE PLUS
- 1-3MB E-C APCH750U 179
- 2-3MB E-C N A 245
- 3MB E C N A 295
- POWERMATE 386/16, 20
- 4-16MB E-C N A 495
- 8-16MB E C N A 675
- POWERMATE SX
- 2MB E-C APCH855 275
- 4-8MB E-C APCH653 358
- 8MB EC N A 495
- POWERMATE SX PLUS
- 2MB E-C N A 278
- 4-8MB E-C APC852E 378
- 8MB E C N A 578
- POWERMATE SX 16
- 2-8MB E-C OP4108201 213
- 2MB KIT N A 84
- POWERMATE SX/20
- 2MB CPU MODULE OP4108101 172
- 2-8MB E-C OP4108102 213
- 2MB KIT N A 84
- POWERMATE SX 16I, SX/20I, SX/20VI
- 2MB KIT OP4108103 84
- 8MB KIT OP4102101 320
- POWERMATE 286C, 286 PLUS
- 1-3MB E-C APCH250K 195
- 2-3MB E-C N A 245
- 3MB E C N A 295
- POWERMATE 386/20
- 2MB MOD APCH655E 299
- 8MB MOD APCH656E 699
- POWERMATE 386/25, 386SX25
- 2MB MOD APCH655X 285
- 8MB MOD APCH656X 725
- 8MB 8MB APCH657X 725
- POWERMATE 386-25S
- 2MB KIT OP4105201 92
- 4MB KIT OP4105203 174
- 8MB KIT OP4105202 330
- POWERMATE 386/33E 486/25E
- 2MB MOD OP4105131 195
- POWERMATE 386/33I
- 1MB MOD OP4106204 62
- 4MB MOD OP4106205 180
- 16MB MOD OP4106206 699
- POWERMATE 486/33I
- 2MB KIT OP4108103 84
- 8MB KIT OP4102101 295
- POWERMATE EXPRESS 486/33E, 50E, 486SX/20E, 25E
- POWERMATE EXPRESS TOWER 486/25TE, 33TE, 50E, 486/SX25TE
- 1MB MOD OP4106204 99
- 4MB MOD OP4106205 225
- 16MB MOD OP4106206 675
- SILENTWRITER MODEL 90 & 25E
- 2MB MOD OP4892 138
- SILENTWRITER MODEL 95
- 2MB MOD 9502 125
- SILENTWRITER MODEL 2
- 2MB MOD 4897 130

COMPAQ

- LTE 8088 PROCESSOR
- 512K MOD 117077001 $ 107
- LTE 286
- 1MB KIT 117081001 86
- 2MB KIT 117081002 86
- 4MB KIT 117081003 175
- LTE 386S 20
- 4MB C C 121175002 182
- LTE LITE 20, 25
- 2MB C-C 129769001 120
- 4MB C C 129769002 190
- 8MB C C 129759003 380
- 16MB C C N A 1295
- SLT 286
- 1MB MOD 110235001 80
- 4MB MOD 110237001 218
- SLT 386S 20
- 4MB MOD 118305001 189
- PORTABLE III
- 2MB KIT 117332001 80
- INTERFACE 107808001 110
- EXP BOARD 107811001 250
- PORTABLE 386
- 1MB KIT 107651001 110
- INTERFACE 107207001 125
- 4MB E-C 107653001 349
- 4MB ADM 107654001 349
- PORTABLE 486C
- 2MB MOD 118689001 75
- 4MB MOD 118690001 149
- 8MB MOD 129877001 289
- DESKPRO 286
- 2MB KIT N A 79
- 3-16MB E C N A 129
- DESKPRO 286E
- 2MB KIT N A 79
- 3 16MB E C N A 129
- DESKPRO 386-16
- 1MB KIT 108071001 120
- 1MB E-C 108069001 209
- 2MN E C 108069-71 001 348
- 4MB E C 108070001 464
- 8MB E C 108070 72 001 695
- DESKPRO 386S
- 1MB E C 113633001 188
- 4MB E C 113634001 290
- 1MB MOD 113646001 75
- 4MB MOD 112534001 172
- DESKPRO 386 20E, 25E
- 1MB E-C 113644001 180
- 4MB E-C 113645001 290
- 1MB MOD 113131001 75
- 4MB MOD 113132001 172
- DESKPRO 386-33
- 2MB MOD 115144001 120
- DESKPRO 386/33L, 486/33L
- 2MB MOD 115144001 120
- 8MB MOD 115561001 349
- 32MB MOD 116568001 1385
- 6 SOCK EC 116569001 199
- DESKPRO 486/25, 50L
- 2MB MOD 115144001 120
- 8MB MOD 116561001 349
- 32MB MOD 116568001 1385
- DESKPRO 386/25M, 486 33M, 486S 16M, 25M
- 1MB MOD 118688001 49
- 2MB MOD 118689001 79
- 4MB MOD 118690001 140
- 8MB MOD 129877001 289
- 8 SOCK-EC 129160001 291
- DESKPRO 286N, 386N, 386S 20N
- 1MB MOD 118688001 49
- 2MB MOD 118689001 79
- 4MB MOD 118690001 140
- 3 SOCK-EC 118700001 88
- PROLINEA 3/25S, 3/25ZS
- 2MB KIT 141738-001 88
- 8MB KIT 141742-001 299
- PROLINEA 4/33, 4/66
- 1MB MOD 141582-001 45
- 2MB MOD 141583-001 85
- 4MB MOD 141584-001 149
- 8MB MOD 141585-001 299
- SYSTEMPRO
- 2MB MOD 115144001 94
- 8MB MOD 116561001 349
- 32MB MOD 116568001 1385
- 6 SOCK-EC 116569001 199
- SYSTEMPRO LT 386-25S, 486SX-25S
- 1MB MOD 118688001 49
- 2MB MOD 118689001 79
- 4MB MOD 118690001 149
- 8MB MOD 129877001 299
- 8 SOCK EC 129160001 291
- CONTURA 3/20, 25
- 2MB MOD 139497001 80
- 4MB MOD 139498001 150
- 6MB MOD 139499001 310
- DESKPRO M-SERIES
- SYSTEMPRO LT 486SX 25S & 325 25SE
- 2 64MB BD 129160 685 / 340
- 4 64MB BD 129160 690 / 480
- 8 64MB BD 179160 877 / 570
- SYSTEMPRO XL
- 16MB KIT 136816001 640
- 32MB KIT 136817001 1280
- 128MB KIT 139918001 CALL
- 8 SOCK-EC 139938001 $CALL
- PROSIGNIA
- 1MB MOD 118688001 49
- 2MB MOD 118689001 79
- 4MB MOD 118690001 149
- 8MB MOD 129877001 299
- 16MB MOD 139917001 499
- 32MB MOD 149147001 1099
- LITE 4/25C
- 2MB CRD 142337002 120
- 4MB CRD 142337003 199
- 8MB CRD 142337004 360

SUN

- SPARCSTATION ELC
- 4MB MOD X104Q $ 173
- 16MB MOD X116Q 650
- SPARCSTATION IPC
- 4MB KIT X104Y 184
- 16MB KIT X116Y 650
- SPARCSTATION IPX
- 4MB MOD X104U 173
- 16MB MOD X116U 650
- SPARCSTATION 2
- 16MB KIT X116W 650
- SPARCSTATION 330
- 8MB KIT X108E 480
- 32MB KIT X134A 2250
- SPARC 1, 1+, 4/40, 60, 65
- 4MB KIT X104C G H Y 184
- SPARC SLC (4/20)
- 4MB MOD X105Z 173
- 4 110
- 16MB KIT X115D 650
- SPARC II, 4/40, 60, 65, 75, 330, 370, 390
- 16MB KIT X116H Y WD 650
- 4 330, 4 370, 4 390
- 8MB KIT X108E 480
- 32MB KIT N A 1400
- SPARC10
- 16MB MOD X116F 700
- 64MB KIT X164F 2800
- SPARCSERVER 630MP, 670MP, 690
- 64MB KIT X168A 2100

DELL

- 320N, 212N, 320NPLUS
- 1MB MOD 3133203 $ 80
- 2MB MOD 3103204 130
- NL20, NL25
- 2MB MOD 3103213 149
- 325P, 325D, 333D, 333P, 320SX, 433P, 486D, 486P
- 1MB MOD 3102505 80
- 4MB MOD 3102507 175
- 486D, 486P
- 16MB MOD 3102625 680
- 420, 425, 433, 466, 450DE, 450SE, 450TE
- 2MB KIT 3102466 115
- 4MB KIT 3102467 175
- 8MB KIT 3102468 345
- TE & SE ONLY
- 16MB KIT 3102489 880
- 32MB KIT 3102630 1300
- NOTEBOOK 325NC, 325N
- 2MB 130
- 433E & 425E
- 2MB KIT 3102389 115
- 4MB KIT 3102390 175
- 8MB KIT N A 345
- 316SX
- 2MB KIT 3102349 95

EVEREX

- TEMPO LX, LX20
- 2MB MOD N A $ 80
- TEMPO CARRIER
- 2MB MOD N A 115
- TEMPO 286
- 2MB KIT N A 85
- TEMPO 386SX
- 2MB KIT N A 85
- 4MB KIT N A 170
- STEP SERIES 286 12, 16, 20, 386-16
- 2MB KIT N A 85
- 4MB KIT N A 170
- STEP SYSTEMS 386S, 386SX 20
- 4MB KIT N A 170
- 8MB KIT N A 312
- 16MB KIT N A 625
- 386 25, 33, SERVER 386, 486 33, 486SX 20, 486EISA, SERVER 486
- 4MB KIT N A 170
- 16MB KIT N A 685

IBM

- N51SX & N51SLC
- 2MB MOD 07G1879 $ 129
- 4MB MOD 07G1880 199
- 8MB MOD 07G1881 399
- L40SX N33SX LAPTOP
- 2MB MOD 79F0999 99
- 4MB MOD 79F1000 149
- 8MB MOD 79F1001 315
- P75 & P75
- 2MB MOD 6450902 77
- 4MB MOD 6450128 149
- PS 1 286
- 512K MOD 1057035 34
- 2MB MOD 92F9935 85
- PS 1 386SX
- 512K MOD 1057035 34
- 2MB MOD 92F9935 85
- 4MB MOD 92F9694 149
- PS/2 25
- 128K KIT 78X8955 29
- PS/2 25 & 30 286
- 512K KIT 30F5348 30
- 2MB KIT 30F5360 85
- 0-16MB E-C N A 129
- PS 2 35SX, 35LS, 40SX
- 1MB MOD 6450603 42
- 2MB MOD 6450604 75
- 4MB MOD 87F9977 149
- 8MB MOD 6450129 289
- PS/2 55SX & 50LS
- 1MB MOD 6450603 42
- 2MB MOD 6450604 75
- 4MB MOD 87F9977 149
- 0-16MB E-C 199
- PS/2 57SX, N57SLC, 56SX, 56SLC, 76 & 77
- 2MB MOD 6450902 77
- 4MB MOD 6450128 149
- 8MB MOD 6450130 295
- PS/2 70-061, 70-161, 121, 081, E61
- 1MB MOD 6450603 42
- 2MB MOD 6450604 75
- 0-32MB E-C 199
- PS/2 70-A81, -A16, -A21, -A61, B61, B21
- 2MB MOD 6450608 75
- 0-32MB E-C 199
- PS/2 80 A16, A21, A31
- 4MB MOD 6451060 199
- 0-32MB E-C 199
- MODEL 90XP & 95X INSTALL IN PAIRS
- 2MB MOD 6450902 77
- 4MB MOD 6450128 149
- 8MB MOD 6450130 289
- 16 BIT EXPANSION CARD FOR MODELS 50, 60, 55SX, 65SX, 50LS MAXIMUM TWO CARDS PER MACHINE
- 0-16MB E-C 199
- 1MB MOD 6450603 42
- 2MB MOD 6450604 75
- 4MB MOD 87F9977 149
- 8MB MOD 6450129 295
- 32 BIT EXPANSION CARD FOR MODELS 70 & 80 MAXIMUM TWO CARDS PER MACHINE
- 0-32MB E-C 169
- 1MB MOD 6450603 42
- 2MB MOD 6450604 75
- 4MB MOD 87F9977 149
- 8MB MOD 6450129 299
- 4019 & 4019E
- 3.5MB E-C 1038675 159
- 4029
- 4MB MOD 118335 157
- THINKPAD 300
- 2MB CRD33G9288 165
- 8MB CRD33G2989 480
- THINKPAD 700T
- 8MB RCD8451167 460
- THINKPAD 700 & 700C
- 2MB MOD07G1419 138
- 4MB MOD07G1420 230
- 8MB MOD07G1421 399
- N45SL
- 2MB MOD92F8804 115
- CL57SX LAPTOP
- 2MB CRD07G1419 138
- 4MB CRD07G1420 230
- 8MB CRD07G1421 399
- PS/1 CONSULTANT 2133, G11, G13, G14, ESSENTIAL W11, W13, W14, VALUEPOINT 3207 & EXPERT S11, S13, S14
- 1MB MOD6450603 42
- 2MB MOD6450608 75
- 4MB MOD6450128 149
- 8MB MOD6450130 299
- VALUEPOINT 425SX25, DX/33 & DX2/66 INSTALL IN FOURS
- 1MB MOD96F9260 45
- 4MB MOD96F9291 149
- PRO 386SX M21-23
- 2MB MOD6450902 77
- 4MB MOD6450128 149
- 8MB MOD6450130 299
- PS/2 80-041
- 1MB MOD6450375 60
- PS/2 80-081, 111, 121, 161, 311 & 321
- 2MB MOD6450379 105
- MODEL 95-50 CMP, CMT ECC MODULES
- 4MB MOD6451158 305
- 8MB MOD6451159 575
- XSTATION 120 & 130
- 1MB VRAM4201 155
- 1MB MOD6450603 42
- 2MB MOD6450604 75
- 4MB MOD34F2933 149
- RS/6000 POWERSTATION POWERSERVER 220
- 4MB MOD6450128 149
- 8MB MOD6450130 289
- RISC SYSTEM 6000 NO BOARD INCLUDED
- 16MB KIT 4010 975
- 32MB KIT 4033 1500
- 64MB KIT 4036 2980
- PS NOTE
- 4MB N A 194
- 8MB N A 325

SILICON GRAPHICS

- 4D 100 & 120, 4D SERIES 200, 300, 400
- 8MB KIT H4C08X $ 500
- 32MB KIT H4D32X 1425
- 4D 20 PERSONAL IRIS, 4D25, 4D40, 4D50, 4D70, 4D80, 4D85, CS 12, TURBO 12 & 16
- 4MB KIT H4C058 170
- 4D 20 & 25
- 16MB KIT HUC16B 505
- IRIS CRIMSON
- 16MB KIT H4C16X 870
- 64MB KITR N A 2700
- 4D RX, INDIGO RPC, PERSONAL IRIS & IRIS INDIGO
- 8MB KIT HUC08C 505
- 32MB KIT HUC32H 1850

ACER

- ANYWHERE 1120NX
- 2MB CARD 1120NX $ 195
- ANYWHERE 6385S, K3865
- 2MB CRD N A 195
- 4MB CRD N A 325
- 1100NX, 1100LS
- 4MB KIT N A 180
- 1100 16SX
- 2MB KIT N A 110
- 4MB KIT N A 190
- 1100 20
- 2MB KIT 9100023008 90
- 1100 25, 33
- 4MB KIT 9100023004 150
- 1170, 1172, 1173, POWER 500
- 2MB MOD 9148623002 80
- 4MB MOD 9148623003 175
- 8MB MOD 9148623004 285
- 1200
- 4MB KIT 9148623002 175
- 8MB KIT 9148623003 285
- 16MB KIT 9148623004 780

PRINTER MEMORY

- FUJITSU RX 7100, 7200N
- 2MB $ 295
- KONICA LP3110, 3115
- 1MB 140
- 2MB 210
- 3MB 280
- KYOCERA F1200S, F3300, F3300A
- 1-2 3-4MB CALL
- KYOCERA F820, F1000, F1000A, F3000A, F5000
- 1MB 90
- CITOH-4 PLUS + 5E
- 1MB 100
- CITOH CI-6
- 1MB 120
- 2MB 165
- 4MB 225
- CITOH CI-8
- 1MB 60
- 2MB 140
- COMPAQ $CALL
- PAGEMARQ 15 & 20 $CALL
- DATAPRODUCTS LZR650 $CALL
- EPSON EPL 4000, 4100, 6000, 8100 $CALL
- PAINTJET XL300 $CALL
- HP LASERJET FAX $CALL
- PACKARD BELL PB9500 $CALL
- AT&T 593 $CALL
- TEC 1305SB, 1321C, 1322D $CALL
- FACIT P6060 $CALL
- NCR 6435 $CALL
- CITOH CI-5 $CALL
- HARRIS 3M $CALL
- ATARI SLM-804PCV $CALL
- OASYS $CALL
- MANNESMAN TALLY 905-906 $CALL
- PHILLIPS NMS 1480 $CALL
- IBM 4079 $CALL
- KYOCERA S 800AT $CALL
- NEC SILENTWRITER 2 580, 560P, 562P & 95 $CALL
- SEIKOSHA OP104, OP108 $CALL
- OLIVETTI PG108, PG208 $CALL
- SHARP JX9700, -E, -H $CALL
- QMS PS860, PS1700, 825MR $CALL
- OKIDATA OL810 & 410 $CALL

AT&T

- SAFARI NSX 20
- 2MB C C 37650 $ 190
- 4MB C-C 37651 340
- 6300WGS
- 2MB KIT 37727 175
- 6386, 6386E/WGS
- 4MB KIT 37716 285
- 6386/SX
- 2MB KIT 37336 70
- 0-16MB E-C N A 129
- 6386/25, 33WGS
- 2MB KIT 37261 70
- STAR SERVER 486 33E
- 4MB KIT 37261 285
- 16MB KIT 37263 885
- STAR SERVER 486 33S
- 4MB KIT 37344 225
- 16MB KIT 37345 885

MAGNAVOX

- NOTEBOOK METALIS 286, 386SX
- 4MB MOD 295
- NOTEBOOK METALIS 386SX16 & 386SX20
- 2MB MOD N A 130
- 4MB MOD N A 295
- HS500, 300, 386SX, 286
- 2MB KIT 85
- 4MB KIT 150
- HS, PR, MX 1200, 286, HS, PR, MX 1600, MCP160, PR6ACO, 386SX-16, HS, PRSX20, HS6ECO, 386-20SX, HS3300, 386-33, HS486, 486SX
- 1MB SIMM 55
- 4MB SIMM 175

Canon

- LPB-4, -4PLUS, 4LITE
- 1MB MOD S632240 $ 140
- 1-2MB E-C S632230 145
- 2MB E-C N A 201
- LBP-8II
- 1-4MB E-C S631300 78
- 2-4MB E-C S631880 138
- 3MB E-C S631300 181
- LBP-8III, -8PLUS
- 1-3MB E-C S632340 145
- 2-3MB E-C S632350 201
- 3MB E-C S632360 377

TI

- TRAVELMATE 2000
- 1MB MOD 2568034001 $ 90
- TRAVELMATE 3000
- TRAVELMATE 3000WINSX
- 2MB KIT 2568776001 90
- TRAVELMATE 4000WINSX
- 4MB MOD 25812650001 225
- MICROLASER PLUS, XL
- MICROLASER PLUS TURBO
- 1MB MOD 255739001 61
- 2MB KIT N A 120
- 4MB KIT N A 240
- 8MB KIT N A 480

EPSON

- NB-SL 20, 25, 25C
- 2MB MOD A80077 $ 120
- 4MB MOD A808781 199
- 8MB MOD N A 1200
- NBSS
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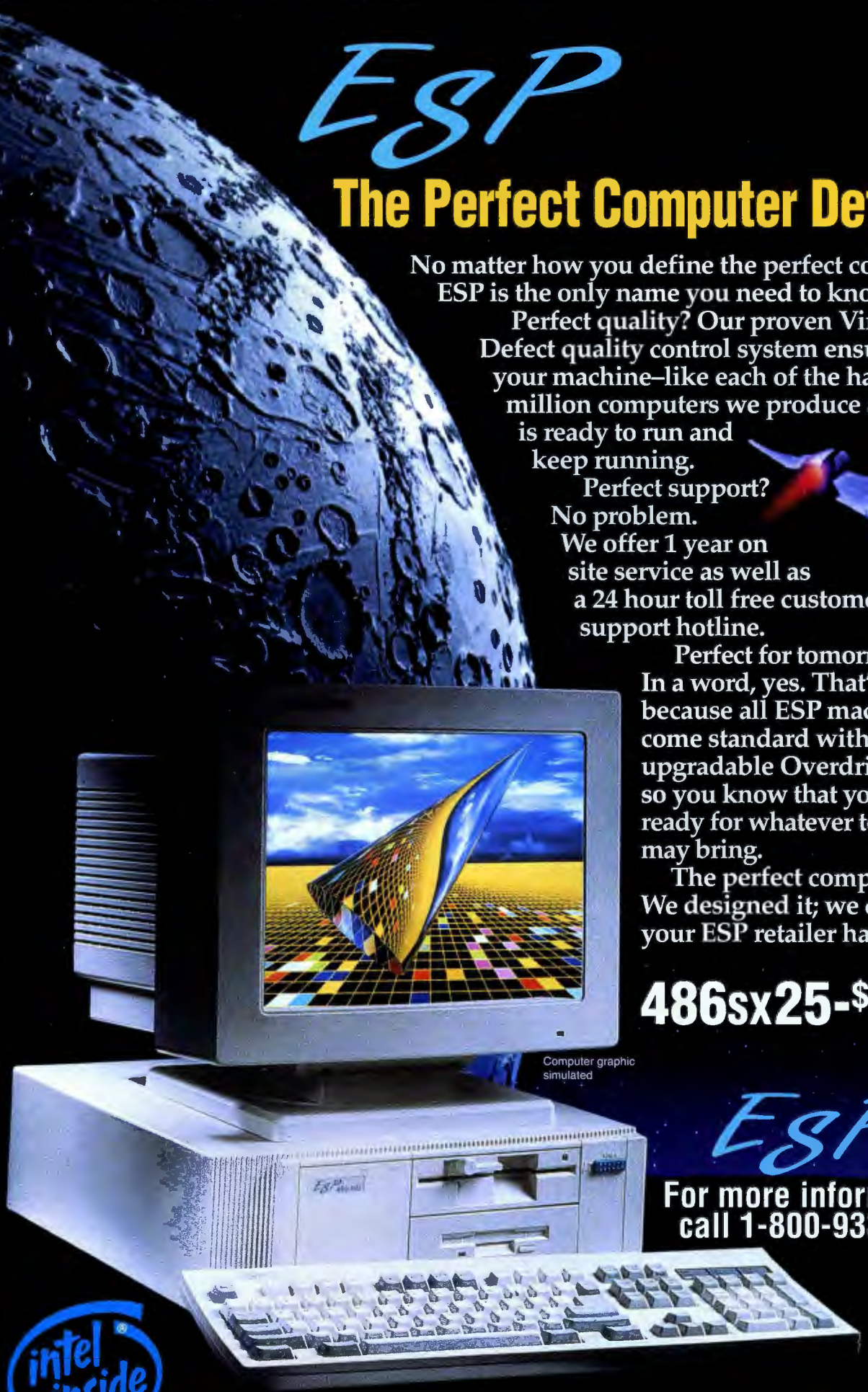

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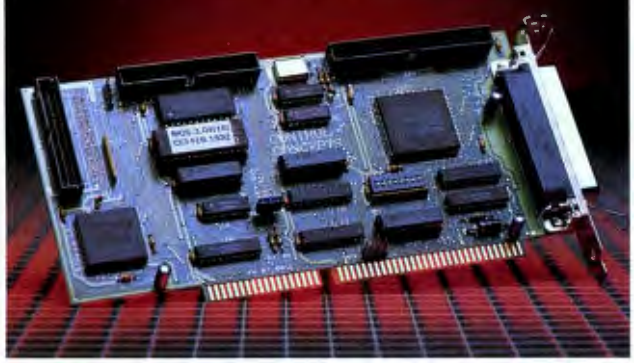

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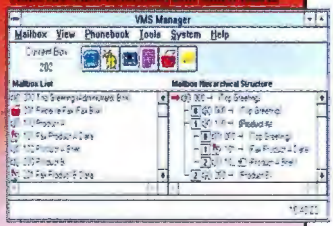

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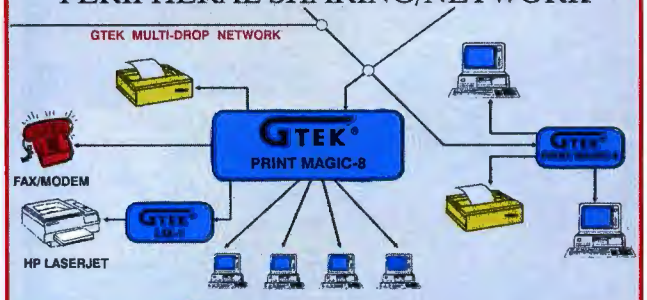

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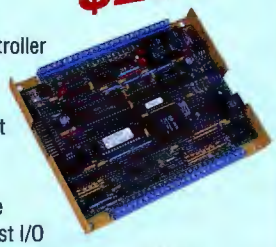

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426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442
443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459
460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493
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596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612

Inquiry Numbers 613–799

613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629
630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646
647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663
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732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748
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766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782
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Inquiry Numbers 800–986

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936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952
953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969
970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986

Inquiry Numbers 987–1151

987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001		
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1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061		
1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076		
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1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106		
1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121		
1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136		
1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151		

Inquiry Numbers 1152–1316

1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166		
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1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301		
1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316		

Inquiry Numbers 1317–1481

1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331		
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1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376		
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1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481		

Product Category Information
Circle the numbers below for additional information on the products you're interested in.

Hardware
Accessories/Supplies 1
Add-in Boards 2
Bar Coding 3
Communications/Networking 4
Computer Systems 5
Data Acquisition 6
Disks & Optical Drives 7
Diskettes/Duplicators 8
Fax Boards/Machines 9
Graphics Tablets/Mice/Pen Input 10
Keyboards 11
LAN Hardware 12
Laptops & Notebooks 13
Mail Order 14
Memory/Chips/Upgrades 15
Miscellaneous Hardware 16
Modems/Multiplexors 17
Monitors & Terminals 18
Multimedia 19
Printers/Plotters 20
Programmable Hardware 21
Scanners/OCR/Digitizers 22
Tape Drives 23
UPS 24

Software
Business 25
CAD/CAM 26
Communications/Networking 27
Data Acquisition 28
Database 29
Educational 30
Engineering/Scientific 31
Entertainment 32
Graphics 33
Macintosh 34
Mail Order 35
Mathematical/Statistical 36
Miscellaneous Software 37
On-Line Services 38
Operating Systems 39
Programming Languages/Tools 40
Security 41
Shareware 42
Software Duplication 43
Spreadsheets 44
Unix 45
Utilities 46
Windows 47
Word Processing 48

General
Books/Publications 49
Recruitment 50
Miscellaneous 51

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2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

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Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!

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Fill out this coupon carefully. ***Please Print.***

Name

Title

Company

Address

City Country Code

Phone Fax

A. What is your primary job function/principal area of responsibility? (Check one)
1 ❑ MIS/DIP
2 ❑ Programmer/Systems Analyst
3 ❑ Adminstration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?
7 ❑ Senior-level 9 ❑ Professional
8 ❑ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ❑ Yes 11 ❑ No

D. What operating systems are you currently using? (Check all that apply)
12 ❑ PC/MS-DOS 15 ❑ Unix
13 ❑ DOS + Windows 16 ❑ MacOS
14 ❑ OS/2 17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
18 ❑ 1-25 20 ❑ 51-99
19 ❑ 26-50 21 ❑ 100 or more

July 1993 92 97 99

Valid until September 30, 1993

Inquiry Numbers 52–238

52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
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Inquiry Numbers 239–425

239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
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409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425

Inquiry Numbers 426–612

426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442
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562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578
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Inquiry Numbers 613–799

613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629
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766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782
783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799

Inquiry Numbers 800–986

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885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901
902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918
919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935
936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952
953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969
970	971	972	973	974	975	978	977	978	979	980	981	982	983	984	985	986

Inquiry Numbers 987–1151

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1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121		
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Inquiry Numbers 1152–1316

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Inquiry Numbers 1317–1481

1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331		
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1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466		
1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481		

Product Category Information
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Hardware
Accessories/Supplies 1
Add-in Boards 2
Bar Coding 3
Communications/Networking 4
Computer Systems 5
Data Acquisition 6
Disks & Optical Drives 7
Diskettes/Duplicators 8
Fax Boards/Machines 9
Graphics Tablets/Mice/Pen Input 10
Keyboards 11
LAN Hardware 12
Laptops & Notebooks 13
Mail Order 14
Memory/Chips/Upgrades 15
Miscellaneous Hardware 16
Modems/Multiplexors 17
Monitors & Terminals 18
Multimedia 19
Printers/Plotters 20
Programmable Hardware 21
Scanners/OCR/Digitizers 22
Tape Drives 23
UPS 24

Software
Business 25
CAD/CAM 26
Communications/Networking 27
Data Acquisition 28
Database 29
Educational 30
Engineering/Scientific 31
Entertainment 32
Graphics 33
Macintosh 34
Mail Order 35
Mathematical/Statistical 36
Miscellaneous Software 37
On-Line Services 38
Operating Systems 39
Programming Languages/Tools 40
Security 41
Shareware 42
Software Duplication 43
Spreadsheets 44
Unix 45
Utilities 46
Windows 47
Word Processing 48

General
Books/Publications 49
Recruitment 50
Miscellaneous 51

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ADVERTISER CONTACT INFORMATION

Inquiry No.		Page No.	Phone No.
133	PKWARE INC	64	414-354-8699
*	PROGRAMMER'S PARADISE	65	800-445-7899
111	PROGRAMMER'S PARADISE	66-67	800-445-7899
	Q		
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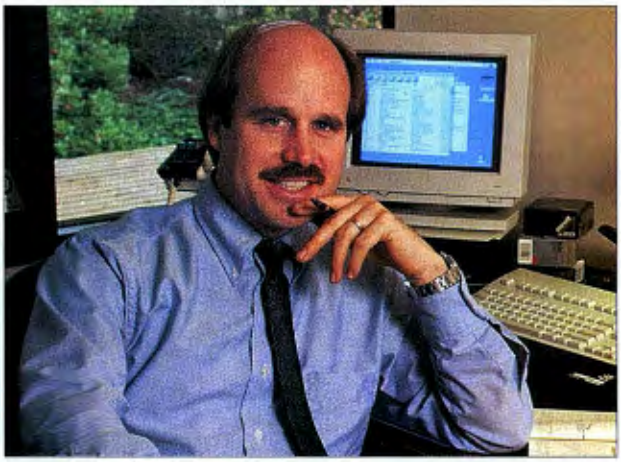
Commentary **Paul Saffo**

A Conspiracy of Silence

Let's not hide the health risk of electromagnetic-field radiation any longer



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Warning: The information revolution may be hazardous to your health. Don't look for this notice to appear on the next computer you buy, even though evidence is mounting that the EMFs (electromagnetic fields) emitted by our new tools have subtle but real health effects. U.S. government agencies have barely begun to study the issue, and computer makers have been astonishingly closemouthed about the risks their products may pose.

This is not the case in Scandinavia, where EMF risks have been under investigation for some time. Last December, the Finnish Institute of Occupational Health reported on a multiyear study that linked EMFs generated by VDTs (video display terminals) with increased miscarriage rates among clerical workers. Specifically, pregnant women exposed to fields of over 3 milligauss were three times as likely to miscarry as others exposed to less than 1 mG.

Two Swedish studies linked EMFs of similar strength with increased leukemia risk among children and adult males. These findings were enough for NUTEK, the Swedish body that regulates EMF emissions, to announce that with regard to future regulations, it would act on the assumption that there is a connection between exposure to power-frequency magnetic fields and cancer. The Swedes have long maintained voluntary guidelines encouraging manufacturers to limit EMF emissions from VDTs to a level of 2.5 mG, measured at half a meter from the screen. Now they are lowering the acceptable emission levels—and making them mandatory.

I had long been indifferent to the EMF issue, but these developments motivated me to assess my personal risks. What little I discovered made me envy Swedish consumers. None of the computers I use are labeled to indicate EMF emission levels, and their manuals are similarly silent on the subject. Calls to the manufacturers yielded nothing helpful, so I purchased a gaussmeter and decided to measure my computers for myself. I was shocked to discover that every computer I use would qualify as Swedish scrap. If the readings on my meter are accurate, I am being baked like some virtual TV dinner by emissions that are well above the standards the Swedes consider to be safe.

Frankly, I feel betrayed by our regulatory agencies and the companies making the computers I use. They have chosen the path of silence while they conduct further studies, making us unwitting guinea pigs in what may prove to be a lethal experiment.

At the very least, a notice indicating emission levels should be affixed to every machine sold, so we know what we are being exposed to. This has been done in Sweden for years, and all new VDTs sold there emit far less than 2.5 mG for the simple reason that consumers routinely purchase the VDT with the lowest emission level. We should also follow the lead of the Swedish government, which is encouraging electromagnetic sanitation in the workplace as a further precaution while EMF research continues.

But U.S. manufacturers have other ideas when it comes to government guidelines in the workplace. A VDT law passed by the city of San Francisco last year was struck down in a legal challenge backed by IBM and other manufacturers. IBM explained that it preferred to work at a statewide level, but we haven't seen a rush by IBM or anyone else in the computer industry to catalyze state or federal legislation in this area.

There are a few bright spots in this otherwise dismal landscape. Several small manufacturers (e.g., Radius and Sigma Designs) sell monitors meeting the Swedish guidelines. Other companies (e.g., No-Rad) offer products designed to reduce EMF emissions on existing machines. Perhaps their success is having an impact—it's rumored that the major manufacturers are pushing hard to reduce emissions on their new models, even as they try to keep their public profile on the subject low.

If the manufacturers had any sense, they would abandon their shyness regarding the subject of EMF risks and make consumers full partners in understanding this complex and uncertain issue. Researchers may ultimately prove that EMF emissions are harmless phantoms, but until then, prudence dictates informed and levelheaded caution. It is up to us as users to demand that manufacturers and regulators alike support this goal. ■

Paul Saffo is a research fellow at the Institute for the Future, a nonprofit research organization in Menlo Park, California. You can contact him on BIX c/o "editors," on the Internet at editors@bix.com, or on MCI Mail as "psaffo."

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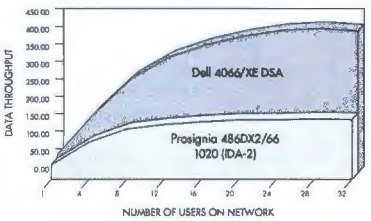
- One Diskette Drive (3.5" or 5.25")
- Eagle Technology NE3200 EISA (available from Dell)

Disk Mirroring and Duplexing also available, not included in price featured.

Tested system included an additional 3 Eagle cards for an extra $2,325.



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†*Testing independently audited by Bounds, Chatelain and Pharr. For detailed test results call TechFax℠ at 1-800-950-1329.*