

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

Reviewed: The Best Portables

**Revealed: What Microsoft
Left Out of Windows 95** P. 27

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ENCRPTN STRY** P. 77

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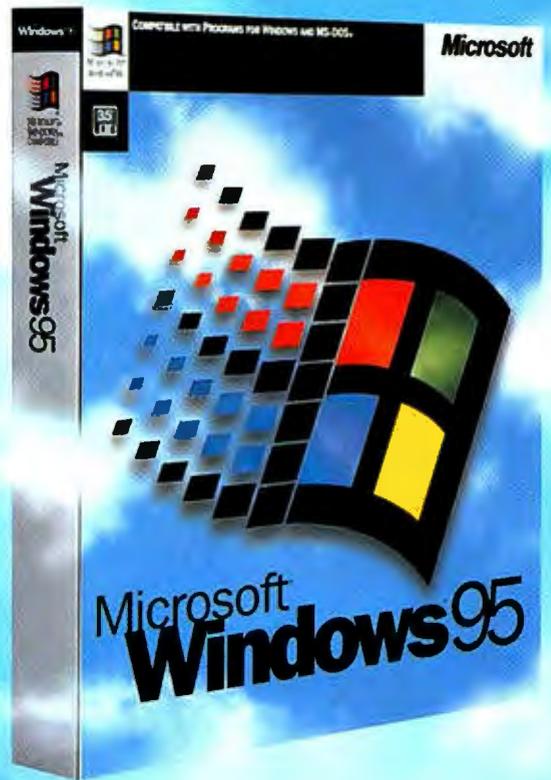
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"The Millennium is nothing short of the best all-around PC available on the Market today."

PC Magazine, April 25, 1995



May 30, 1995
P120 MILLENNIA

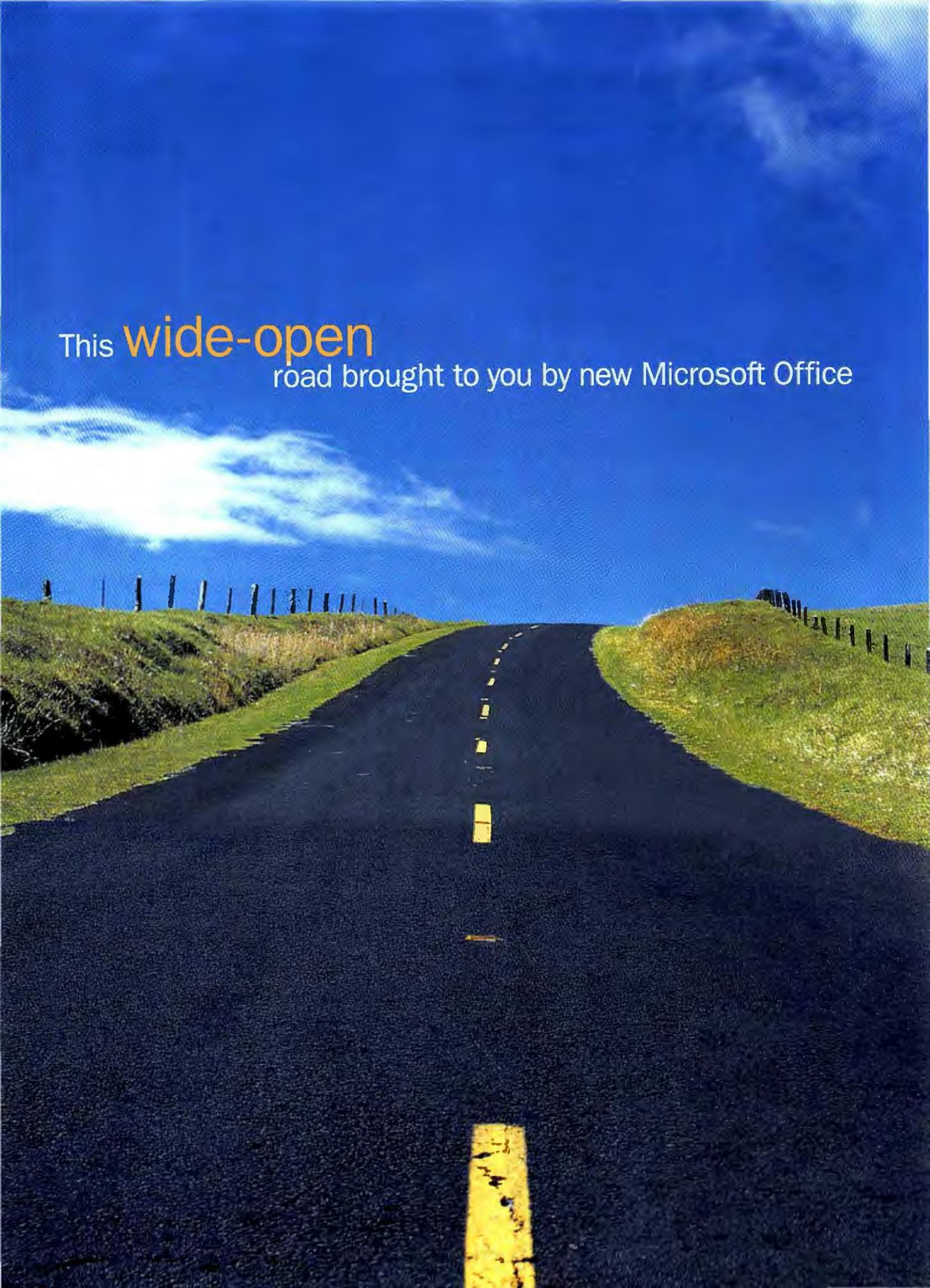
According to PC Magazine's most recent Windows based tests, the Micron P120 Millennium is a "star performer." The Millennium garnered the

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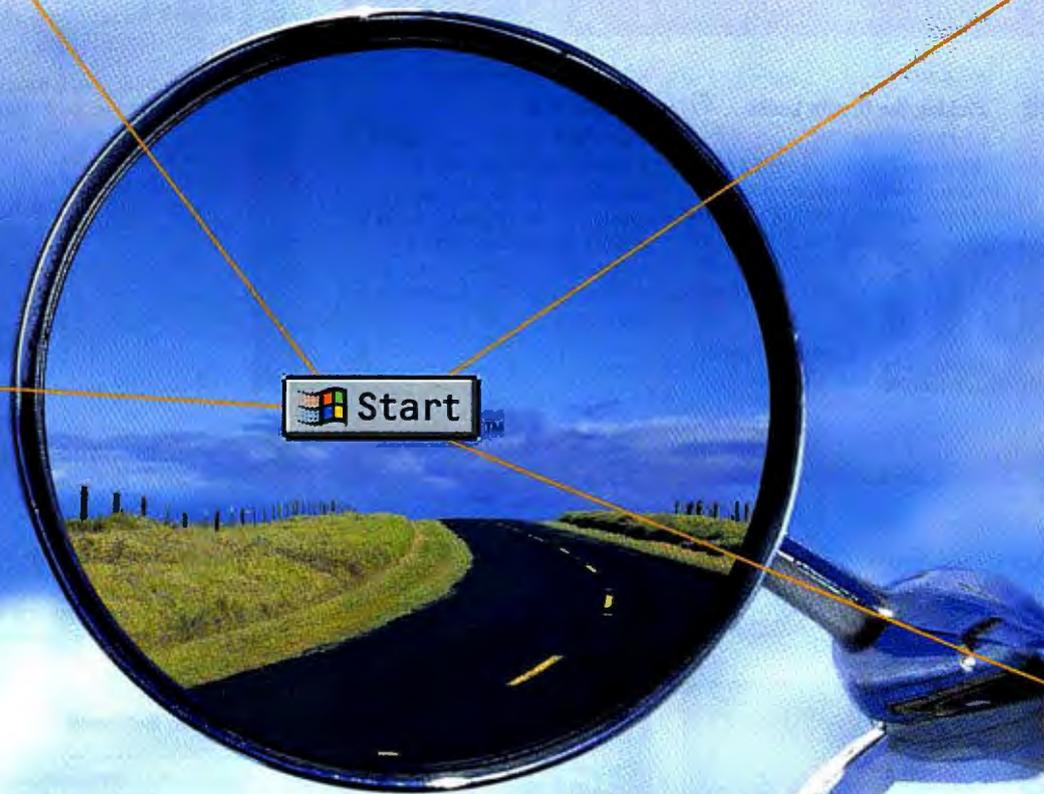


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Now you can take full advantage of Windows 95.

New Microsoft Office was designed to work hand-in-hand with the Windows® 95 operating system and its simplified user interface. To make the most of 32-bit performance, long filenames, shortcuts, multitasking, and the Windows Explorer. Together, they make computing fundamentally easier and faster. They make it possible for you to spend less time computing, more time working effectively.

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OCTOBER 1995

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COVER STORY The New PC

BY TOM R. HALFHILL 52

Despite faster and faster chips, today's PC is basically yesterday's AT. But that's about to change. Here are the technologies that will help the PC evolve to its next stage. Plus, some products that embody these new technologies.

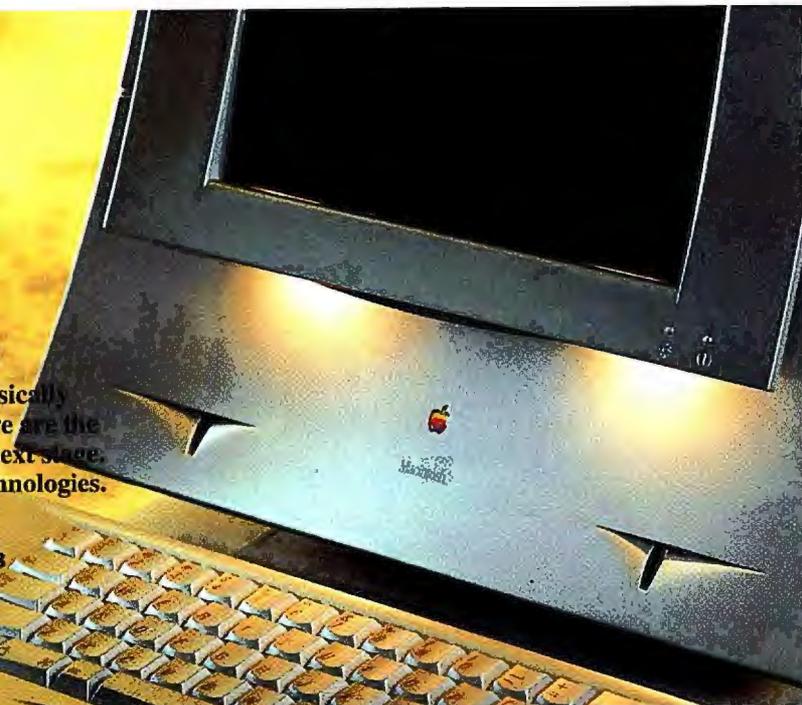
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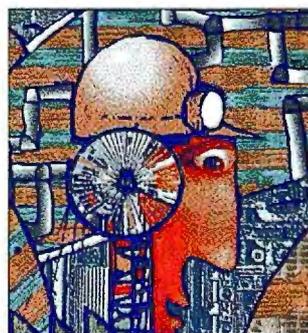
Here's how corporations, researchers, and scientists are using data-mining techniques to discover everything from new customers to new galaxies.



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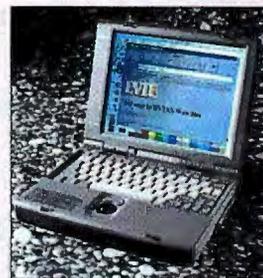
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BY SHASHI PRASAD

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BY STEPHEN COBB

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BY JERRY POURNELLE

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PROGRAM LISTINGS

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From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow the instructions at the prompt.

This page presents the articles in this issue according to computing platform.

DOS/WINDOWS

Intel's Rivals Ready to Exploit P6 Weakness.....26

Further tests confirm what we reported last month: If you're running mainly 16-bit DOS and Windows applications, don't rush out to buy a P6 PC. Or maybe you should consider AMD's K5 or Cyrix's M1.

Coming: A Better Multimedia Platform.....27

Windows 95 has several technology components, such as 32-bit video codecs, designed to make it a better foundation for multimedia. But some other significant pieces are missing.

New Replication Options in Access, Oracle, and Notes.....30

Database programs get a feature that will be a big hit among developers supporting remote workers.

Run-Time Error Checking Comes to Compilers.....34

New development packages from Borland, Microsoft, and Nu-Mega should help Windows programmers check their code.

We Plugged, but They Didn't All Play.....36

We test a bunch of alleged Plug and Play devices and find that you often have to do some work before you get to play. Somehow it's not surprising.

Face to Face.....69

This explanation of the H.32x standard also looks at some Windows products for videoconferencing.

A Data Miner's Tools.....91

Forget the pick and shovel. Here are programs that can help you sift through mountains of data and separate the nuggets from the slag.

Windows 95: The Numbers.....113

BYTE tests shipping Windows 95 code against Windows for Workgroups 3.11, revealing the performance limitations of Microsoft's new OS.

Applications 95 Arrive.....117

Enterprises might not rush to deploy a new desktop interface, but they will move to Windows 95 for the powerful new applications it enables. Here's a review of some of the best so far.

Au Revoir, Mon Ami.....127

Lotus's new version of Ami Pro—now called Word Pro—has some innovative additions, especially for workgroups.

Digital Cameras for Real Work.....129

Affordable digital cameras—priced under \$1000—from Apple, Kodak, and Logitech are good for business, scientific, and publishing applications.

Weaving a Thread.....173

Borrowing from the ideas of object-oriented programming, Windows NT was designed from the ground up to support multiprocessing and multithreading.

Pournelle: Death Swoops and Upgrades.....181

In a month of big upgrades, Dr. Pournelle installs the latest version of Win 95 and—guess what?—runs into a few problems.

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In which we report on the whereabouts of OS/2 for the PowerPC.

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Rick Grehan works with the latest version of IBM's Visual Age C++ development environment for OS/2. It combines visual programming tools with a compiler.

Pournelle: Death Swoops and Upgrades.....181

It's upgrade time at Chaos Manor. Jerry installs OS/2 Warp Connect. Despite "one major design defect," he finds it "solid as a rock."

MACINTOSH

Options Increase, Prices Drop for Mac Add-Ons.....40

If you've got a PCI Macintosh, you're going to have a big selection of graphics accelerators. Card kings of the PC realm (ATI, Matrox, miro, and others) are bringing their products to the new-bus Macs.

Face to Face.....69

Videoconferencing gets a compatibility kick from the H.32x standard. QuickTime Videoconferencing and other products bring H.32x support to the Mac.

A Data Miner's Tools.....91

Specialized software for digging valuable information out of mountains of stuff.

Power Mac Gets PCI.....123

If you were getting delirious and thinking you needed a Pentium, stop right now and read this review. The PCI-based Power Mac 9500 is the new Apple dream machine.

Digital Cameras for Real Work.....129

Apple's QuickTake 150 digital camera offers improved resolution and image processing. Similar cameras from Kodak and Logitech provide higher resolution for printed images and have Mac software, too.

Apple's Dynamic Duo.....160

The PowerBook Duo 2300, with its PowerPC 603 CPU, provides RISC performance and long battery life. It's a welcome addition to anyone's briefcase.

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The two-tier thread library in Sun's Solaris lets applications developers take advantage of multiprocessing and multithreading.

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New Replication Options in Access, Oracle, and Notes.....30

Databases make it easier for mobile and remote workers to be in sync with the home office.

We Plugged, but They Didn't All Play.....36

We test some allegedly Plug and Play products—including some network cards—with Windows 95.

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Personal computers of the next two to five years will be better equipped for networking, with connectivity built into the hardware and the OS.

Face to Face.....69

Getting one videoconferencing system to work with another is going to be less of a sticky wicket, thanks to an international standard called H.32x.

Data-Mining Dynamite.....97

One of the best ways to capitalize on an enterprise's information is to build a data warehouse, a server-based replication of a mainframe's data. When users need information, they send a query to the warehouse.

BOMB's Away.....105

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Applications 95 Arrive.....117

Visual Voice for Win32 is one of the killer applications for Windows 95. This 32-bit OLE implementation provides developers with tools to build telephony-based applications.

Internet Firewalls.....179

Internet connections are being hacked and cracked at an alarming rate. Firewall technology can keep your network safe. A new consortium aims to ensure the reliability of these network condoms.

Pournelle: Death Swoops and Upgrades.....181

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Put a fork in it.

The hard drive is done.



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The only two advantages magnetic hard drives held over optical drives have now been eliminated. In both price and performance, the new Pinnacle Apex 4.6 GB is the first optical drive to totally cook magnetic hard drives.

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- Greater reliability and durability than hard drives
- Removable disks allow easy portability and security

THE CROSSOVER IN STORAGE TECHNOLOGY

We've always known that some day optical drives would replace magnetic hard drive technology in the computer industry. Simply put: optics are superior to magnetics. The numerous limitations of hard drives make this fact obvious. Hard drives crash, they're a pain to move around, they fill up too quickly, and you constantly have to back them up.... So why do we buy

these things? Because up until now, we've never had an alternative that offered the speed, price and capacity of the Pinnacle Apex 4.6 GB optical drive. The Apex signals the dawn of a new era in computer storage.



Internal PC version • 5.25" half-height

DESIGNED FOR ALL YOUR STORAGE NEEDS

The Apex's combination of high capacity, impressive speed and removable/portable media make it the ideal storage device for a broad range of applications:

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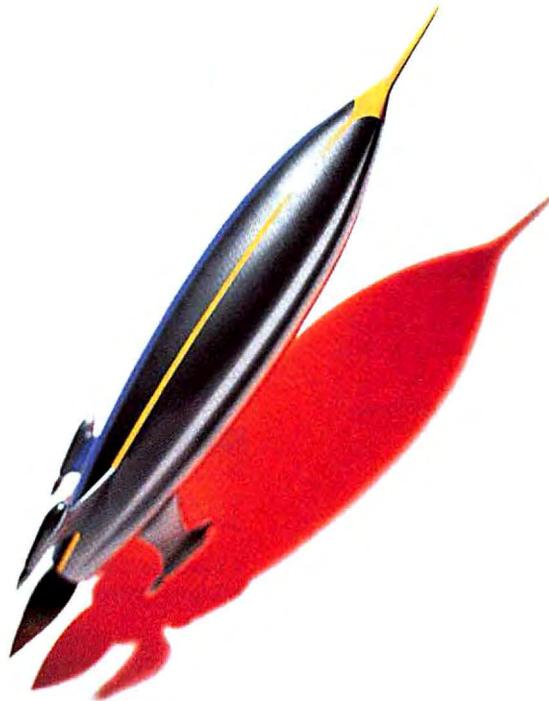
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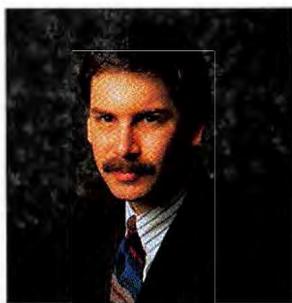
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I Can See What You Mean



New products and services will free us from the shackles of old technology. First to fall: the PC's AT architecture.

From the home office I've set up in my Boston apartment, I have a clear view across the Charles River to MIT. Sometimes when I'm editing a BYTE story about far-future technology, I look up from my desk and wonder just what is going on in the MIT Media Lab, what strange future they're assembling over there.

But it turns out that with the right software, I can see what they're doing. Literally. MIT, along with dozens of other institutions and businesses, runs a number of Web-accessible spy cameras (or just *cams* in the vernacular). There's even a guy over there, Steve Mann, who has mounted a wireless video camera on a helmet. Jump to his page (<http://www.white.media.mit.edu/~steve/netcam.html>) and you can see what he sees.

Mann, in fact, has a troop of friends with headcams. You think the scariest moment in a businessperson's life is when Dan Rather and the *60 Minutes* crew knocks on the door? Try to imagine how you'd feel if six people wearing head-mounted video cameras showed up in your office.

Among the mad-scientist community of computer engineers, it's an accepted notion that wearable computers and their I/O devices are just around the bend. And it's also accepted that, not far behind them, is the generation of users who will come to accept implanted computer technology.

As Marc Demarest, director of strategic marketing for Sequent Computer Systems, says, "The computer wants inside your head." He expounds the frightening point of view that technological evolution is opportunistic, like the evolution of parasites. The devices seek hosts. And he doesn't mean Sequent superminicomputers. He means a living, breathing class of host, who will come to depend on technology the way we now depend on the bacteria in our digestive system.

His evidence: Computers are getting closer to us and our personalities. We can now get affordable virtual-reality goggles that put SVGA monitors 2 inches from our

eyeballs. And there is a whole industry growing up around designer mouse pads, screen borders, and even color-coordinated computers—all of which are designed to make us more comfortable with the technology. But technology would be even more "in our head," Demarest says, if software user interfaces were less adversarial and more visceral, as they are in good video games, which present enormous amounts of information—graphical, intuitively—and put the player in a "tight loop" of information and response.

If the concept of computer evolution matching biological evolution is a little too far out for you to grapple with right now, at least you can agree with me that the computer wants inside your wallet. When we began doing this month's Cover Story, "The New PC," I called Ted Selker, IBM's manager of its user systems ergonomics research division. Selker designed the IBM TrackPoint eraserhead pointing device, not to mention the Butterfly keyboard on the ThinkPad 501C. I asked him what leading-edge machines he had floating around in his lab that he could send us for the story. He said, "Give me two days. I'll build you a wallet computer."

The wallet computer didn't make it into this issue (too far out even for us), but several other new technologies did, including those embodied in the machines on this month's cover. Illustrating the latest trends in dockable portables is IBM's Leapfrog (the squarish machine with the confusing case). Apple shows its vision of portable technology migrated to the desktop (check out the screen and keyboard), and Archistrat has a line of computers based on a new bus architecture.

None of these machines use the ancient architectures of the PC—ISA cards and slow serial ports, for example. We think that's great. The old architecture has been with us for too long and is hobbling our steps into the future. These new machines are the platforms for the future. We'll be seeing new architectures on our desks soon, just as you may soon be seeing wearable webcams in your office lobby. ■

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This front-loading slot lets users customize the notebook by slipping in their choice of modules: a CD-ROM drive, floppy drive, second lithium ion battery or second hard drive.

Versa's multimedia capabilities fully meet the needs of today's mobile professionals. With a choice of large 10-plus inch TFT color screens, with resolutions up to 800 x 600, the VERSA

4000 can display presentations in up to 16.8-million colors. Other multimedia features include two stereo speakers, microphone, Sound Blaster® Pro-compatible stereo sound system, four audio ports, volume-control dial and full-motion video support.

The VERSA 4000 also has two PC Card slots and complete desktop-docking capabilities. Two infrared ports support printing and file transfer. Users can expand the standard 8MB memory up to 40MB: 540MB/810MB disk storage up to 1GB. Pre-installed software includes Windows® 95.

C&C for Human Potential

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DIGITAL INTER- ACTIVE SERVICES VIA COPPER PAIR

Telstra of Australia is implementing a pilot program to deliver interactive video services over existing telephone copper pair cables to 300 subscribers in Melbourne. The enabling technology is called ADSL, Asymmetric Digital Subscriber Line technology.

As prime contractor for the project, NEC Australia is responsible for system design, equipment supply and overall integration. Key equipment includes video servers, MPEG encoders, switches, ADSL line cards, and set-top boxes.

The pilot program will use two types of ADSL transceivers: 2Mbps Carrierless Amplitude Phase units and 6Mbps Discrete Multi-Tone units. The system will deliver live and stored video programs to support both Pay-per-View and Video-on-Demand services.

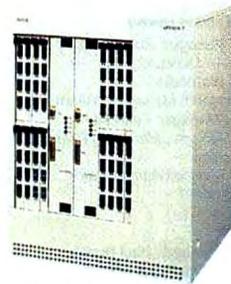
The system architecture is among the world's most advanced in terms of scalability and openness to future enhancements. It accommodates both new subscribers and multiple video information providers.

The system can be upgraded to provide a wide range of interactive multimedia services. They include home shopping, travel services, directories, databases, video games and instructional/educational programs.

NEW ENTERPRISE ATM SWITCHES

Many enterprises are enhancing communications with LANs based on ATM technology. To meet diverse user needs, NEC has expanded its lineup with two new enterprise ATM switches, ATOMIS 5E and ATOMIS 7E.

ATOMIS 5E features throughput of 2.5Gbps. It supports interfaces of OC-3/STM-1, TAXI, DS3, E3, and 6.3Mbps. ATOMIS 7E offers maximum throughput of 10Gbps. It further supports OC-12/STM-4.



ATOMIS 7E

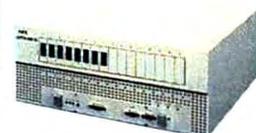
To maximize network reliability, ATOMIS 7E features redundant switches and controllers.

Both enterprise switches support a full SNMP agent. This enables integrated network management of LAN equipment such as routers and hubs. Both switches comply with ITU-T, ATM Forum and other international standards.

NEC has also introduced ATOMVIEW, a sophisticated system for integrated management of ATM networks. ATOMVIEW automatically

recognizes network structure and collects traffic data. Its graphical display simplifies maintenance and control operations. ATOMVIEW complies with the latest ATM

Forum standard for Call Admission Control.



ATOMIS 5E

NON-LINEAR MO EDITING SYSTEM

Tapeless, non-linear program editing is a major advance in TV broadcast technology. NEC has introduced a smart, simple, PC-based system that allows users to take advantage of the vast capacity of magneto-optical (MO) disks.

Our non-linear editing system centers around a compact MO video disk recorder and a 23-GByte MO disk. The 30cm disk records 32 minutes of uncompressed NTSC video and audio, or 38 minutes of PAL video and audio.

The VF-200 MO video disk recorder offers many advantages. Real random access allows you to select start-points, end-points and sequencing at will. You can edit and transmit during recording. It permits separate editing of high-quality video/audio and still/slow playback. You can remove disk cartridges for permanent storage.

NEC's non-linear MO editing system is a versatile performer, designed for on-line news and sports as well as off-line applications.

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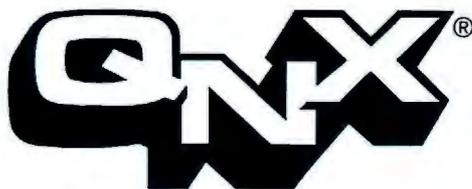
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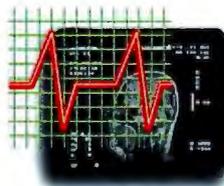


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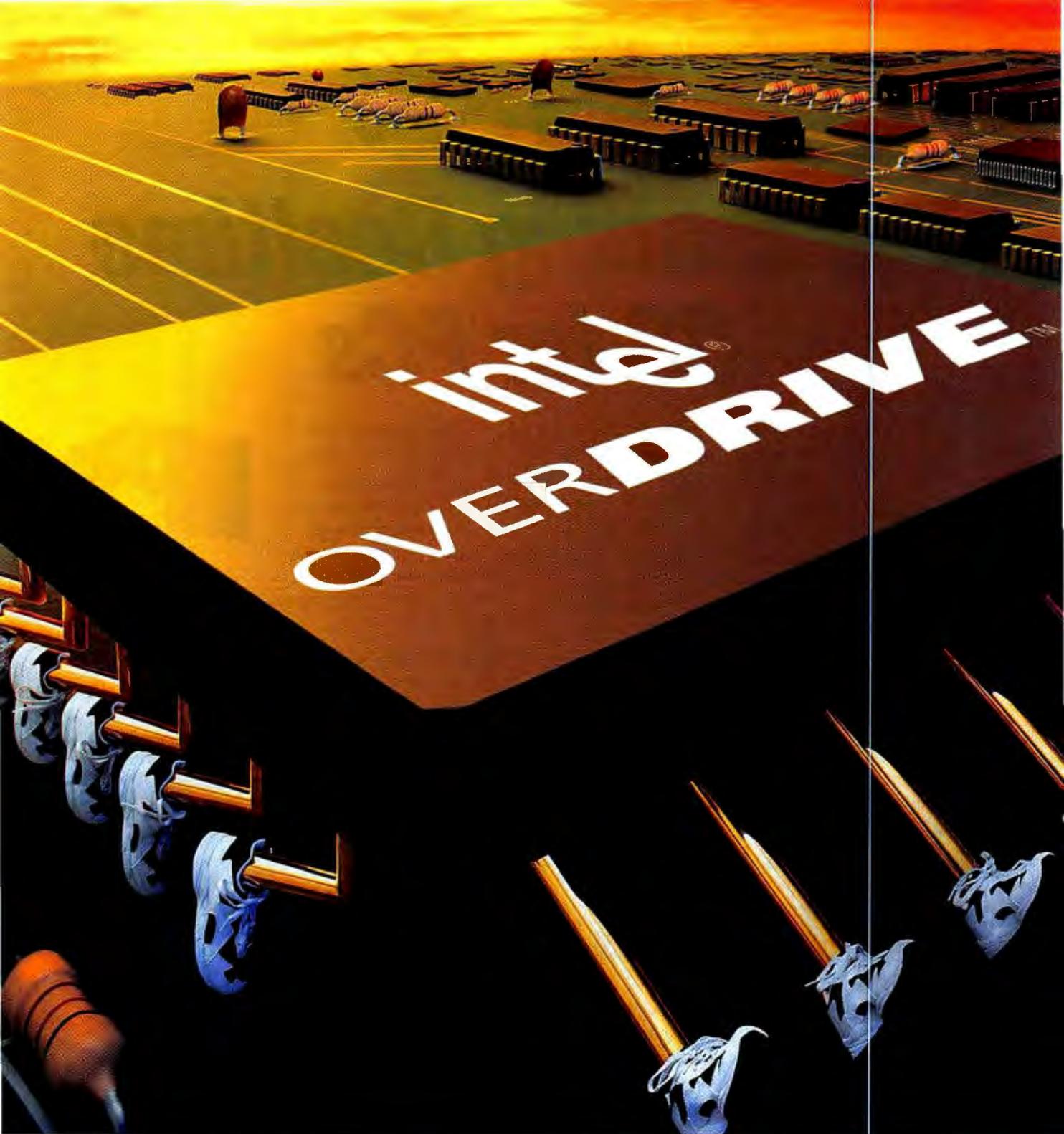
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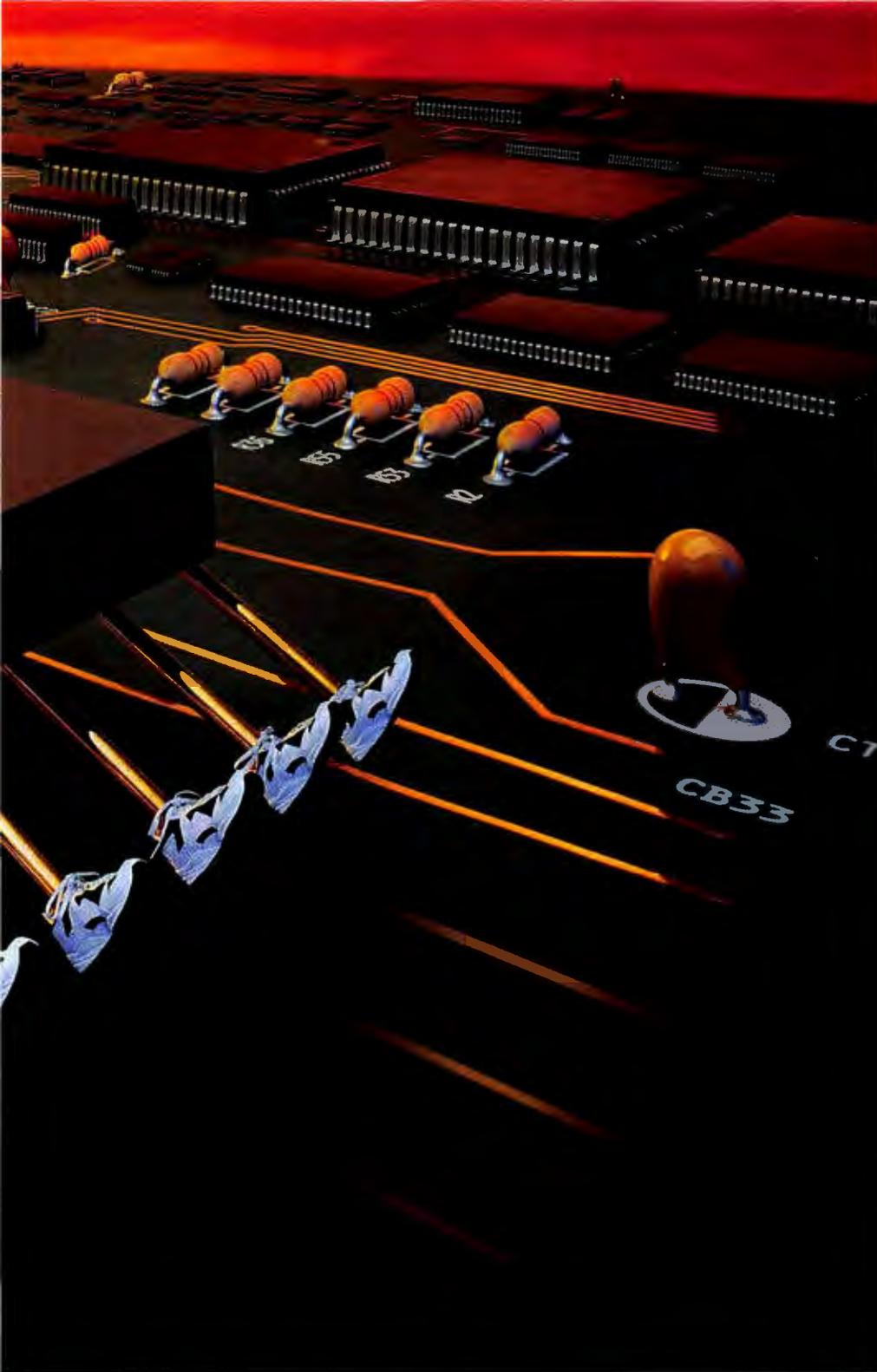
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©1995 Intel Corporation. †The 63-MHz Pentium OverDrive processor for most 50-MHz and 25-MHz Intel486 CPU-based systems is available now. The 83-MHz Pentium OverDrive processor for most 66-MHz and 33-MHz Intel486 CPU-based systems is available now. ‡The 100-MHz Pentium OverDrive processor for most 66-MHz and 33-MHz Intel486 CPU-based systems is available now. *Index ratings are for processors running in write-back mode. i486™ processor-based systems supporting the write-through mode will yield approximately 15% lower iCOMP index ratings when upgraded with the Pentium OverDrive processor. *Other trade names are the property of their respective owners.

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will be available in September, 1995. ††Source: iCOMP[®]: A Simplified Measure Of Relative Microprocessor Performance. Intel Corporation, 1992. †††Pentium OverDrive processor iCOMP scores are the property of their respective holders.

Drive[®] processor upgrade.

The Inelegat Kludge

I'm a bit confused by your article on Windows 95, "The Elegant Kludge" (August). The title and first two paragraphs seem to set the tone: Windows 95 is still "just" Windows. The "Windows 95: Head-to-Head" matrix (page 54) clearly shows that OS/2 Warp Connect is the superior choice. Then after lots of words describing the architecture of Windows 95, you conclude that I still should buy it because it has a slick user interface. Or worse yet, if I want a "real" 32-bit operating system, I should consider Windows NT. If Windows 95 is half-baked, why should I believe that the same cook didn't forget something in the baking of Windows NT as well? I'm not sure if it was the author's intention, but I think OS/2 Warp may be worth looking at now.

Doug Carter
dougc@clam.com

Telling It Like It Is

Bravo! Your August cover story delivered the first honest and complete coverage of what Windows 95 is and isn't. Win 95 is an important stepping stone to the next (real) operating system for Intel-based PCs. I picked up an extra copy of the issue to distribute around the office (I want to keep mine in one piece).

Dick Womack
Senior finance systems support analyst
Pepperdine University
dwomack@pepperdine.edu

Why Did Win 95 Win?

In your News & Views story "Network and Windows 95 Take Top BYTE Awards" (July), you state that the editors voted Windows 95 as the Best Operating System and the Best of Show because "This was the first Comdex at which Windows 95 was in full display on the show floor." I was under the impression that BYTE gives something the Best of Show prize at Comdex because of its outstanding

quality and usability, not because its manufacturer plasters it everywhere, forcing others to follow or go out of business. This is nearly as sad as seeing BYTE's Web server use 8.3 filenames.

Szabolcs Szigeti
pink@fsz.bme.hu

Windows 95 is not perfect, but it is a pretty good step toward dragging the huge Windows installed base into a 32-bit future. And some of the 32-bit apps that Win 95 enables will be powerful, innovative, and just plain neat.—Eds.

OS/2 or Not OS/2

I have been a BYTE subscriber for years, but I was upset with the August issue. Of the three articles listed in the Contents by Platform index as OS/2 articles, two were actually about Windows 95 and one was about Lotus Notes. The shift in your editorial stance to ignore a major operating system has led me to feel deserted by BYTE. I realize that you have to cover Windows 95, as it is "hot" news. But to disguise those articles as OS/2 articles is insulting to those of us who use OS/2 and have no plans to change to Windows 95.

Steve Shultz
72073.1673@compuserve.com

Blasts in the Past

In the August issue, "The Last Blasts Quiz" seems to imply that there will not be any more Blasts from the Past page. That would be very disappointing. I think the Blasts column is one of the most valuable in BYTE, and I hope it can continue. It gives us a perspective on what everyone used to think was the latest thing.

Duke Briscoe
duke@harlequin.com

Blasts from the Past was a special column to help us and our readers prepare for our 20th anniversary issue, which we published last month.—Eds.

GNU Is Gnot Gnarly

In his Code Talk column entitled "ANSI C Anywhere" (June), Rick Grehan wrote of how difficult it is to port the GNU C/C++ compiler and how easy it is to create a new C compiler using a different set of tools.

GNU C/C++ is just like those other tools, requiring a target machine file and machine description file. I was able to have a bug-free GNU compiler for the Hitachi-HD16 processor in four days. And the GNU C/C++ outperforms most optimizing compilers.

Kerwin F. Medina
via e-mail

I personally found the GNU documentation difficult to follow. It could have improved since I saw it; it could also be that I simply didn't have the mental horsepower necessary. In any case, I am happy to hear that you had such an easy time of it. I applaud the entire concept behind GNU products.

—Rick Grehan, senior technical editor
rick_g@bix.com

Unfriendly Reader Interface

I don't mean to be a Luddite, but I hope the new background/foreground color schemes you used in your cover story "Inside the Mind of Microsoft" (August) are not a harbinger of future BYTE graphics. The dark-shaded text boxes were very hard to read except in perfect lighting conditions. Are you attempting to emulate certain newly arrived cyberzines? If so, please reconsider!

Jim Wheelock
New York, NY

Agreed. In the future, we will try to make our articles easier to read.—Eds.

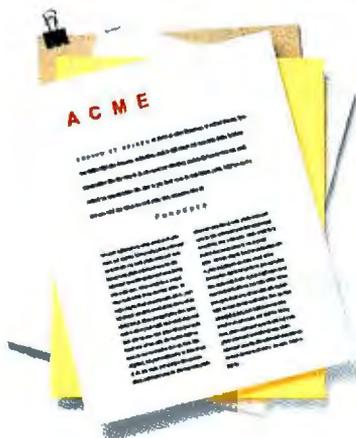
Totally RAD, Dude

I found "The End of Programming" (August) very helpful. Having just taken a PowerBuilder class (but not having built anything with it yet), your warnings and suggestions are well-taken advice regarding how to best use the RAD (rapid application development) technology. I plan to keep a copy of your article with my manuals.

Mike McIntosh
Mike_McIntosh@sysprog-ada.ccmail
compuserve.com

We want to hear from you. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX to editors@bix.com. Letters may be edited.

A YEAR IN THE LIFE OF A FRAMEMAKER DOCUMENT.



JAN 14

Acme Development Company's marketing department worked as a team to create its first marketing plan. Everyone contributed, each using FrameMaker's text, graphics, layout, formatting, and long document features. The end result was the best marketing plan in Acme history.



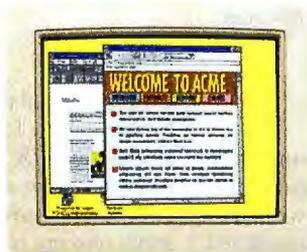
SEP 27

Oops! Fido just made a meal out of some essential drawings. Fortunately, FrameMaker can import directly from the architect's workstation, since it supports popular CAD, graphic, and word processing file formats. It even runs on platforms like Macintosh, UNIX, and Windows.



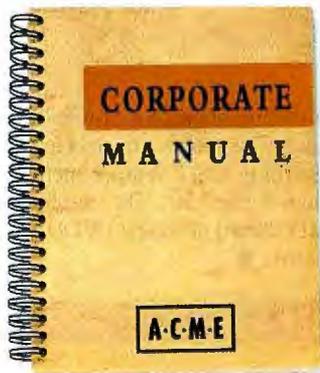
MAR 28

Business was booming, so Acme included its skyrocketing sales figures in the marketing plan. FrameMaker imported a variety of graphics, and flowed text neatly around them with the help of the new auto text wrap feature. It even has unsurpassed table editing for multipage tables.



DEC 3

Soon Acme had its very own Web site to help disseminate company information to employees and customers all over the world. So naturally, Acme made extensive use of FrameMaker's new HTML export capabilities. Now all its material could be published directly to the Internet.



MAY 10

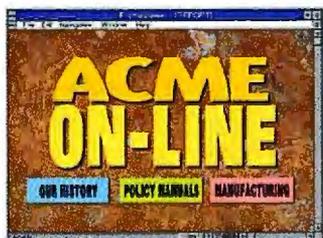
Acme hit the bigtime and went public, becoming Acme Corporation. To make sure all the IPO documentation was consistent, FrameMaker's import text and graphics by reference feature was used extensively for retrieval and update of boilerplate information created in FrameMaker or other applications.



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FRAME



JUL 1

Suddenly Acme had a need to communicate online—to save time, paper, and even a few trees. So they used FrameViewer™ for instant online distribution with no additional post-processing or conversion required. It even supports FrameMaker's automatically generated hypertext links.

Slight Misunderstanding

There is a small error in Tom Thompson's feature story "Apple's New Operating System" (June). He asserts that Copland's hardware abstraction layer is "a feature currently found only in Windows NT." In actual fact, IBM's OS/400 and its predecessor S/38 CPF have been based on a HAL since the first S/38 was introduced in the early 1980s.

David Welden
Newport Beach, CA

Our article was describing a new desktop OS, so we were comparing it with other desktop OSes. Just as NT and Copland will probably not appear on an AS/400, OS/400 is not going to be running on a PowerPC or Intel desktop machine anytime soon.

—Tom Thompson, senior technical editor, tom_thompson@bix.com

Make the Senders Pay

I agree with Nick Baran's Commentary ("Stop, Look, and Listen!," August). Billions of dollars are going to be wasted as companies try to launch poorly considered information services. Forget the notion that people will pay to receive information. Look instead at industry models where senders carry the brunt of the costs, such as advertising-driven media like TV and radio broadcasting or newspaper and magazine publishing. We need new industry models that support distribution of digital information from paying senders. Invest those billions of dollars, but in services that we as customers want and can afford.

Peter Ruhe
peterr@wimsey.com



Lighten Up on Microsoft

I was very impressed by Rafe Needleman's editorial on Microsoft ("Why I Love/Hate Microsoft," August). I have always felt that those who bashed Microsoft for the way it does business were simply suffering sour grapes. They were upset at the fact that they didn't market their products or

ideas as well as Microsoft does.

Gerry O'Brien
Moncton, New Brunswick, Canada
gerryobr@nbnet.nb.ca

I am amused by the resentment and furor emanating from Microsoft bashers. In your recent editorial, I sense that you dislike the company when you use phrases such as "Evil Beast" and "corporate arrogance." If Microsoft does not understand the corporate market, it can hardly be called arrogant. Ignorant, perhaps, but not arrogant. Windows is not perfect, but neither is anything else created by human beings. Show me a DOS, Mac, or OS/2 user who never had to reboot his or her computer and I will show you a bridge for sale.

Gary Wong
Oakland, CA

Amiga Redux

I was surprised to see an article essentially devoted to LightWave3D ("Desktop Hollywood F/X," July). I guess this is because it is now available for real personal computers (sarcasm intended) and not some obscure toy like the Amiga, which was four to five years ahead of its time. In your list of company addresses, you included Commodore Business Machines, but Commodore has been out of business for over a year now. The Amiga is now owned by Amiga Technologies GmbH, a part of Escom AG.

Zoltan Hunt
Downsview, Ontario
am609@freenet.toronto.on.ca

Amiga fans, rejoice! German company Escom AG has acquired Commodore

Electronics Ltd. and Commodore's Amiga technology. Escom's plans reportedly include producing the Amiga 600, 1200, and 4000 series and melding Amiga and MS-DOS systems. Here's the contact info: Escom AG, Tiergarten Strasse 9, Heppenheim, Germany 64646; +49 6252 7090; fax +49 6252 709 442.

—Ed DeJesus, senior editor
edejesus@bix.com

GSM Is Not MSG Backward

It was nice to read your "Special Report on Mobile Computing" (June). As a reader living outside the United States, I noticed that there was no mention of GSM, the global system for mobile communications. I have heard rumors that some GSM operators will start soon in the U.S. It would be nice to read about it and how companies are using it. GSM provides 9600-bps connections, which are not the most efficient, but better speeds are coming.

Jan Laakso
jan.laakso@cc.tut.fi

GSM is very popular in Europe. Unfortunately, I leave my mobile phone here when I travel abroad because the standards are different. I would gladly trade my phone for a GSM unit if I could get GSM services in the U.S.

—Rafe Needleman

FIX

Due to an editing error, our article "The Elegant Kludge" contains a mislabeled diagram describing OS/2 Warp's memory model (August, page 56). The two boxes labeled VxD should be labeled VDD. We regret the error. ■

COMING UP IN NOVEMBER

• ENTERPRISE DATABASES

We look at industrial-strength databases for the desktop: Oracle for OS/2, DB/2 for OS/2, and Microsoft SQL Server for Windows NT.

• ZAPPED!

We report on our tests of uninterruptible power supplies (UPSes) that not only provide the juice but can communicate with your PC for controlled shutdown.

• WORKSTATIONS

More reviews of Windows NT workstations, including an Alpha 21164 and a new crop of PowerPC systems.

• LET YOUR NETWORK DO THE WALKING

Directory Services help bring ever-larger and complex networks under control.

• SIMULATING BUSINESS

How Siemens Solar Industries has made extensive use of simulations as part of its effort to reengineer business processes.

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The graphic is a vertical timeline of Creative Labs products. At the top, a sequence of four figures shows the evolution of man from an ape to a modern man in a suit. Below this, four rows of product boxes and images are shown, each with a label underneath:

- Row 1:** Microsoft MS-DOS, WINDOWS 3.1, and Microsoft Windows 95.
- Row 2:** "BEEP" (represented by a speaker icon), SOUND BLASTER PRO, SOUND BLASTER 16, and SOUND BLASTER AWE32 PnP.
- Row 3:** "HELLO" (represented by a modem icon), MODEM BLASTER 14.4, and MODEM BLASTER 28.8.
- Row 4:** 5 1/4" (represented by a floppy disk icon), OMNI 2x, BLASTER CD 4x, and BLASTER CD 6x.

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NEWS & VIEWS

X86 PROCESSORS

Intel's Rivals Ready to Exploit P6 Weakness

Benchmarks run on an early reference system confirm that the P6 is not the best chip for running 16-bit software. AMD and Cyrix say they won't have the same problem.

BY THE BYTE STAFF

The mediocre performance of the next-generation P6 processor on Windows and 16-bit DOS code creates an opportunity that Intel's competitors are eager to exploit. At least two of those competitors, AMD and Cyrix, say their respective next-generation x86-compatible processors, the K5 and the M1, will not suffer from the P6's defects when running Windows 3.1 or Windows 95 software.

As reported in BYTE last month (see "P6 Weakness Revealed"), preliminary benchmarks run by Intel indicated the P6 performs best when running 32-bit code. Older 16-bit and current mixed 16/32-bit code (as found in Windows 3.1 and Windows 95, respectively) that makes use of segment writes, partial register operations, unaligned data accesses, and instruction-prefix bytes stymies the P6. This is because when Intel started designing the P6 about five years ago, the company thought most code running on today's desktops would be 32-bit. Thus, the P6 was not optimized for 16-bit performance. BYTE recently confirmed the P6's poky 16-bit performance by

running a variety of benchmarks, including a special 16-bit version of the cross-platform BYTEmark CPU and FPU benchmarks (see the figures below).

AMD says its K5 has extra tag fields and comparators in the reorder buffer to handle partial register accesses more smoothly than the P6. Also, unlike the P6, the K5 can execute segment changes speculatively, a technique that avoids significant performance penalties.

Cyrix's M1 has special circuitry that makes its performance when handling segment-register writes, partial register updates, and instruction-prefix bytes better than that of the P6 when running 16-bit and mixed 16-/32-bit Windows code. Cyrix officials say the M1 will offer better 16-bit and equivalent 32-bit performance as the P6.

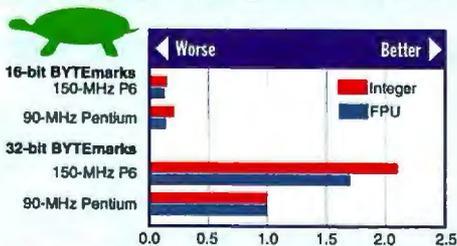
Tests performed on an early P6 reference system produced by Intel highlight the P6's 16-bit/32-bit performance gap. We ran a variety of benchmarks on a 150-MHz P6 reference system. The system had a 60-MHz I/O bus, 64 MB of two-way interleaved RAM, a Diamond Stealth Pro video card, and the P6's integrated, 256-KB secondary cache. Our tests indicate that for running 16-bit applications, you'll almost always get equal or better performance for less money if you buy a PC based on a 90-MHz or faster Pentium instead of one based on a first-generation P6 processor.

When running a 16-bit version of BYTE's cross-platform BYTEmark CPU/FPU benchmarks, our baseline 90-MHz Dell Pentium outperformed the 150-MHz P6 on all tests except the Fourier test. The reason the P6 won here is because every test except the Fourier test operates in a source/destination fashion.

With source/destination operation, the tests process a quantity of data (source) and output another quantity of data (destination). For example, the IDEA test reads a large array of text and encrypts it into a destination array.

All the source/destination-

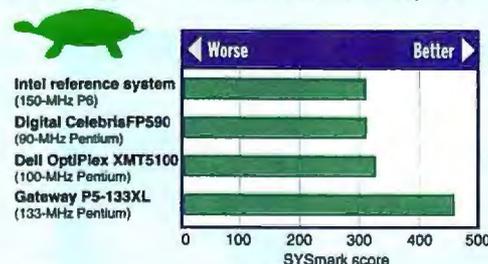
P6 Poky While Running 16-bit Software



A 90-MHz Pentium running 32-bit extended DOS in protected mode = 1.0.

BYTE's cross-platform BYTEmark CPU and FPU benchmarks confirm that a 90-MHz Pentium outperforms a 150-MHz P6-based system running 16-bit code. The performance of the P6 improves over that of the Pentium when running 32-bit code, as you would expect.

16-bit Application Performance Poor, Too



SYSmark scores are from the BAPco's SYSmark benchmark running a variety of Windows 3.1 applications.

The P6's difficulty with 16-bit code is less pronounced at the application level, but it's still noticeable. Practically any 100-MHz Pentium-based machine will outrace a 150-MHz P6-based computer when running Windows 3.1 applications.

style tests must call the segment-offset calculation routine repeatedly. On the P6, this results in a performance penalty, because that routine involves a segment-register load.

If Cyrix and AMD can deliver processors that offer better 16-bit and comparable 32-bit performance as Intel's first P6, then both companies will likely sell more chips to users

who want to maintain their investment in legacy code. But the window of opportunity is small. Microsoft's release of Windows 95 should push the market toward 32-bit software.

And when Intel pumps up the P6's clock speed to 200 MHz, which is expected to happen later in 1996, the P6 should outperform the Pentium no matter what software it's running.

WINDOWS 95

Coming: A Better Multimedia Platform

Windows 95 includes numerous multimedia technologies, such as 32-bit video codecs, integrated MIDI and WAV audio, and support for enhanced audio CDs. But users will have to wait for other enhancements.

The first release of Windows 95 lacks a number of 3-D- and multimedia-related technologies, including OpenGL; support for hardware-assisted, full-motion video acceleration; and the Windows 95 game subsystem, among others. The lag time between the first release of Windows 95 and the appearance of additional multimedia capabilities could range from one to several months (see the table at right).

One key element that's missing from Windows 95 is support for full-motion video acceleration. This feature is missing because Microsoft removed support for the Display Control Interface (DCI) from Windows 95 earlier this year due to stability issues, according to company officials. Version 2 of DCI, which was to have incorporated several technologies for games and video-hardware acceleration, was replaced by the Direct series of APIs and the Windows 95 game subsystem.

Since DCI is not supported in Windows 95, and final code for implementing the Direct APIs wasn't slated to ship until late September, users will have to wait at least a month before new cards from such companies as Matrox, ATI Technologies, and Number Nine Visual Technology will be able to accelerate full-motion video movies in Windows 95. "Microsoft's road map for

video acceleration has been quite wobbly," says an official at one hardware-acceleration company. "However, the situation should be sorted out by this fall."

Microsoft's plans for 3-D in Windows 95 have evolved, too, as the company is rolling out two new APIs to complement OpenGL. One new 3-D API, called RealityLab, is expected to enter general beta testing in September and ship commercially in 1996.

RealityLab, which Microsoft received when it acquired London-based RenderMorphics earlier this year, is a cross-platform, high-level, real-time API. The first applications written to another API, called Direct

3-D, could ship later this fall.

David Britton, group marketing manager for Windows 95 multimedia, says RealityLab is for developers who want to write consumer, business, and some virtual-reality applications using a high-level API. Direct 3-D, meanwhile, targets a different type of developer—one "who wants to get every ounce of speed and performance from the system," Britton says. Thus, Direct 3-D should appeal to developers of high-paced action games. The target market for OpenGL, which is currently available for Windows NT 3.51 and slated to ship for Windows 95 next year, is still high-end professional CAD and modeling ap-

plications. Some vendors wonder if OpenGL will ever ship for Windows 95.

Microsoft's Britton says the company will continue to improve upon Windows 95's multimedia capabilities. "You have two waves here," he says. "The first release of Windows 95 already has a faster GDI [Graphical Device Interface], 32-bit video, and other enhancements. And then, starting in September, a whole new suite of software will come out; we'll be supercharging Windows 95."

Until that happens, however, perhaps the fairest grade to give Windows 95's multimedia support is an *I*, for incomplete.

—Dave Andrews

FUTURE WINDOWS 95 MULTIMEDIA SCHEDULE

COMPONENT	COMMENT	DUE DATE
Software MPEG playback	Will allow about 24 frame-per-second playback of CD-ROM MPEG movies on high-end Pentium-based PCs.	Undetermined.
Windows 95 Game Subsystem	Allows programs written to the Direct series of APIs (e.g., DirectDraw) to execute under Windows 95.	First version, to be distributed by independent software developers with their applications, may ship in late September. Time frame for inclusion in Windows is undetermined.
DirectDraw, DirectSound, DirectPlay, DirectInput APIs	Games and multimedia APIs that allow hardware-accelerated 2-D video, high-performance sound, networked multiuser support, and digital joysticks.	The first applications and drivers for hardware-accelerator cards could appear in late September.
Direct 3-D device driver interface	Driver interface for hardware developers that lets boards accelerate multiple 3-D APIs used by software developers.	Expect applications and drivers for hardware to begin appearing this fall.
Direct 3-D	Low-level API for software developers, especially those developing games, who want fast 3-D performance.	The first Direct 3-D applications might appear this fall.
RealityLab 3-D API	High-level, real-time 3-D API for developers writing consumer, business, and virtual-reality applications.	Expected to enter broad beta testing in September. Expect final code and the first applications in the first quarter of 1996.
OpenGL	High-end 3-D API for developers writing professional CAD, modeling, and other engineering applications.	Available now in Windows NT 3.51, but Windows 95 availability is slated for 1996.
Surround Video	A 360-degree multimedia environment (for more information, see "See You Around," May BYTE).	Undetermined.

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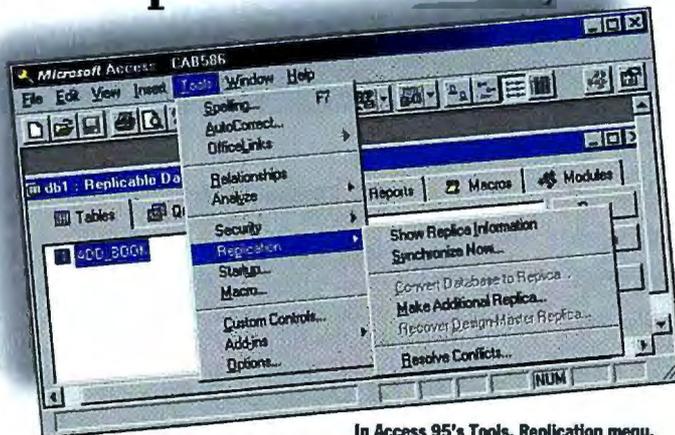
DATABASE TRENDS

New Replication Options in Access, Oracle, and Notes

The new 32-bit version of Microsoft's Access for Windows 95 database, which is slated to ship this fall, offers a host of new features. But one that should especially appeal to developers supporting remote workers is replication. Made popular by Lotus Notes and introduced for enterprise databases, such as Oracle 7, replication allows Access 95 users to work remotely with a copy of the master database and later incorporate all their changes into the master database.

Based on use of a beta version of Access 95, the easiest way to use the database's replication is through the Windows 95 Briefcase. Making a database replica is as easy as dragging and dropping a database file from a server into the Briefcase of a notebook PC that's docked to your network.

Because Windows NT 3.51 does not have the Briefcase interface, users of that OS (as well as Windows 95



In Access 95's Tools, Replication menu, the items in black-on-gray are for managing replicas after a database is converted to a design-master replica. The options in gray list selections for converting a database to a design-master replica and recovering from a faulty design-master replica.

users) can control Access replication in two ways: by using the Tools, Replication menu, which provides commands for controlling replication, or by using Visual Basic for Applications, which replaces the Access Basic programming language used in older versions of Access.

Dropping a database file into the Briefcase of a connected portable computer initially creates a regular replica and a design-master replica. The regular replica is used for updating data changes. Database developers use the design-master replica to propagate database-design changes to other replicas.

Access 95 offers replication management tools and automatic conflict resolution. But these tools don't offer quite the level of granularity that other programs, such as Lotus's (Cambridge, MA) Notes 4.0 and an upcoming version of Personal Oracle 7 from Oracle (Redwood Shores, CA), do.

Conflict resolution in a replication is the process of reconciling changes to two replicas that are inconsistent. If, for example, in one replica a customer's Bill To address changes, but in another replica the Ship To address of the same record changes, the two records conflict when they're synchronized

tion of Access.

Replication Manager, which will be released with the Access Developer's Toolkit, adds functionality and simplifies management. This Access component permits the scheduling of replication for particular times, such as 3:00 a.m., and the setting of synchronization rules for the sequence of replication among replicas. It also provides a "dropbox," a network location for holding replica updates. When replicas become connected to the network, they can update themselves with the dropbox contents.

But neither Oracle nor Microsoft supports field-level replication, which is promised for Notes 4.0, the Lotus groupware platform that's now slated for availability in the fourth quarter of this year. Field-level replication accelerates synchronization by reducing the amount of data that's passed in a replication.

For instance, if one field changes in a record (which is actually a document in Notes), then, instead of the whole document being passed in the replication, just a single field is passed. Field-level replication's increased efficiency bodes well for administrators who manage worldwide Notes networks.

Desktop users will have a rich array of replication options available in the fourth quarter of this year. Access 95 provides this functionality to a whole class of department-level developers. Personal Oracle tightly integrates with Enterprise Oracle to deliver some of the rich functionality of its flagship product. Lotus will reduce the time needed to replicate databases with Notes 4 when it rolls out field-level replication.

—Rick Dobson

ACCESS 95

GOOD FOR:

- Letting mobile workers periodically synchronize their remote databases with the home-office version.
- Letting small businesses synchronize database replicas across a few offices.
- Database administrators who want to balance the load on a database by directing users to replicas.
- Developers who want to distribute design updates through Access replication.
- Database backup (only changes are replicated).

BUT NOT FOR:

- Replicating Access 95 data directly with Microsoft's SQL Server.

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Target Platforms: Windows 95, Windows NT, Windows 3.x, Win32s, OS/2 Warp, OS/2 2.x, Extended DOS, Novell NLM, OS/2 1.x, DOS

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"(Watcom C/C++) delivered the fastest executables we saw in this roundup."
PC Magazine, April 11, 1995.



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New Back-UPS: \$119 blackouts, brownouts

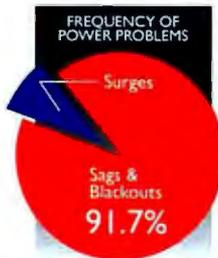


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Source: Contingency Planning



Source: Bell Laboratories

IN THE NEXT THREE MONTHS, MORE THAN 30,000,000 PCs WILL BE HIT BY POWER PROBLEMS...

Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.

WHY A \$119 APC UPS COSTS LESS THAN A \$9. "SURGE PROTECTOR"...

Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.

And since sags and blackouts represent more than 90% of power problems likely to hit your computer, even quality, high-performance surge suppressors are literally powerless to protect you from data loss.

That's why you need instantaneous battery backup power from an APC Uninterruptible Power Supply to prevent



For extended brownout protection for advanced PC workstations call about APC's New Back-UPS Pro!

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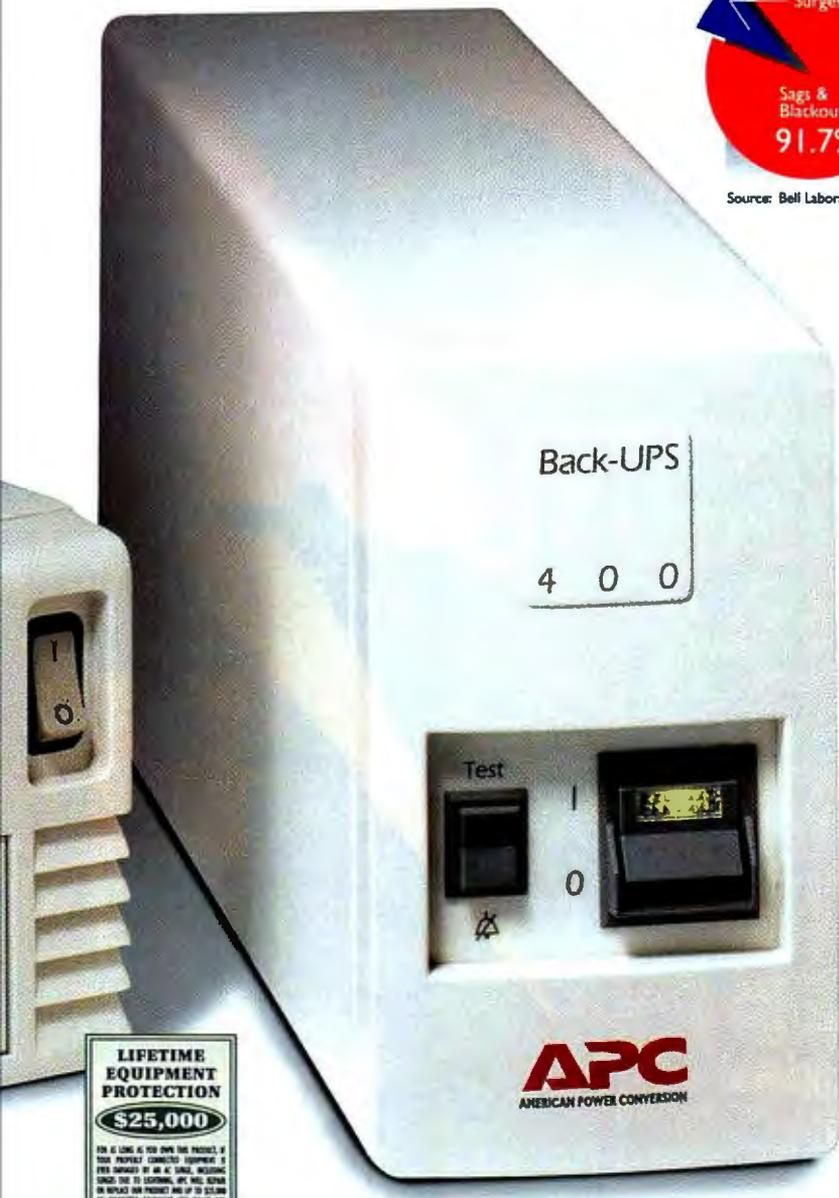
"Don't take chances. Get the ultimate protection... from APC."
--PCWorld

"★★★★ Back-UPS should be standard on every desktop... effective, affordable, designed to last..." --PC Computing

"A UPS can pay for itself the first time it saves your data." --MacUser



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APC
AMERICAN POWER CONVERSION

protection against and other trials by fire

More than 3,000,000 satisfied customers count on APC reliability that goes above and beyond the call of duty

After a raging fire which took 18 trucks to subdue, Michael Benolkin, director of the Systems Division at Correa Enterprises, Inc. didn't expect much. "While rummaging through the ashes, we heard something beeping. Our four APC units were still in action, while two UPSes from another brand were history. We're still using these same APC units at our new office location - they still work like a charm! We're impressed with the ruggedness, reliability, and product support offered by APC."



Trial by Fire

Brian Krause, Network Manager for Goodyear Airship Operations, knows how critical APC protection can be. "The night of the All-star game a tornado came through our blimp hanger and took out our roof. Our airships demand absolute communication so I protect our local and remote servers with the most reliable protection I can find: APC. APC's PowerChute software shut our server down in an orderly way... closed out all files nice and neatly. When we reconnected, everything came back up perfectly, without a hitch."



Trial by Air

Doug Welch learns his reliability lessons well: "While still a Computer Science student, I was at home preparing a large spreadsheet for a final project when Anchorage experienced an all too common 5+ Richter earthquake. If not for my Back-UPS 400 it would have been back to square one! I'm now the Network Systems Manager at Charter College, in charge of three networks. I learned my UPS lesson well back in my student days. I've never been disappointed with APC and the product has had quite a work out."



Trial by Earth

Faced with a water main break, Mark Conley, Regional Manager of Novell's remote sales office in Detroit was amazed at APC's reliability. "The APC unit was sitting in an inch and a half of water, working just fine, as though nothing was unusual and we lost no data to this disaster. We've used APC here now for at least four years - more than a dozen units are all around the office, and we're well satisfied, so we were even more impressed to learn that the units are amphibious!"



Trial by Water



Back-UPS Award Winning FEATURES

- ▶ Unmatched surge/lightning protection for maximum hardware safety
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- ▶ 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

Model	Application	Sugg. List
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400	Desktop 486/386 systems	\$199
450	Tower 486/386 systems	\$254
600	CAD/CAM workstations	\$359
900	Longer runtime	\$529
1250	Multiple systems	\$689

keyboard lockups, data loss, and crashes. With an APC UPS, you get six times the protection of a high-end surge protector for little more than twice the price. And \$119 is much less expensive than false peace of mind. APC UPSs carry up to a \$25,000 lifetime guarantee against surge damage to your properly connected equipment, and are available to suit any application, from network servers and PCs, to fax and satellite systems.

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PROGRAMMING TOOLS

Run-Time Error Checking Comes to Compilers

The familiar programmer's grind—compile, run, debug, and repeat as necessary—will have another major step added to it if proponents of run-time error checking have their way. Borland, Microsoft, and Nu-Mega Technologies are making strong efforts to integrate this reliability-enhancing technology more deeply into the programming cycle by hooking run-time error checkers directly into the Borland C++ and Microsoft Visual C++ integrated development environments (IDEs).

Tools vendors have always supplied programmers with expressive languages, such as C, and prewritten code in programming libraries, which lets developers write more powerful applications for end users. Meanwhile, in today's highly competitive market, programmers must race to add new features to their programs. However, the difficulty of tracking memory and resource allocation grows with the use of higher-level APIs and language extensions. The result of these two trends is often more features—but also more bugs—in applications.

"Top quality is not the winning market feature in applications today," says Jim Moskun, chief technology officer at Nu-Mega (Nashua, NH, (603) 889-2386). Nu-Mega hopes to help reverse that trend with its Bounds Checker Professional, slated for September announcement (price at press time was undetermined).

The company's current Bounds Checker for Windows, which automatically flags memory and resource leaks, monitors illegal address references, and validates Windows and C-library APIs, established the Windows run-time error-detection category of tools. But Bounds Checker, according to Nu-Mega president Frank Grossman, is used primarily in the quality-assurance stage of program testing, in which a programmer often receives an error report months after writing an errant module.

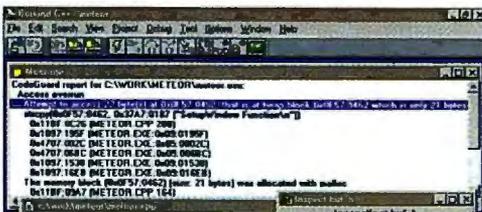
Bounds Checker Professional, in contrast, is designed for daily use, allowing programmers to catch errors while the code is still fresh in their minds. "We want programmers to check early and check often," says Grossman. The program integrates directly into the Visual C++ environment on the toolbar, making it as easy to error-check a program as it is to merely run it. The program also enables programmers to do



1) Nu-Mega's Bounds Checker Professional indicates an invalid argument, the cause of which was an uninitialized structure-size field.

2) The middle pane shows the call stack.

3) Here, Bounds Checker Professional displays the source code, with the offending code highlighted.



CodeGuard hooks into the Borland C++ 4.5 IDE, detecting memory and resource errors and validating API parameters in a one-step process for programmers writing 16-bit Windows programs.



OS/2 for PowerPC?
(see "OS/2 on the PowerPC Slated for This Year," June 1994 BYTE)

The official word from IBM is that OS/2 for the PowerPC is expected to enter general beta testing this fall and to be released by the end of the year. IBM has shown preliminary versions of OS/2 running atop PowerPC hardware at several industry trade shows over the past several months, but performance on these demonstration machines was poky.

The delay of OS/2 for the PowerPC means that IBM's new PowerPC-based Personal Computer Power and ThinkPad Power series of computers and notebooks can run only Windows NT or AIX. Meanwhile, Canon (Costa Mesa, CA) is positioning its new PowerPC-based Power Workstation line of systems and notebooks as "PowerPC Windows NT solutions."
—D. A.

such things as ignore validation flags or errors by module or by function, which allows team members to check only the files that they've modified, or ignore a known bug in application framework code.

Bounds Checker Professional's ability to let project managers establish libraries of acceptable errors lets a manager give each programmer a readily definable mission: Make every module run cleanly through error checking. Nu-Mega's error-detection software will run with all Visual C++ environments.

Microsoft (Redmond, WA, (206) 882-8080) is also making run-time error detection a more integral part of its upcoming Visual C++ 4.0 by including C debugging libraries. These libraries should help programmers identify problems that occur at the interface between the user and Microsoft-supplied code.

Borland (Scotts Valley, CA, (408) 431-1000) is also releasing new error-checking programs. Although Bounds Checker Professional works with Borland and Symantec compilers, it is tightly bound only to Microsoft's Visual C++ IDE. Borland's new CodeGuard program brings a similar level of error-checking integration to the Borland camp.

CodeGuard hooks into the Borland C++ 4.5 IDE, detecting memory and resource errors and validating API parameters in a one-step process for programmers writing 16-bit Windows programs. CodeGuard isn't quite as expert as Bounds Checker Professional is at handling tricky API problems, but Borland officials say they will continue to add capabilities to their program.

As tool vendors put run-time error detection into the hands of every programmer, developers and end users alike will benefit. Developers will become more efficient and effective, while users will get better, more reliable programs.
—Steve Apiki



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see
what's
possible

WINDOWS 95 PLUG AND PLAY

We Plugged, but They Didn't All Play

Windows 95 brings together a variety of components to make installing new peripherals in a PC as easy as upgrading a Mac. But tests of several new Plug and Play (PnP) devices show that unless you have all the required pieces in your PC, you can expect to do a lot of work before you get to play.

Various pieces of the PnP puzzle were available prior to the release of Windows 95 (see "Transforming the PC: Plug and Play" in the September 1994

version BackUPS Pro 650 UPS from APC (West Kingston, RI, (401) 789-5735), highlighted the benefits of PnP when it works, as well as the frustrations that you can expect when it doesn't. When PnP worked, configuring the BackUPS Pro was a breeze. We plugged in the AC cord, connected the serial cable to our PC, turned on the UPS, and rebooted the PC. Windows 95 detected the presence of the new UPS and pre-

boot-up, Windows 95 sends out a query on the serial port. The APC UPS responds with a message that includes the product's name and serial number. If Windows 95 doesn't recognize the device from its hardware list, it then begins the installation process described above.

The APC UPS/Windows 95 combination worked fine on an old no-name clone PC, but it didn't work on a much-newer Zeos Pantera. Neither system had a PnP BIOS, but both should have been able to complete the auto-detection and automatic software installation. Nothing we tried could get the Zeos/Windows 95/APC combination to work automatically. We finally resorted to a manual installation, using the Add Hardware applet in the Control Panel.

Adding a UPS isn't too difficult a process, since it's an external peripheral. Where PnP is really supposed to help is when you add an internal card, as well as after you've installed it; you can reconfigure PnP cards without having to reopen your computer.

To test this capability, we first tried an EtherEZ 10Base-T network adapter from Standard Microsystems Corp. (SMC, Hauppauge, NY, (800) 762-4968). This time we installed the Windows 95 CD before putting in the card. When we rebooted, the PC detected the new adapter and installed the software from the CD without any additional intervention on our part.

But unfortunately, the computer had previously been using a non-PnP NE2000-compatible adapter. Because this older adapter wasn't a PnP device, Windows 95 still loaded its driver, even though the card was no longer installed. The

Windows 95 Device Manager indicated an error in using the NE2000-compatible device, but the Microsoft Networking log-in did not; it simply said that no domains were available.

From the Device Manager, it was a relatively simple matter to remove the NE2000 device. Even so, after we plugged in the PnP network adapter, it took an awful lot of configuring and rebooting before we got it to work.

Our only true success story was with the Future Domain (Irvine, CA, (714) 253-0400) PNP-1640 SCSI controller (see the screen at left). The PC initially detected the new card much as it did the APC UPS and the SMC EtherEZ. But even better, whenever we removed the Future Domain card and then rebooted the PC, the device driver did not load, and no entry appeared in the Device Manager.

Note that our mouse, which was not a PnP device, showed an error because it was not plugged into the serial port. If the mouse had been PnP compatible, Windows 95 wouldn't have loaded the driver at all.

PnP promises a better future for those who want to upgrade their PCs. But as our experience illustrates, PnP works best when everything—the BIOS, the OS, all the attached devices, and your applications—are PnP compatible. This is welcome news for vendors who want to sell new PnP products, but not such great news for system administrators. For those without a PnP BIOS, the combination of Windows 95 and PnP devices still brings benefits. But adding new devices is still not without some pain, and the experience is rarely as simple as plugging something in and turning it on.

—Rex Baldazo



When we installed APC's UPS, Windows 95 detected the new device and presented this dialog box, which prompted us to install software from a floppy disk. If we had loaded the Windows 95 installation CD into the PC's CD-ROM drive, this dialog box would not have appeared; instead, the APC software would have installed directly from the Windows 95 CD.

When we installed a Future Domain SCSI controller, the PC recognized the device automatically. Even better, the PC performed properly after we removed the SCSI controller.

BYTE). But the piece that pulls it all together is a PnP OS. Thanks to the arrival of Windows 95, the promise of PnP on the PC has at last become a reality—sometimes.

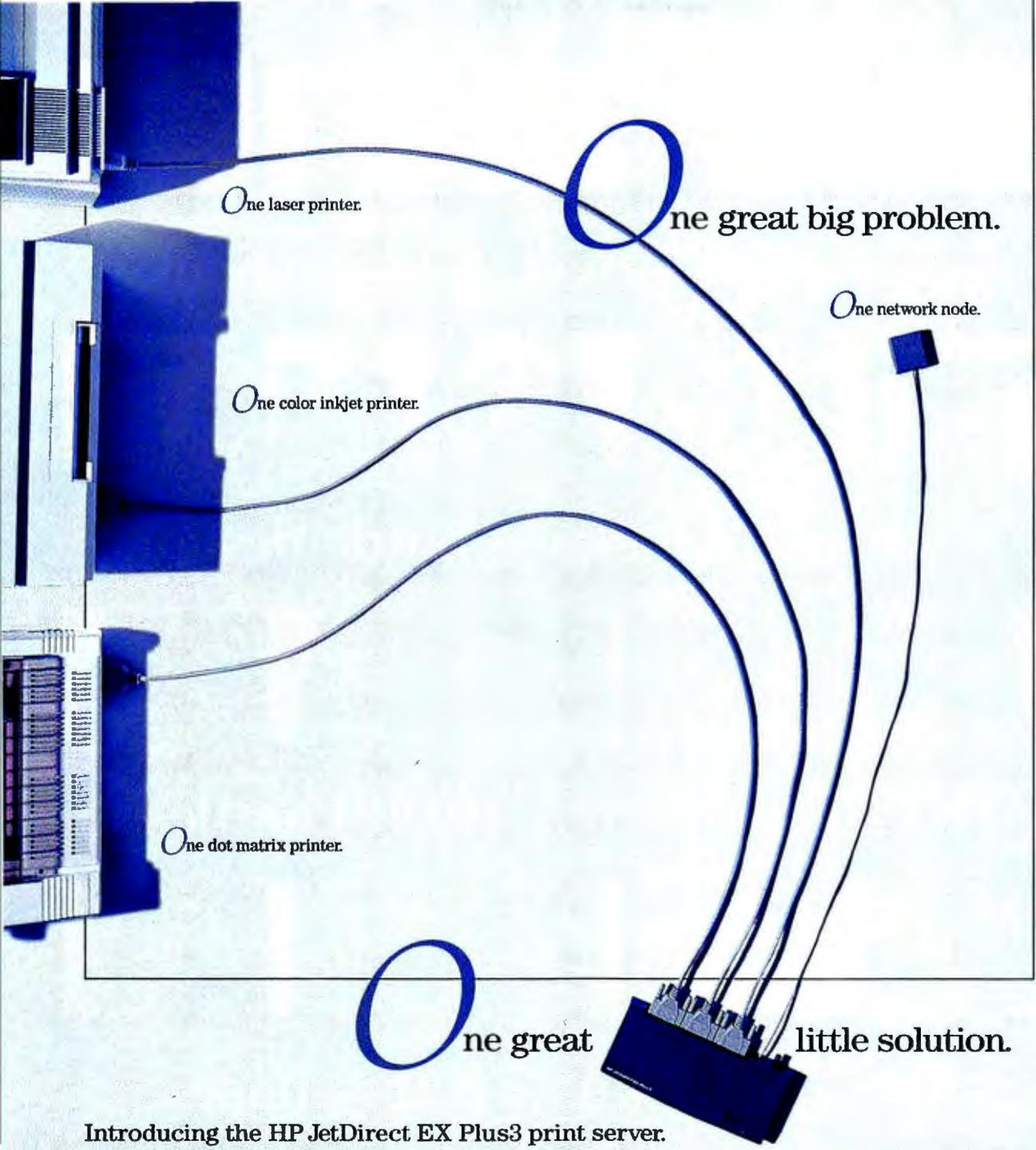
BYTE tested several new PnP devices, legacy SCSI and network adapters, and a new uninterruptible power supply (UPS). To evaluate how the new devices will fare in the typical office containing older PCs, we tested them on legacy computers that don't have a PnP BIOS. Our tests show that if you have a variety of legacy equipment, you may need to pray before you play.

One peripheral that we tested, the American Power Con-

presented a dialog box (see the screen above).

If we had loaded the Windows 95 installation CD into the PC's CD-ROM drive, the process would have been even smoother. The dialog box would not have appeared; instead, the APC software would have been installed directly from the Windows 95 CD. Regardless, once the APC software was installed, we didn't have to tell the software which serial port to use, set the data transfer rate, or perform any of the other operations that adding UPSes has traditionally required.

This magic involves a handshake between Windows 95 and the APC UPS. During



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Fortunately, there's an easy way out—and in. The new HP JetDirect EX Plus3 print server lets you connect up to three printers to the

network, using only one LAN connection. Best of all, it works with any parallel printer, and supports virtually every network protocol and NOS out there.

For fast faxed information, call 1-800-964-1066.* You'll discover that for every problem, there's a solution. At least when it comes to network printing.

NOS Compatibility: Novell NetWare; Microsoft® Windows™ 95, Windows NT, Windows for Workgroups, LAN Manager; IBM LAN Server; UNIX®: HP-UX, SunOS, Solaris, IBM AIX, SCO UNIX, Ipd; Apple EtherTalk
Management Support: HP JetAdmin print management software enables consistent installation and management of any HP JetDirect connected printer on the network;



- supports SNMP-based network management software
- Flash memory for easy upgrades
- Multiple protocols with automatic switching
 - Three high-performance IEEE 1284 ports
 - 3-year return to HP warranty
 - HP JetDirect EX and EX Plus3 print servers support all parallel printers
 - HP JetDirect cards support HP printers with I/O slots



Specifications for HP JetDirect EX Plus3. Award logos apply to HP JetDirect EX. *In Canada, call 1-800-387-3867, Dept. 239. Microsoft is a U.S. registered trademark and Windows is a U.S. trademark of Microsoft Corporation. UNIX is a registered trademark in the United States and other countries, licensed exclusively through X/Open Company Limited. ©1995 Hewlett-Packard Company RND016





You're on the road. With a client.



You need to locate a bottle design.



HQ's database has 40,000 bottles.



And all you know is the shape.



Sort of.





Perfect.

Your mind recalls information visually. But can a client/server database advance that far?

Well, IBM's exclusive Query By Image Content (QBIC) technology for DB2® should open your eyes. It actually lets you locate a range of records based on shape. Or color. Or even texture. Which can translate directly into faster access to data—including multimedia—to help you make better business decisions.

Not that such advances should surprise you. IBM has led the way in databases as long as there have been databases. (Indeed, DB2 is at work in over 90% of the *FORTUNE 500*®.)

And DB2 has a long history of offering useful innovations for information management, such as tools to manage your database remotely, pull information from disparate databases, and replicate corporate

data across a number of different locations.

DB2 meets open industry standards too, working seamlessly on OS/2®, AIX®, HP-UX®, Sun Solaris®, OS/400®, MVS, VM and VSE—and soon on Windows NT™ and Siemens Nixdorf SINIX®. Its broad scalability ensures that your database will deliver speed and efficiency from any size server.

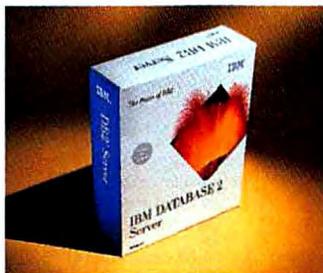
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leading companies, DB2 is the shape of things to come.



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APPLICATION TRENDS

Help Gets Natural

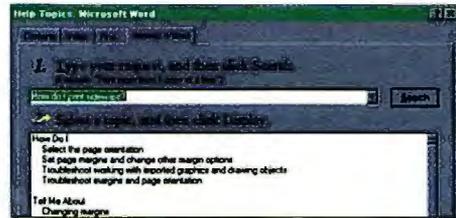
To learn how to use the software they depend on, computer users have for years either dialed up technical-support lines or asked friends and coworkers. Now they can ask their software instead, using plain English.

A new capability, dubbed natural-language processing (NLP), allows a stumped user to type in a question such as "How do I get these numbers into a bar graph?" In response, the software directs the user to an appropriate help screen or

a step-by-step tutoring routine.

These NLP features are showing up in new versions of programs from Lotus, Microsoft, Novell, and other software vendors. Microsoft's (Redmond, WA, (206) 882-8080) Office 95, for example, contains an Answer Wizard that lets you type in anything ranging from a few words to a complete statement or question in search of help.

Lotus's WordPro for Windows has a similar feature called Ask the Expert, which



In Microsoft's Word for Windows 95, when you ask a question such as "How do I see what this document looks like before printing?," you get a list of help topics that help answer your question.

prompts you to complete a "How Do I" question and then takes you to the appropriate help screen.

Novell's WordPerfect Division (Orem, UT, (801) 429-7000) says it plans to apply a host of NLP features to the next edition of Perfect Office, which is due to ship by the end of this year. A query in Perfect Office will yield not only help screens

but also interactive "coaches," templates, and "quick task" routines.

The next step will be to let users ask their computers questions by talking rather than by typing. Novell is already planning a 1996 or 1997 version of Perfect Office that will take NLP to the next level: voice recognition of plain-English questions. —Chris O'Malley

OPTIONS INCREASE, PRICES DROP FOR MAC ADD-ONS

Mac users will find a wide variety of options this fall when choosing graphics accelerators for their PCI Power Macs. The entry of such companies as ATI Technologies, Matrox, Number Nine Visual Technology, and others into the PCI-based Mac market means that Mac users can choose from a range of peripherals that cost less than comparable cards developed for the older NuBus. "There is more competitiveness now in the PCI Mac market," says Tony Bojorquez, product marketing manager for graphics cards at Radius. "Our PCI products are consistently [priced] lower across the board than comparable NuBus products," he adds. It also appears that some vendors selling PCI cards for both the Mac and PC markets will keep their prices the same. For example, Number Nine's Imagine 128 for Power Mac sells at the same price as its PC cousin. Other vendors, including Matrox and Miro, will price their Mac accelerators slightly higher. —D.A.

COMPANY	PRODUCT	DESCRIPTION	SUGGESTED RETAIL PRICE
ATI Technologies Thornhill, Ontario, Canada (905) 882-2600 fax: (905) 882-2620	Xclaim GA	24-bit color at up to 1152- by 870-pixel resolution (4-MB version) or 832 by 624 resolution (2-MB version)	\$649 (4-MB) and \$449 (2-MB)
Diamond Multimedia Systems San Jose, CA (408) 325-7000 fax: (408) 325-7070	Javelin Video 3240XL and 3400XL	24-bit color at up to 800 by 600 resolution and 24-bit color at up to 1152 by 870 resolution, respectively; both offer QuickTime video scaling and dithering acceleration	3240XL, \$399; 3400XL, \$569
Matrox Dorval, Quebec, Canada (514) 969-6320 fax: (514) 969-6363	MGA Millenium for the Mac	Mac version of graphics and 3-D accelerator	\$649
miro Computer Products Palo Alto, CA (415) 855-0940 fax: (415) 855-9004	Five PCI cards for the Mac, including the miroChroma 1280PV	24-bit color at up to 1280 by 1024 resolution; displays and captures VHS and Super-VHS video; 30-fps QuickTime movies at up to 1280 by 1024 resolution	Price for miroChroma 1280PV undetermined
Number Nine Visual Technology Lexington, MA (617) 674-0009 fax: (617) 674-2919	Imagine 128 for the Power Mac	128-bit graphics and video accelerator; up to 1600 by 1200 resolution with 16.8 million colors (8-MB version); up to 1600 by 1200 resolution at 65,000 colors (4-MB version)	\$899 (4-MB) or \$1599 (8-MB)
YARC Systems Newbury Park, CA (800) 275-9272 fax: (805) 499-4048	Screamer, Hydra, and RIP	The Screamer accelerates QuickDraw 3-D applications; the dual-processor Hydra accelerates rendering; RIP converts the Canon color copier into a networked printer	\$995, \$1995 and up, and \$14,995, respectively
Radius Sunnyvale, CA (408) 541-6100 fax: (408) 541-6150	Several products, ranging from the low-end PrecisionColor 8/1600 to the high-end ThunderColor 30/1600	24-bit color at up to 832 by 624 resolution (PrecisionColor 8/1600); 24-bit color at up to 1600 by 1200 resolution, plus DSP-accelerated Photoshop and CMYK display (ThunderColor 30/1600)	\$599 for PrecisionColor 8/1600; \$2499 for ThunderColor 30/1600
Radius	Thunder IV GX 1600 for NuBus	Comparable to the ThunderColor 30/1600	\$3699

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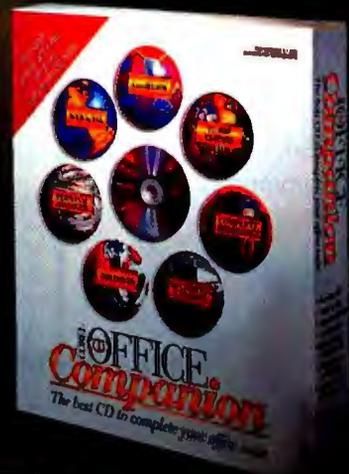
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KUR-0130

We are Gateway 2000.



August 1985
 "Hey, Mike ...
 call me crazy
 but I've had
 this craving all
 day to start a
 computer
 company!"
 Ted Waitt

September 5, 1985
 Congratulations, it's a computer
 company! Gateway 2000 is
 born at the Waitt Family Cattle
 Farm outside of Sioux City, Iowa.



August 1985
 Ted's grandma,
 "Momo," takes a
 leap of faith and
 becomes Gateway's
 first principal
 investor securing a
 \$10,000 loan.



April 2, 1986
 The Livestock Exchange
 Building at the Sioux
 City Stockyards:
 Gateway's first home
 away from home.

February 1988
 25 systems built
 and shipped in
 one day! All 10
 phones ringing
 off the hook from
 Gateway's first
 major ad in
*Computer
 Shopper*,
 "Computers
 from Iowa?"



November 1985
 Ted springs for
 Thanksgiving
 dinner for entire
 Gateway
 workforce (Mike
 Hammond).



1986
 Gateway 2000 ships its
 first PC.

August 3, 6918
 Dyslexic shipping clerk
 covers for Ted over lunch
 and becomes Gateway's
 first sales rep.



1987
 Texas Instruments PC
 customers exchange
 TI PCs for Gateway
 2000 IBM com-
 patibles.

February 1987
 Ted and Mike get sick
 of looking at each
 other. Up go the first
 cubicle walls!

September 1988
 Gateway sells 386-20
 PC for \$2,995, receives
Byte magazine's Award
 of Distinction.

September 1988
 Gateway herd finds
 greener pastures in
 Sergeant Bluff, Iowa
 (we moved there).

1988
 Industry
 First!
 EGA color monitors
 standard on all systems.

*We will always be happy, but
 we will never be satisfied.*

It started as a dream, born on an Iowa farm. Today,

10 years later, the same company that once clocked

in by a rooster crow is recognized

as the nation's PC industry leader.

The Gateway 2000® secret? Give

PC buyers a quality product, the

latest technology, and incompa-

rable service — all at an unparal-

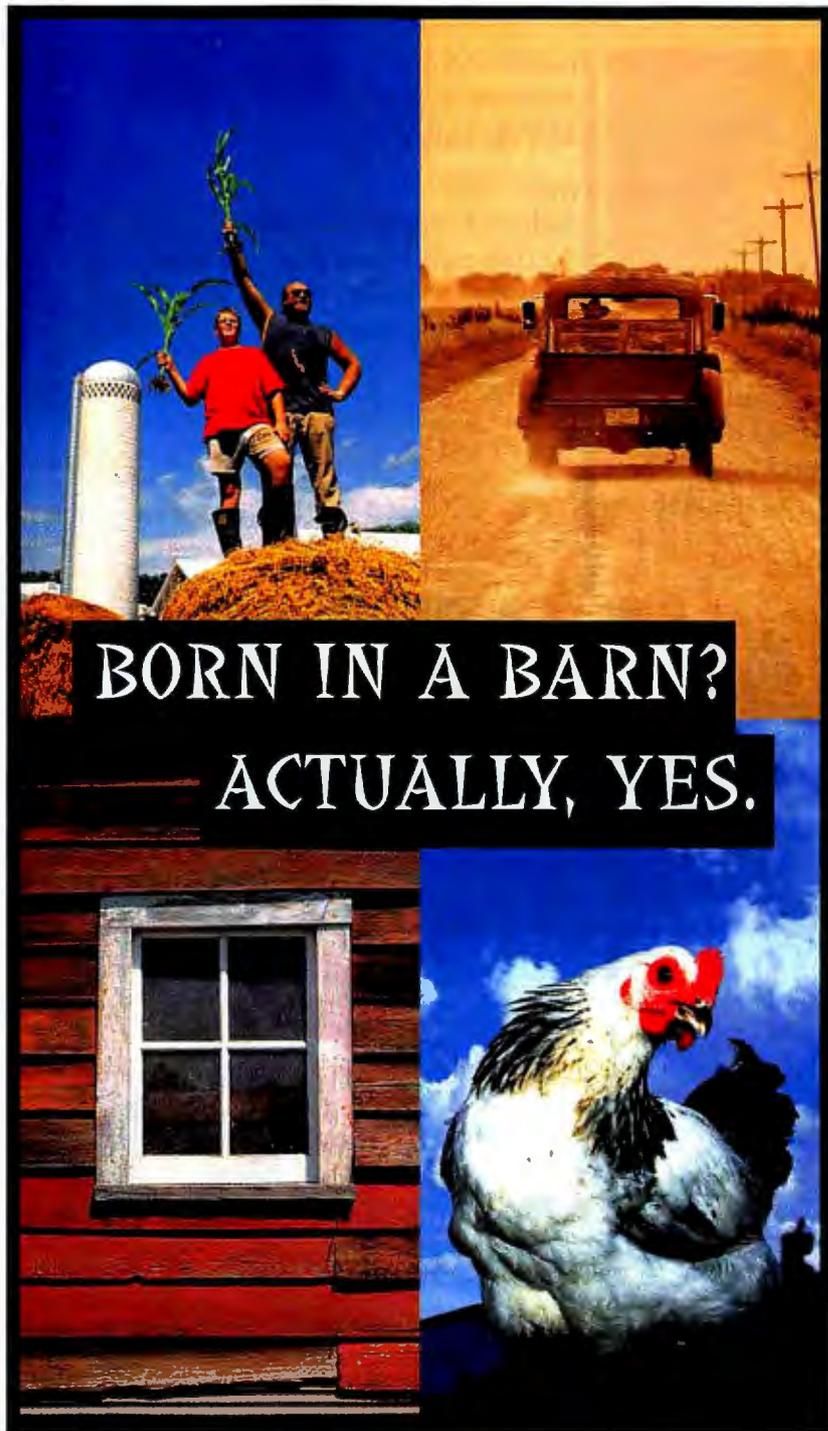
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employees know what it takes to

get the job done right. And we're

ready to outdo ourselves in the

next decade and beyond.

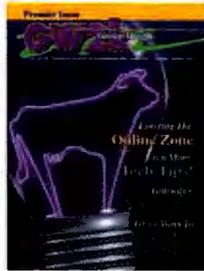


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 - 3.5" Diskette Drive
 - 17" .26dp Vivitron™ Color Monitor
 - 9-Bay Tower Case
 - AnyKey®+ Keyboard
 - MS Mouse 2.0
 - Microsoft® Windows® 95
 - 10th Anniversary System Software Collection: MS Office 95, Professional Edition and Generations
 - Gateway Gold™ Premium Service
- \$3999**



March 1995
Premiere issue of
GW2k: Gateway Magazine.

May 1995
Technical support completes
12,046 calls in one day! All techs
treated to sparkling cider in plastic
champagne glasses.

July 1995
Gateway ranks first among
Intel/Windows PC manufacturers
in brand loyalty.



May 1995
Gateway's P5-120
is named the
"fastest PC in the
world," by
PC/Computing.

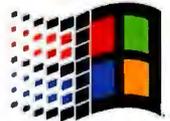


1993 Sales: \$1.7 billion
Employees: 3,500

1994 Sales: \$2.7 billion
Employees: 4,500



Designed for



Microsoft
Windows 95

November 1994
New Gateway
facility opens in
Kansas City.

June 16, 1995
Gateway is first to offer
Windows 95 as a free
upgrade on all standard
configurations.

July 28, 1995
Gateway goes
"down under"
to Australia.

August 1, 1995
Gateway Gold
Service and
Support program
unveiled.

December 1994
The Liberty small
notebook makes
its debut.

Industry
First!



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We share the vision of being our customers' only logical choice.

Industry First!

1989
It doesn't get any better than this — standard VGA monitors!

June 1989
Gateway goes online with GW2k BBS.

December 1989
McGraw-Hill purchases 386-20s and achieves immortality as Gateway's first major Fortune 500 customer.



1991
Gateway becomes first company to win all four Computer Shopper Best Buy desktop awards.

Industry First!

February 1991
Gateway is first to introduce non-interlaced monitors on all systems.



April 1991
Gateway introduces cow-spotted boxes.

Industry First!

February 1992
Customers rejoice! Gateway begins offering choice of application software with new systems at no extra charge.

1992
Barely seven years old and already Microsoft PC Manufacturer of the Year.

1993
Gateway offers first Family PC multimedia system for \$1995.

August 1993
The ColorBook and HandBook 486 enter Gateway's stellar product lineup.

May 1994
Gateway announces three-year warranty on all desktop PCs and monitors.

July 1, 1994
Gateway opens a showroom in Paris, France.



1989 Sales: \$70.5 million Employees: 176 **1990** Sales: \$275.5 million Employees: 600 **1991** Sales: \$626.7 million Employees: 1,300 **1992** Sales: \$1.1 billion Employees: 1,850

1990
The population of North Sioux City reaches a whopping 2,019.

May 1990
Microsoft Windows is now standard on all Gateway systems. **Industry First!**

October 1990
Gateway's first 486 system hits the market value-priced at \$5,295.

April 1991
Technical support completes a record number of 2,800 calls in one day!



March 1992
Technical support holding queue is empty for the first time in company history.

May 1992
Going mobile with our first portable computers, including the HandBook, the industry's first subnotebook.



Industry First!

October 1993
Holy leprechauns! Gateway Europe sets up shop in Dublin, Ireland.

September 1993
Gateway introduces first VESA system.

October 1993
Gateway offers our first Pentium system, the P5-60, for \$3599 and sweeps Computer Shopper's Best Buy awards for third consecutive year.

You've got a friend in the business.

INTERNET BROADCASTING

Radio Comes to Cyberspace

The golden days of radio are behind us, but a new era in audio broadcasting on the Internet is just beginning.

At least two companies have developed software for the Internet that lets you listen to audio, such as a news broadcast or a promotional sound clip, without first having to download the audio file to your hard drive. Developers are using these audio compression/delivery solutions to develop World Wide Web pages that you can see and hear. By the end of this year, more than 100 radio stations could be using these solutions to broadcast over the Internet.

Sending sound over the Internet is certainly nothing new.

However, Unix AU, Mac AIFF, and Windows WAV sound files, which typically measure 1 MB or larger, are voracious consumers of network bandwidth. Popular early Internet talk-radio experiments, such as Carl Malamud's half-hour "Geek of the Week" broadcast, typically required 15 MB. It was possible to listen to "Geek of the Week" in real time, but only if you had a 64-Kbps or faster connection.

Two new audio compression/delivery systems, RealAudio from Progressive Networks (Seattle, WA) and StreamWorks from Xing Technology (Arroyo Grande, CA), allow users with slower Internet connections to enjoy audio broadcasting. RealAudio and

StreamWorks both enable Web users to listen to audio without having to download a sound file first.

The quality of sound that StreamWorks and RealAudio provide will vary depending on your network connection, but you can typically expect AM-radio quality. RealAudio is designed to give you 16-bit, 8-kHz sound. At worst, you will think you're listening to an across-the-border AM radio station. At best, it sounds like a nearby AM station.

The quality of a StreamWorks broadcast can improve with higher bandwidth. Xing

Technology says that users with 9600-bps to 14.4-Kbps connections can expect AM-quality radio, but at 128 Kbps the quality of the broadcast can scale all the way up to CD-quality stereo sound. StreamWorks is based

on MPEG, so it can also compress video and allow Web users with ISDN connections to view full-motion video. One application for Internet audio is to enable radio stations to reach a wider geographic audience. But there are a lot of other applications for Internet audio besides radio broadcasting (see the box "Internet Audio Applications" above), including some that haven't been thought of yet.

—Steven J. Vaughan-Nichols

INTERNET AUDIO APPLICATIONS

- On-demand broadcasting (e.g., for following local sports teams or political issues from anywhere in the world)
- Corporate information systems
- Web kiosks
- Long-distance training and education
- Audio libraries

CODE TALK

RICK GREHAN



A New Age for OS/2 Programmers

A new version of IBM's Visual Age C++ development environment for OS/2 combines visual development tools with a compiler that generates executable programs comparable to those generated by Watcom's C/C++. Visual Age C++ (\$449 and up; for more information, call (800) 426-3333 and ask for "star 725" or contact <http://www.torolab.ibm.com> on the Internet), for use with OS/2 2.11 and OS/2 Warp version

3 or higher, is descended from a similarly named Smalltalk development system. In fact, most of the environment's Visual Builder component executes in Smalltalk, although you would never know it.

Visual Age's integrated development environment (IDE) consists of a number of interoperating tools. Although



Visual Age's environment workframe shows a make operation in progress.

you could use Visual Age simply as a C/C++ development system,

it places heavy emphasis on the paradigm of constructing an application by wiring together software "parts." This parts concept is fully realized in the Visual Builder, a classic visual development system in which you assemble programs by dragging icons (parts) out of a toolbar, dropping them into your application's window, and then defining execution behavior by linking the parts together.

I used the environment to build a window that manages a phone-list database consisting of a data-entry field, an Add button, and a listbox. When I typed a new name into the entry field and pressed the Add button, the entry field's contents were appended to the list in the listbox. Within Visual Builder, I assembled this application by first dragging and dropping the entry field, button, and listbox from a tool palette to the window. Next, I established a link between the button and the listbox by drawing a connection line between the two. The Builder then simultaneously prompts and guides you through defining what action activates the connection (pressing the button); what method in the listbox is "fired" by that action (appending an entry); and where the data associated with the method comes from (the entry field). Through all of this, you don't write one jot of C++ code; Visual Builder does it.

Along with the Visual Builder, Visual Age arrives with the usual host of development tools: browser, debugger, and performance analyzer. IBM also provides Open Class, a set of C++ class libraries that represents IBM's answer to Microsoft Foundation Classes (MFC). Visual Age can also directly generate System Object Model (SOM) objects.

The performance of executables generated by the Visual Age compiler appears to be on a par with that of my favorite compiler, Watcom C/C++. I moved the BYTEmark source code into a Visual Age project, compiled it, and got neck-and-neck results. Watcom scored indexes of .40 for the integer test and .26 for the floating-point test, while Visual Age turned in an index of .43 for integer and .24 for floating-point. (Both were run in an OS/2 full screen within Warp 3.0 on a 66-MHz 486.)



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MOROCCO: Futur & Soft 212 2 40 03 97
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SINGAPORE: Systems Design PTE LTD 65 747 2266

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VENEZUELA: HRT-M Osers 58 2 261 4282

FUTURE DISPLAY TECHNOLOGIES

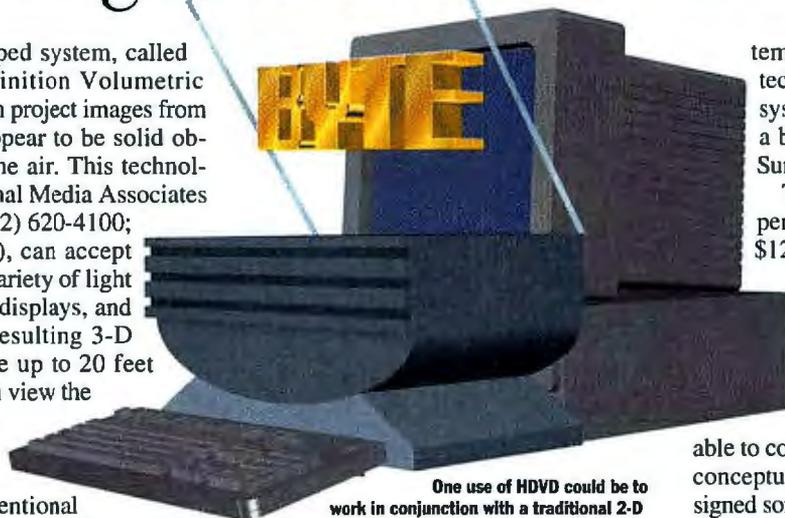
3-D Images That Float in Air

A newly developed system, called the High Definition Volumetric Display (HDVD), can project images from a PC so that they appear to be solid objects suspended in the air. This technology, from Dimensional Media Associates (New York, NY, (212) 620-4100; fax (212) 620-7771), can accept 2-D images from a variety of light sources, such as PC displays, and project them. The resulting 3-D aerial images can be up to 20 feet in width, and you can view the images under a variety of lighting conditions.

Projecting a conventional PC screen through an HDVD system results in a floating plane that displays real-time stationary and full-motion images. By generating and displaying image objects in a special format, a PC has the ability to act as a source of true 3-D images that can be viewed at different angles. "What we have is technology that's unencumbered by 3-D glasses or virtual-reality headsets," says Susan Kasen Summer, DMA's chairwoman. "It gives consumers a new way of viewing the software that they already have on their PCs."

HDVD systems might one day enable businesspeople to give 3-D presentations. There are also numerous possible applications in such areas as education, museum and trade-show kiosks, entertainment, the military, and the medical field, which has already begun investigating its use in surgical rehearsal.

"HDVD is going to play an interesting role in the evolution of advanced display technology," says Jeff Marshall, senior managing director at Bear Stearns (New York, NY), a brokerage firm that specializes in high technology. "We are encouraged that they have been able to develop the technology this far—and even more encouraged by the possibilities



One use of HDVD could be to work in conjunction with a traditional 2-D PC display, such as in a kiosk. The 2-D PC display could show data on the computer's monitor while you view a 3-D display that hovers in front of the PC.

of future applications."

For now, no directly competing technologies appear to exist. Although other 3-D systems are in development, including goggle-based virtual-reality viewing sys-

tems and Sanyo's image-splitting technology, they aren't projection systems. "It's still an image inside a box; it's not in free space," says Summer of HDVD's competition.

Today, HDVD technology is expensive (base prices begin at about \$12,000) and, as a result, currently out of the reach of consumer products. DMA holds the exclusive patent on the technology and is now working with established hardware vendors to make the technology available to consumers at a lower price (see the conceptual illustration at left). "We have signed some multinational contracts, which will be announced," says Summer, "and I think that by the beginning of the year, you'll see it [HDVD] in some consumer products." Adds Marshall: "Within the next two to three years, I expect to see the new wave of display technology and applications in wide use."

—Wayne Kawamoto

INTERNET E-MAIL

Coming: (Almost) Free Internet E-Mail

When someone offers you something for nothing, there's usually a catch. In the case of free Internet E-mail, the catch is the same one that comes with free TV: advertising.

Two companies, Freemark Communications (Cambridge, MA) and Juno Internet Services (New York, NY), are launching free, completely advertiser supported E-mail programs this fall. Both programs run on Windows, and both companies plan to offer Mac versions in 1996. Both products use proprietary interfaces and Internet connections. Thus, you won't be able to use their connections with another E-mail program, such as QualComm's Eudora, or another Internet application, such as Netscape.

The target audience of these products is people with little or no on-line experience. The idea behind each program is that while interest in the Internet and the World Wide Web is high, E-mail is currently the most popular application on the Internet and is growing in importance (see the chart). These free services are tailored for those who want just E-mail. The "price" you must pay is reading the ads that are attached to your incoming E-mail. Users may object to having to read these ads, but Prodigy has already shown that it's possible to combine advertising with an on-line service.

Both Juno and Freemark support basic E-mail only; neither supports Multipurpose Internet Mail Extensions (MIME) for binary attachments. Freemark will provide a toll-free phone number for nationwide network connectivity in the U.S. At press time, Juno said it may offer toll-free phone numbers, X.25 WANs, and local phone numbers. Juno can be reached at <http://www.juno.com>, and Freemark at <http://www.freemark.com/>. Considering the minimal cost of using a conventional on-line service (\$100 to \$200 annually) for E-mail, however, only the most cost-conscious users are likely to find either service of much interest.

—S. J. V. N.



Working in the Code Mine

DENNIS BARKER

It's hell working at Microsoft. Or so it is for the techno-turks in *Microserfs*, a zippy novel about 20-somethings hacking away in Mr. Bill's code mines. In the great work literature of the past, cruelly oppressed laborers slaved in slaughterhouses, sloshing around in guts and gore. These kids are bummed because they have to stay up all night debugging, trying to meet shipping dates, strung out on Chee•tos and Tab, living in fear of being flamed by Bill.

Meanwhile, they exist day by day, line by line, lamenting their lack of personal lives ("my universe consists of home, Microsoft, and Costco"), plotting their escape from Redmond, and being sure to check Microsoft's NASDAQ price.

The main characters are programmers—narrator Daniel works in product testing—but they talk more like industry groupies. They make a few obligatory references to C++ and class libraries, but mostly they talk Silicon Valley trash: the differences between Microsoft and Apple ("better cafeterias" versus "better nerd toys"), the "weird" corporate culture at Intel (staffers are suspected of being cyborgs), gossip, why Windows is counterintuitive, and the Cult of Bill.

And they whine, oh how they whine, that they're not "One-Point-Oh"—the first people to work on the first version of something. Being One-Point-Oh is what makes you a Cyberlord rather than a Microserf.

Coupland gets a little too cute sometimes, and his characters tend to talk like sitcom people, always quick with the riposte and bubbling with witty asides. But his observations are dead-on; he's much funnier than anyone writing in the high-tech press. There's a great scene set in a meeting with venture capitalists. Daniel uses pop metaphors to describe the money types. There's "VC Woman with Barbra-Streisand-in-Concert Hairdo" and "Young VC guy, who would be the same age as Rosemary's Baby."

Coupland's treatment of computers is more cultural than technical. They are props rather than an essential part of the story. In fact, he's more

interested in the low-tech knickknacks of the social landscape than he is in computing technology. For every reference to a Pentium or the Internet, there are a hundred mentions of warehouse stores, Pop-Tarts, Legos, *Melrose Place*, CNN, and aerosol cheese.

But that's OK. Coupland uses these cultural bits to good effect. Daniel describes his housemates in terms of their dream *Jeopardy* categories. There are enough pop references in this book to fill a CD-ROM on merchandise and entertainment of the late twentieth century.

Coupland's story is only partially about working at Microsoft. Mostly, it's about people and their relationships, not about the epic struggle to link objects. It's all seen through the eyes of 20-year-olds, but don't let that scare you away. The concerns here are universal: family, friends, and making a living.

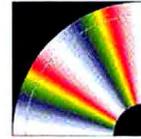
Compared to some of the great work novels, *Microserfs* doesn't have the weight of Upton Sinclair's *The Jungle*, and it doesn't have the low-down grit and pathos of Charles Bukowski's *Post Office*. But it's a pretty good story, sometimes touching, often funny, and it's a very entertaining chronicle of life in these weird times. ■

Dennis Barker has never worked in a code mine, but he's held a variety of editing positions at BYTE. You can reach him on the Internet or BIX at dbarker@bix.com.

MICROSERFS

Douglas Coupland
Regan Books/HarperCollins
ISBN 0-06-039148-0

\$21



MARILYN REMEMBERED

BERNARD OF HOLLYWOOD'S MARILYN

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I have always had a fondness for Marilyn Monroe. After all, we share the same birthday (June 1). But my fondness never turned into the fascination that many die-hard fans have for the platinum blonde beauty. Bernard of Hollywood's Marilyn (which works on Macintosh System 7.0 or Windows 3.1 or higher) traces her life from the early days as Norma Jean to that tragic day (August 5, 1962) she died. The disc is based on a book of the same title by Susan Bernard, daughter of renowned Hollywood photographer Bruno Bernard, often described as the "discoverer of Marilyn Monroe."

Accompanied by a jazzy 1950s sound track, you can page through Susan Bernard's text, which offers links to audio and video clips of Monroe. You can also listen to the journal entries of Bruno Bernard. The video clips are highlighted by Monroe's famous rendition of "Happy Birthday" sung to John F. Kennedy, her original screen test, and newsreel footage of Joe DiMaggio at Monroe's funeral. And there's also a screen saver of, guess who, on the CD-ROM.

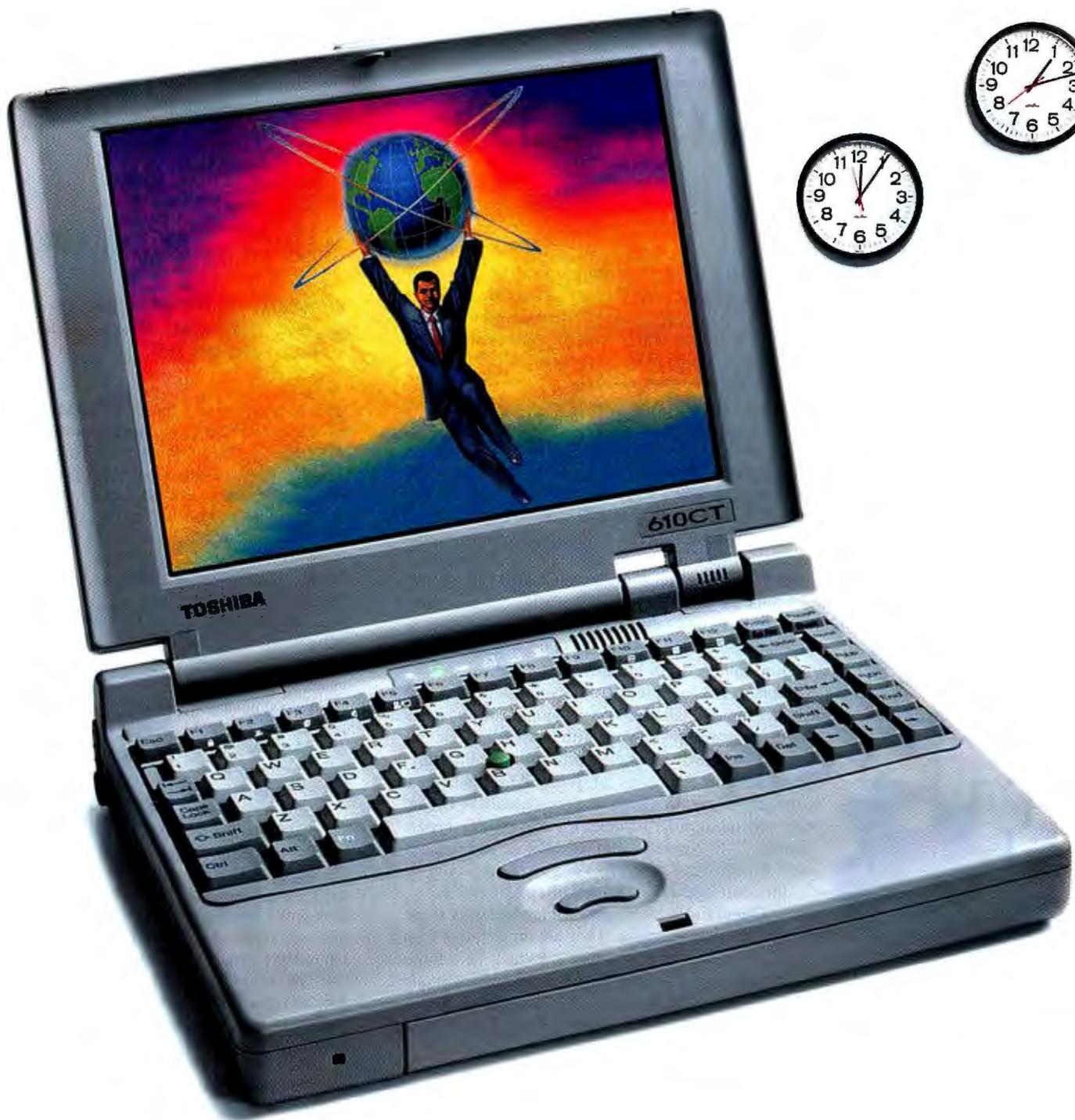
You also get a time line of Monroe's life, which includes a glossary of her 29 films and a list of 103 "essential" Marilyn Monroe facts. Only the truly obsessed fan would care that Monroe had a weakness for chocolate éclairs, that her dress size was 12, and that her favorite snack was caviar.

I was, however, impressed with Bruno Bernard's photographs of Monroe. The disc includes a number of his works, and it's easy to see how they helped Monroe become a legend.

As the cake comes out and my family begins to sing, I'll remember Monroe, but don't ask me to tell you that her pant size was nine.

—Jeff MacClay





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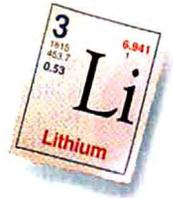
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Circle 105 on Inquiry Card.

Don't be fooled by fast CPUs: The PC of 1995 is little more than a souped-up IBM AT from 1984, which was a minor improvement over the IBM PC of 1981, which was based on technology from the 1970s that wasn't so hot to begin with. Fortunately, that's all about to change.

Some differences will be externally obvious. Think sleek shapes in black or Caribbean colors. Imagine a collection of compact components and a svelte LCD. Reliable voice recognition is on its way. Cables will give way to infrared beams. And built-in video cameras will let your PC stare back at you.

But to really appreciate the new PC, look under the hood. New technologies will unleash the full potential of modern operating systems and microprocessors, and performance bottlenecks from albatrosses like the ISA bus will disappear. Four of these technologies are available now: Plug and Play (PnP), universal serial bus (USB), unified memory architecture (UMA), and native signal processing (NSP). Together, these technologies will create a more integrated PC that is easier to configure, has significantly faster I/O, uses memory more efficiently, offers more features without extra hardware, and costs relatively less than today's equivalent systems.

The new PC won't make its debut with fanfare and fireworks. Rather, it will evolve steadily over the next five years (see "Old PC vs. New PC," page 55). Here's what to expect during that evolution.

Still Praying for Plug and Play

To see tomorrow's PC, look at today's Macintosh. Macs are far from perfect, but they have pioneered many technologies now coming to PCs. Plug and play has been standard since the 1980s, along with reasonably fast and easy-to-use I/O interfaces such as SCSI and the Apple Desktop Bus (ADB). Numerous Macs employ a unified frame buffer/memory architecture, and Power Macs use NSP for some telephony applications. Moreover, the latest Power Macs are the first mainstream computers to discard their legacy I/O bus (in this case, NuBus) in favor of PCI.

Playing catch-up with Apple, however, is not what PC designers have in mind. The goal is to leapfrog the Mac by adopting superior versions of these technologies whenever possible. Leading the charge are Intel and Microsoft, who may be the only companies powerful enough to direct wholesale changes in the industry. (See the text box "Intel and Microsoft: The Agents of Change," page 58.)

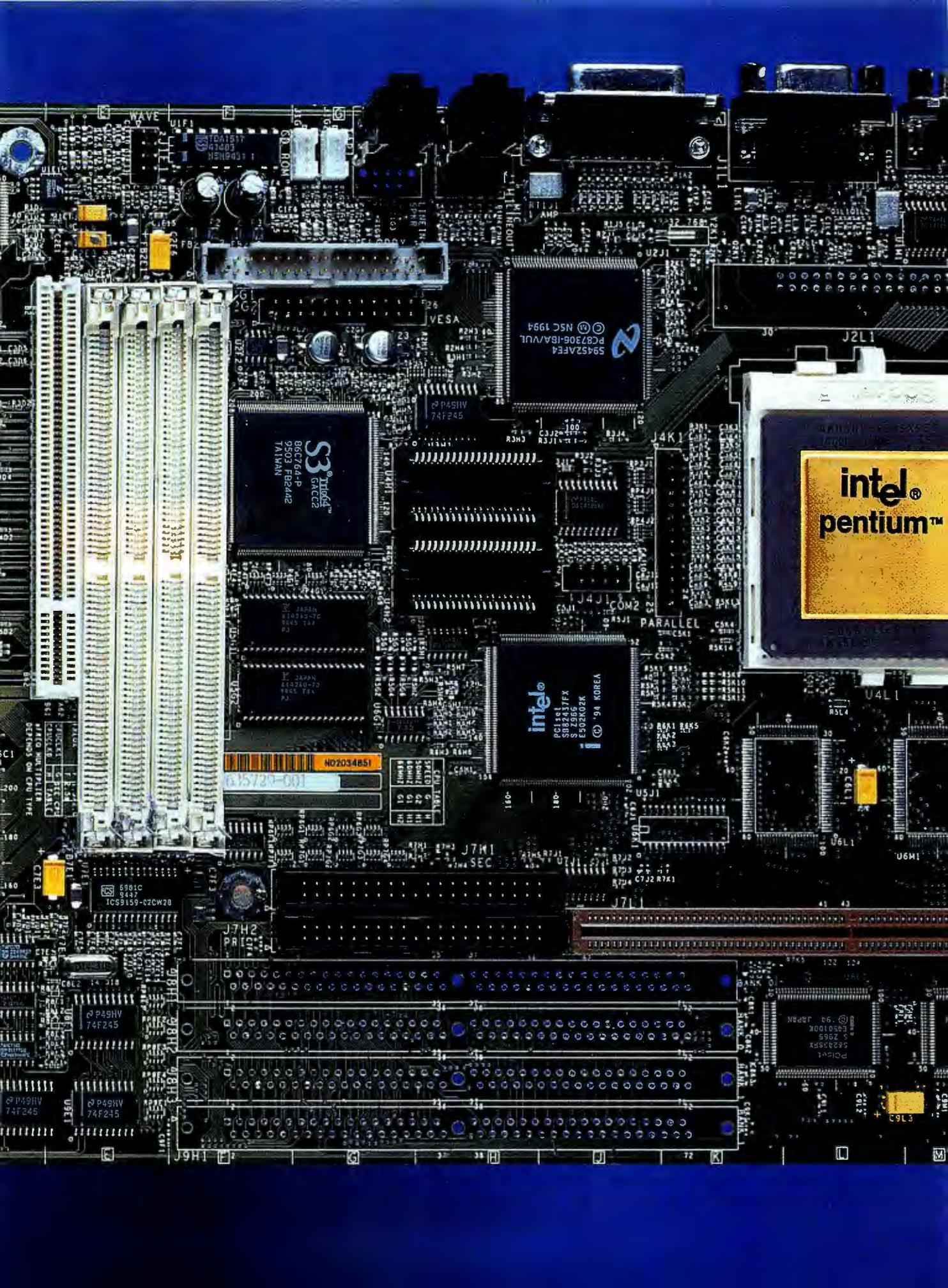
PnP is high on Microsoft's agenda because it's probably the most glaring remaining difference between a PC and a Mac. Although Windows 95 is loaded with PnP features (the Device Manager, dynamic configuration, the Add New Hardware Wizard, and more), they aren't much help if the computer and peripherals don't support PnP as well. Without a PnP BIOS and PnP devices that cooperate with each other and with the OS, painless system expansion will remain just slightly out of reach (see "Transforming the PC: Plug and Play," September 1994 BYTE).

Fortunately for long-suffering PC users, there's strong movement toward PnP. All signs point to wide adoption of PnP throughout the industry in 1996, even if the only mo-

THE NEW PC

**Four new technologies
will usher your next PC
into the '90s**

TOM R. HALFHILL



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tivation for some vendors is to control their skyrocketing technical-support costs.

All along, Apple has preached the gospel that hardware and software must be tightly integrated. Unfortunately for Apple, it's hard to sell this integration as a feature precisely because it's so transparent. It was easy for Apple to achieve this level of integration because, until recently, the Mac was a closed, proprietary system available only from Apple.

Ironically, as the PC becomes more like a Mac, a Mac may become more like a PC, since Apple now is licensing the Mac OS to clone makers and porting it to the PowerPC common hardware platform.

Port Power

USB represents another major improvement in PC architecture. This external I/O interface will begin appearing in commercial desktop systems next year. If it succeeds, USB could eventually replace a whole slew of ports on today's PCs. This won't happen immediately, because the huge installed base of PCs impedes rapid change. Nevertheless, I/O bottlenecks will push PC vendors to add an interface designed with 1990s technology.

Venerable RS-232 serial ports offer speeds of from 9.6 to 115.2 Kbps, depending on the type of universal asynchronous receiver/transmitter (UART) in the computer. USB's maximum bandwidth is 12 Mbps—although actual data throughput is more like 8 Mbps—including a 1-Mbps subchannel for low-speed devices like a mouse or keyboard. That's enough bandwidth to handle everything from keyboards and mice to video monitors, modems, scanners, printers, ISDN adapters, and MPEG-2 compressed video.

In addition, USB is both asynchronous and isochronous. Isochronous transfers, such as audio and video, get top priority, assuring that time-sensitive data streams are not interrupted. USB lets you daisy-chain up to 127 devices in a tiered-star topology: Each device can house a USB hub to which additional devices can connect. Cable segments can be 5 meters long. It supports hot-plugging, so you can add or remove devices without powering down the computer. If the devices and the OS support PnP, the appropriate device drivers can automatically load and unload.

USB is also cheap to implement. Some of Intel's PCI chip sets will soon include USB logic, so the only additional cost is for the 35-cent external connector. As

ON THE COVER

Now that PC architecture is being overhauled (see main story), how different will your next PC look? Our cover shows three possibilities: The Apple Sweep and IBM Leapfrog are industrial designs, while the Archistrat 4b was scheduled to ship commercially as we went to press. All three are significant because their capabilities, as well as their external design, are made possible by the new technologies being incorporated by the next generation of PCs.

Sweep designer Tim Parsey says the flat-panel display inspired Apple to create a desktop system built around components that are smaller and thinner than conventional PCs, but offer the same computing power as the stacked boxes we're used to working with. Inside the Sweep is a standard motherboard that can house next-generation PowerPC chips. The keyboard

tucks away into the horizontal stand. The main vertical segment holds CD-ROM, hard-disk, PC Card, and floppy drives. Built-in audio gets a boost from two tweeters and detached external speakers.

The Leapfrog also uses the LCD to break the bounds of the desktop mold. The portable display panel holds the CPU, as well as the hard-disk, floppy, and PC Card drives. The pen stylus and pen-based software launch applications. For a more traditional desktop unit, attach the LCD panel to the docking station (nicknamed the lily pad), which features a slide-out keyboard.

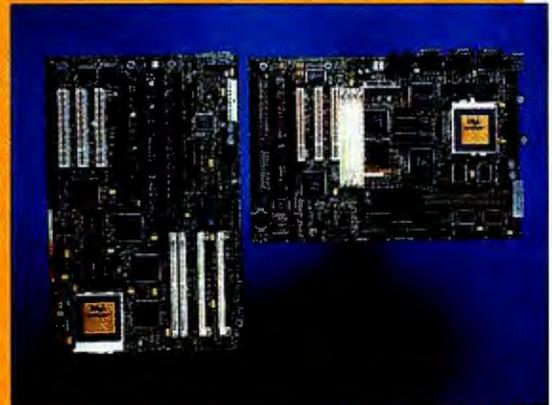
The Archistrat Systems 4s and 4b computers use a custom connector that sits between a partitioned motherboard and a passive backplane. The architecture lets you mix and match CPUs, I/O subsystems, and other fundamental components to accommodate your needs (for details, see the text box "Coming Soon: Archistrat 4s," on page 60).

Coming Soon

ATX Motherboards

Intel's new ATX motherboard is the first major reengineering of the PC motherboard in a decade. It sets a new standard for motherboard configuration for desktops and mini-towers that improves the component layout. ATX also costs less to manufacture; provides easier access to slots, cables, and bays; reduces noise and power consumption by requiring only one cooling fan and a smaller power supply; and fits existing AT and baby AT cases. It also fits into a new small-

footprint case that stacks the rear connectors to save even more space. The ATX will appear in PCs later this year. Contact: Intel, Santa Clara, CA; (800) 538-3373 or (408) 765-8080; <http://www.intel.com/pc-supp/platform.html> or <http://motherbd/atx.html>. **Circle 1075 on Inquiry Card.**



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OLD PC

Take a fresh, hard look at the PC on your desk. Many users don't notice what's wrong because they either assume that computers are inherently difficult to use or they've grown accustomed to walking with a pebble in their shoe. Mac users needn't smirk; some of this applies to your machines, too.

When you boot the machine, it sounds like a vacuum cleaner because of the fans that cool the components and power supply.

The hodgepodge of I/O ports and connectors includes some that haven't been significantly updated since the days of 300-baud modems.

PCs still need plug-in cards for LAN connections, accelerated graphics, or controllers. After you've installed the device, you must endure the torment of DIP switches, jumpers, IRQ conflicts, DMA channels, I/O base addresses, device drivers, and other arcane trivia.

Graphical presentations and other large files won't fit on 1.44-MB disks.

You may get a hernia from lifting the CRT because it's so big.

If you absentmindedly switch off the computer before closing all your programs, you might lose your files or scramble your hard drive.

NEW PC

The new PC of the next two to five years will be much sleeker because the external card bays, USB port, and integrated motherboard devices minimize the need for internal expansion slots. Low-voltage components and advanced power management mean the computer uses less electricity and runs cooler. A software-shutdown feature saves all your files and leaves the OS in a stable state before it turns the power off.

High-speed LANs pipe video directly into windows on your screen.

A color LCD replaces the bulky CRT.

A Universal Serial Bus (USB) makes it easy to add or remove peripherals without rebooting.

High-quality audio and high-resolution graphics with video playback are integrated onto the motherboard.

A microphone is standard, and the motherboard integrates a telephony interface and an RJ-11 phone jack.

All faxes and E-mail messages arrive in a single inbox. If you wish, the computer will read your mail aloud to you.

Desktops use built-in infrared ports to exchange data with each other and with portables.

Optional interfaces connect you to an Integrated Services Digital Network (ISDN) or a cable TV network for wide-band or broadband communications.

You don't need a video-capture board for the camera because it's digital and connects directly to the USB port.

PC Card drives mean you'll rarely have to open the box. With a single memory card, you can transfer your whole working environment from machine to machine in seconds.

A removable-media drive accommodates inexpensive disks that store at least 100 MB of data.

Plug and Play (PnP) is built into the computer's BIOS, the OS, and the devices themselves.

Fast and efficient PCI replaces the antiquated ISA bus.



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other chip makers incorporate USB into their products, the new serial bus will become a standard feature on new PCs. Inexpensive USB might also encourage engineers to include USB hub logic in external peripherals, which would provide for extra USB ports for daisy-chaining additional devices. Cables have only four wires, allowing compact connectors roughly as wide as a staple. Small size is important for notebooks, palmtops, and downsized desktop PCs. For all these reasons, USB appears to be edging out alternative I/O interfaces that have been proposed as the next-generation standard, including GeoPort, Access.bus, FireWire, and SCSI.

GeoPort is a slightly enhanced version of the 12-year-old RS-422 serial ports on Macs. Apple already equips Power Macs with GeoPorts to provide telephony functions. For instance, the GeoPort Telecom Adapter connects a phone line to the Mac while the PowerPC processor emulates a fax modem. Apple formed a consortium called Versit with IBM, AT&T, and Siemens to promote GeoPort as an industry standard, and it will be available for PCs in the form of PCI and PC Cards (formerly PCMCIA). However, GeoPort's relatively slow throughput of 2 Mbps probably eliminates it from contention as the next-generation external I/O port for PCs.

Access.bus is even slower than GeoPort—its data rate is only 100 Kbps. Invented by Philips, it was never intended to be a general-purpose high-speed interface. Instead, it was designed for low-speed peripherals, such as keyboards and pointing devices. It's also used for the Video Electronic Standards Association (VESA) Display Data Channel (DDC), a control interface for video monitors that Microsoft recommends for future PCs. But even though Access.bus costs less to implement in peripherals and on motherboards, its inability to support a wide range of peripherals puts it at a disadvantage with USB.

FireWire—officially known as IEEE-P1394—is backed mainly by Apple, with chip support from Texas Instruments. It has significant advantages over USB. FireWire's data rate is 100 Mbps and will soon be extended to 200 Mbps and 400 Mbps. Also, FireWire is being promoted as a standard interface for consumer video devices, such as digital VCRs and cameras. If widely adopted, it could accommodate much faster peripherals than USB and provide the crucial digital link between personal computers and future con-

INTEL AND MICROSOFT: THE AGENTS OF CHANGE

Finding faults in the PC is not the problem; fixing them is. The basic architecture of PCs remained stagnant for a decade because IBM lost control of the standard in the 1980s and nobody else was strong enough to claim the position of top dog.

Even the leading clone vendors like Compaq, Packard Bell, Gateway 2000, and Dell don't wield enough influence to force fundamental changes. Besides, profit margins are too slim to fund the costly R&D that's required to make it happen.

Result: a power vacuum that has attracted Intel and Microsoft. Both industry giants are frustrated by the problems of the PC system architecture. Intel wants to keep the PC market growing in order to sell more chips; Microsoft wants to ensure that PCs will be powerful enough to support its future ambitions for Windows. Their motivations are self-serving, but in the end, the whole industry will benefit if the result is more efficient systems.

Intel built a lavish R&D facility in Hillsboro, Oregon, known as the Intel Architecture Lab (IAL). In effect, IAL is playing the same R&D role for penny-pinching clone vendors that Bell Labs used to play for the regional Bell telephone companies.

IAL is responsible for inventing, refining, or promoting technologies that either fix problems in the PC architecture or create new applications that accelerate demand for PCs. These technologies and

products include PCI, Universal Serial Bus (USB), Plug and Play (PnP), Telephony API (TAPI), Display Control Interface (DCI), Native Signal Processing (NSP), Digital Simultaneous Voice & Data (DSVD), ATX motherboards, Indeo video compression, ProShare video-conferencing, and CNN at Work.

Microsoft has been playing a key role in developing such hardware/software technologies as PnP, USB, TAPI, and DCI. Recently, Microsoft has been going even further. In a bold imposition for a software company, Microsoft sponsors a yearly confab (the Windows Hardware Engineering Conference, or WinHEC) and publishes an inch-thick manual ("Hardware Design Guide for Windows 95") that instructs hardware companies how to design their future PCs and peripherals. To win the coveted Windows 95 logo, system vendors must follow Microsoft's specifications, right down to putting little icons on the back of the computer so users can tell the mouse port from the keyboard port.

It's hard to imagine a "WordPerfect Hardware Engineering Conference" or a "Hardware Design Guide for After Dark," but then, other companies are not Microsoft. While programmers at other software companies write to the hardware, Microsoft is redefining the hardware around Windows.

Of course, Intel and Microsoft don't always see eye to eye—they've split over such things as DCI and NSP—but in general, they share the same goal: Fix the PC.

Coming Soon

NeoMagic MagicGraph NM2070

Highly integrated components offer more functionality while cutting costs and reducing power consumption. NeoMagic's new MagicGraph NM2070 is a single chip that replaces three or four separate chips in notebook systems, integrating a Super VGA graphics accelerator, a 1-MB frame buffer, a 128-bit memory interface, a RAM digital/analog converter (RAM-DAC), an LCD controller, and PCI/VESA local-bus interfaces. The first notebooks with the MagicGraph NM2070 will be announced this fall. Contact: NeoMagic, Santa Clara, CA; (408) 988-7020, or fax (408) 988-7032; info@neomagic.com; <http://www.rahul.net/neomagic>. Circle 1076 on Inquiry Card.





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sumer electronics products.

But because FireWire logic isn't inherent in chip sets and peripherals, it costs more to implement than USB. Apple has yet to build FireWire into any of its Macs, and it's even less likely to be integrated in PCs. It will probably be available on a PCI board for those who want it in 1996.

SCSI remains a contender. When Apple standardized on SCSI in 1986, it spawned a healthy market for SCSI-based scanners, hard disks, CD-ROM drives, and other peripherals. When PC users began upgrading their systems with CD-ROM drives, SCSI adapters zoomed in popularity. Today, SCSI is an important cross-platform interface standard that's also found on some Unix workstations. SCSI-2 introduced faster throughput in two flavors. Fast SCSI-2 doubled original SCSI speeds to 10 Mbps on an 8-bit bus. Wide SCSI-2 can use a 16- or 32-bit bus for throughput of 20 Mbps. Fast and Wide SCSI achieves speeds of 40 Mbps.

But SCSI has several problems. Current implementations support only eight devices per chain, far fewer than rival serial interfaces. Each end of the daisy chain must be terminated, a prime cause of configuration woes. Each device requires a unique ID number, and some devices don't support all IDs. Because SCSI is a parallel interface, the connectors are relatively large, the cables are thick and expensive, and longer cable lengths are unreliable. SCSI doesn't allow hot-plugging, either.

Work is progressing on new versions of SCSI to address these flaws. The proposed SCSI-3 standard calls for more than eight devices per chain, automatic ID assignment, and faster throughput. There are even proposed serial versions of SCSI-3 that could use fiber-optic cables or gallium arsenide technology to attain speeds as high as 1 Gbps. So SCSI still has a bright future as the high-speed alternative in applications that need peripherals that would quickly saturate the capacity of USB.

RAM Reunification

Since the original IBM PC of 1981, almost all PCs have maintained separate memory for their frame buffer, the block of memory in which the screen image is mapped. This wasn't a problem in the days of monochrome character-mapped video because the frame buffer could be as small as 2 KB. But modern GUIs have created demand for high-resolution, true-color bit-mapped screens. A 640- by 480-

Coming Soon Archistrat 4s

One of the most unconventional system architectures seen in recent years is coming in a new line of servers and desktop systems from Panda Project, a start-up based in Boca Raton, Florida. Panda partitions the traditional motherboard into three independent boards connected to a passive backplane by a proprietary high-speed interface. By separating the CPU, I/O, and main memory into modular subsystems, Panda says it will offer a level of upgradability and CPU independence unmatched by conventional designs.

The CPU board includes the microprocessor, secondary cache, primary PCI bus, and related control logic. (For now, Panda is supporting three CPU architectures—Intel x86, DEC Alpha, and soon IBM/Motorola PowerPC—but others could be added in the future.) The I/O board includes system I/O interfaces, such as ISA, SCSI, or a bridge to a second PCI bus. The memory board contains all the DRAM for main memory. These subsystems connect to the backplane with Panda's high-density Compass interface, a panel of 18 152-pin connectors.

This architecture allows users or resellers to snap together their own systems with the CPU, I/O interfaces, and memory they want.

Panda's first system, the Archistrat 4s server, is expected to debut this fall at \$10,490. That's for a 100-MHz Pentium with 32 MB of RAM and a 1-GB hard drive. Alpha CPU boards are planned for later this year, and PowerPC boards based on the PowerPC common hardware platform are expected in mid-1996.

Archistrat's modularity lets you start with a Pentium and switch to an Alpha, or vice versa.

"It's intellectually satisfying," says Eric Lewis, an analyst at International Data Corp. (Mountain View, CA). "But I don't think most companies are really that interested in switching [CPU] architectures, because then you've got to revamp all your software, too. It seems like a fairly small market."

It's also a market pursued by DeskStation Technologies, which last year introduced a motherboard called the UniFlex. The UniFlex segregates the CPU on a daughtercard that supports either an Alpha 21164 or a Mips-compatible R4600 Orion. (Future versions may also support the Alpha 21164A and the PowerPC 620.) DeskStation puts the UniFlex motherboards into its high-end PCs



for Windows NT.

Panda goes further than DeskStation by partitioning the I/O and memory subsystems as well. Conceivably, you could swap out the memory board to take advantage of faster DRAM technology or change the I/O board if a new bus standard supersedes PCI.

DeskStation's vice president of engineering, Blaise Fanning, says Panda's design is philosophically sound but unnecessary in practice, because memory and I/O technologies don't advance as quickly as CPUs. Also, he adds, by the time you upgrade all the subsystems, you might as well purchase a whole new computer: "The only investment you're really preserving is the backplane."

Previous passive-backplane designs have also been criticized for their high cost or inadequate bandwidth. Panda says its Compass technology solves these problems. The Compass connectors carry about 650 signals between the CPU and the backplane, but they cost only five cents per mated pair, according to Bruce Smith, Panda's vice president of engineering.

BYTE was unable to test a production sample of the Archistrat 4s in time for this article. If nothing else, Panda's modular approach to motherboards is an interesting twist on the system architecture of PCs. Contact: Panda Project, Boca Raton, FL; (800) 892-2892, (407) 994-2300, or fax (407) 994-0191; sysinfo@archistrat.com. **Circle 1083 on Inquiry Card.** DeskStation Technologies, Lenexa, KS; (800) 793-3375, (913) 599-1900, or fax (913) 599-4024 <http://www.dti.com>; sales@dti.com. **Circle 1084 on Inquiry Card.**

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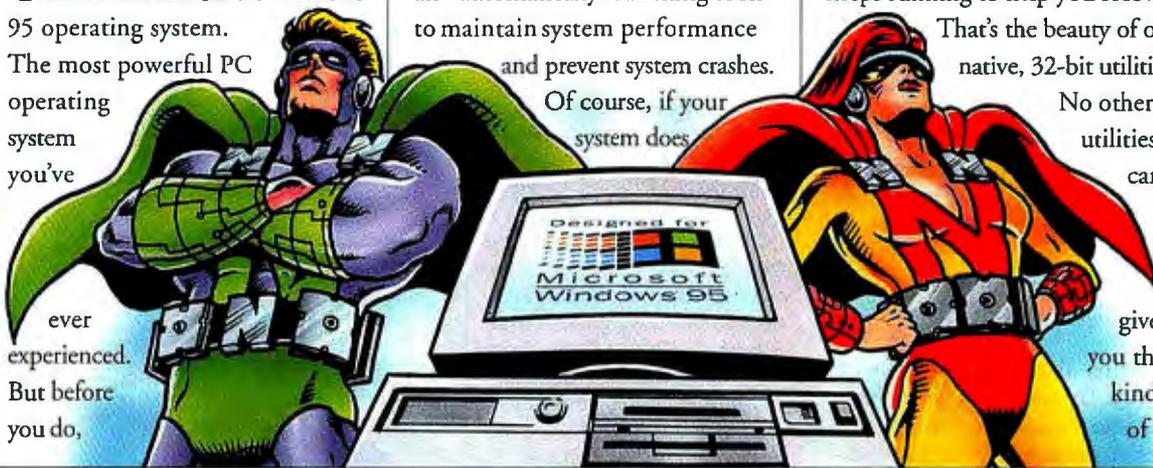
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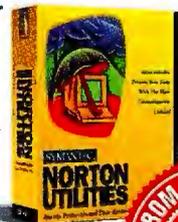
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pixel screen with 8-bit color requires a frame buffer of 300 KB; 1024 by 768 pixels with 24-bit color requires 2.25 MB.

It's not just an issue of more memory. A dedicated frame buffer is fixed in size—no matter which screen mode you're using, the frame buffer always contains enough memory to accommodate the highest resolution and color depth it supports. Your software can't use the left-over memory. Because of the way DRAM is packaged and configured in graphics subsystems, megabytes of memory can go to waste.

UMA unifies the frame buffer with main memory. By allocating just enough RAM to handle the current screen mode, UMA frees up memory for other purposes. Eliminating the dedicated frame buffer is expected to trim about \$50 off the cost of a typical system. Chip sets that support UMA are coming from Weitek, Opti, VLSI, Chips & Technologies, Intel, and Cirrus Logic. PCs with UMA should appear this year or early in 1996.

In all likelihood, UMA will come first to low-end PCs. High-end systems will probably avoid it, because UMA sacrifices performance when the CPU and the graphics controller try to access main memory at the same time. Cirrus Logic estimates the performance hit is about 5 percent for a 16-MB system with a secondary CPU cache, and 10 percent to 15 percent for cacheless systems. An 8-MB system would suffer more. Reduced performance is why Apple, which has used a similar scheme for years, still retains dedicated frame buffers in some Macs.

Mixed Signals

Still up in the air is how PCs will handle signal-processing tasks, such as audio, video, and telephony. This question pits Intel against some other chip makers and against Microsoft.

PCs have taken advantage of general-purpose digital signal processors (DSPs) for years. In 1992, Atari introduced the Falcon030, the first personal computer with a general-purpose DSP. Then Apple built AT&T's 3210 DSP into the Quadra 660AV and 840AV Macs. IBM and Texas Instruments announced the low-cost MWave DSP for PCs. And Microsoft said Windows 95 would have a DSP Resource Manager Interface (RMI), an API layer designed to insulate programmers from DSP-specific features.

But the trend was derailed. First Apple, then Intel, claimed its latest CPUs could handle many DSP tasks natively.

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Whiteboarding and document-sharing are the most useful commercial applications for videoconferencing, but visual images will find a place, too. The Connectix QuickCam (about \$99) transmits a low-resolution gray-scale image and plugs directly into a parallel port on a PC or a serial port on a Mac, so it doesn't need a video digitizer. In five years, little cameras like this could be as common in PCs as built-in microphones are in today's Macs. Contact: Connectix, San Mateo, CA; (800) 950-5880, (415) 571-5100, or fax (415) 571-5195; connectix@aol.com. **Circle 1082 on Inquiry Card.**



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For multimedia files and graphics, 1.44-MB floppy disks just don't cut it anymore. Compaq, 3M, and Matsushita are reviving the Floptical concept: an optically indexed magnetic disk. The disks will hold 120 MB and work five times faster than regular floppy disks. The new drives will also read and write 1.44-MB and 720-KB disks. Compaq hopes to ship its PCs with these drives in 1996. Contact: Compaq Computer, Houston, TX, (800) 345-1518 or (713) 378-8820, fax, (713) 378-1442; <http://www.compaq.com>.



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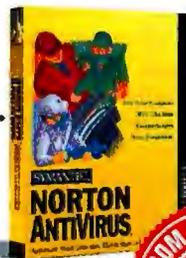
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Apple's GeoPort Telecom Adapter eliminates the need for a modem by connecting the Mac directly to a phone line while using the CPU to emulate a modem in software.

Intel is carrying the concept even further by defining an NSP reference platform for PC vendors and extending the functions to include wave-table audio and software-only video playback. Instead of handing off those functions to dedicated chips and special hardware, Intel's NSP approach uses the CPU to perform audio and video tasks. Intel has demonstrated a 90-MHz Pentium system that uses NSP to display full-motion video in two separate windows while playing eight independent audio tracks.

Partly for these reasons, Microsoft dropped RMI out of Windows 95 and turned it over to Spectron Microsystems, which makes SPOX, a real-time DSP kernel. The lack of a DSP API built into the industry's leading OS is a setback to the widespread integration of DSPs.

In the view of Compaq and other systems vendors, NSP is a cost-effective technology for delivering speech, audio, and other multimedia functions to the business market. But not everyone is ready to shelve DSPs. "The functions that NSP can provide by using the host [CPU], a few dollars' worth of hardware can provide," says Raphael Mehrbians, a senior product manager at Cirrus Logic.

Also, some of that extra hardware is needed anyway, even with NSP. For backward compatibility with DOS programs, PCs need a Yamaha OPL-3 sound chip. The Pentium's wave-table sounds won't be heard unless there's a standard audio codec chip, such as a Crystal Semiconductor 4232. And even though a Pentium can handle such modem functions as data compression and communications protocols, DSP promoters like TI question whether the best use for a high-end CPU is to emulate the modem's data pump.

So general-purpose DSPs may yet appear on PC motherboards, or perhaps be integrated in future CPUs, just as FPUs were. Intel is known to be developing a "multimedia Pentium" (code-named the P55C) for release in 1996. It is expected to add new instructions for signal processing, but at press time details were not available. It may have a multiply-accumulate function or special instructions for decoding MPEG video—a feature introduced last year in the UltraSPARC processor from Sun Microsystems (Mountain View, CA).

Now Showing Integrated Telephony

Built-in telephony is now standard in desktop PCs from several vendors, most notably AT&T, Compaq, and Packard Bell. Typically, these PCs come with the hardware and software required to work as speaker-phones, answering machines, voice mailboxes, and fax machines (with fax-on-demand).



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False starts and growth spurts will buffet the PC industry as it juggles the conflicting issues of cost, performance, and compatibility. Yet change is essential as the competition for desktops becomes fiercer. By mid-1996, expect systems that support the PowerPC common hardware platform, which is backed by IBM, Motorola, and Apple, and designed with the benefit of hindsight.

When PCs were primarily used for word processors, spreadsheets, and data-

bases, the original IBM system architecture was adequate. But multimedia and richer data types have exposed shortcomings in PCs. For the last few years, the industry has been patching the old architecture to keep it competitive. Now the architecture is finally getting the overhaul it really needs. ■

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on the Internet or BIX at thalfhill@bix.com.

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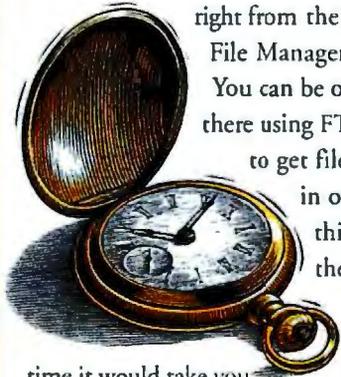
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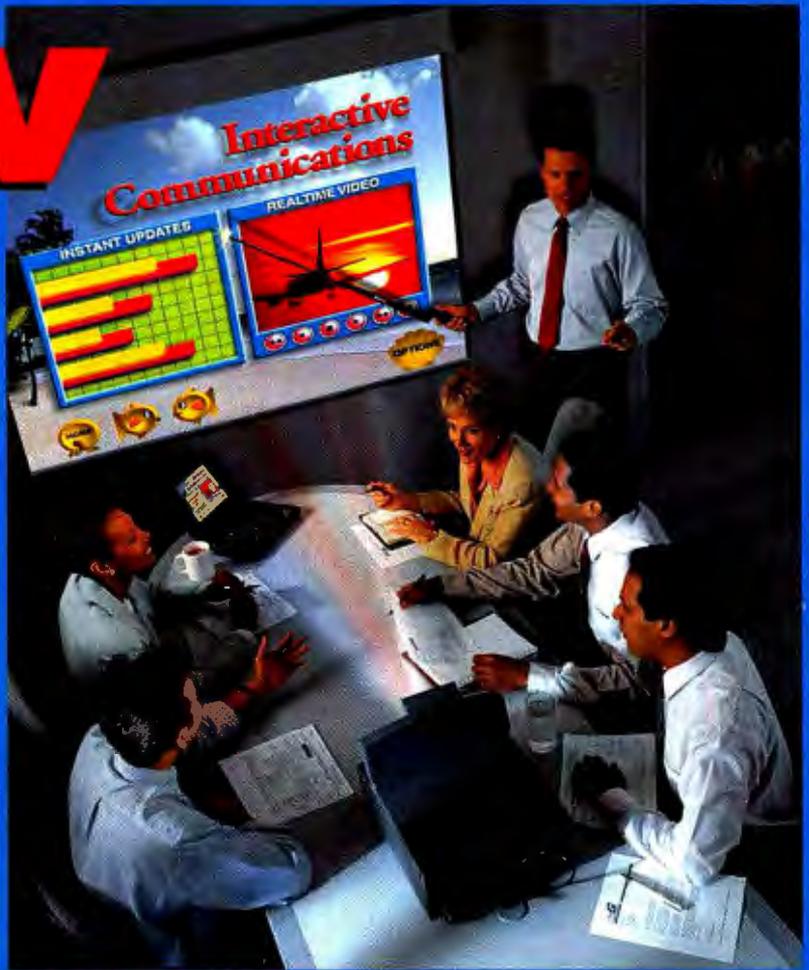
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Face to Face

ANDREW W. DAVIS

At the 1964 New York World's Fair, AT&T showed the videophone, which delivered voice and video over standard telephone lines. Thirty years later, the newest videoconferencing products from AT&T Microelectronics still use standard telephone lines. But there's a difference.

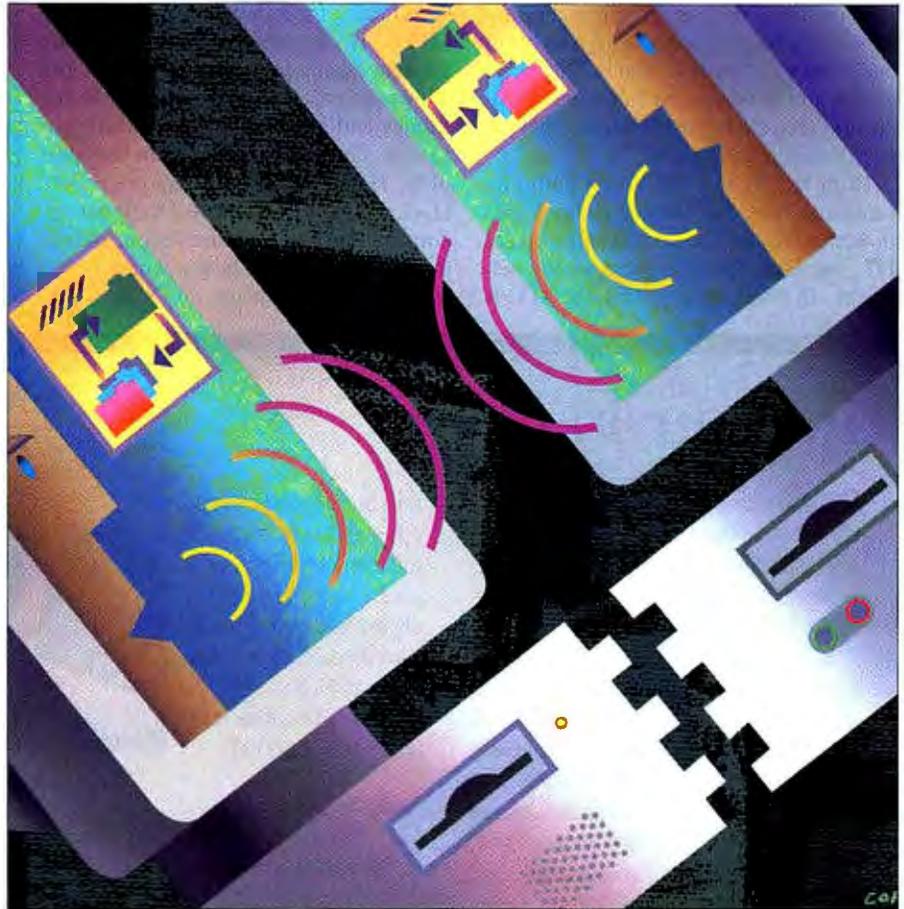
Videoconferencing has finally shed its proprietary shackles. In 1964, AT&T was the last company to lose sleep over interoperability concerns: The original videophone had to communicate only with other AT&T products. But today, deregulation is the rule and interoperability is a serious issue. AT&T's latest-generation conferencing system can communicate with systems from other vendors. The AT&T system and competitors from Intel and PictureTel are an outgrowth of the sometimes acrimonious interoperability battles of the past two years.

But the battles are ending and the standards war is nearly won: By the end of the year, the International Telecommunications Union's H.324 standard should be formalized. H.324 defines how videoconferencing should work over plain old telephone service (POTS) lines and complements H.320, which does the same for ISDN. These standards could bring videoconferencing to general business applications.

Person to Person

Today's desktop videoconferencing (DVC) systems link the computers of collaborating workers (see the text boxes "In Your Face" on page 70 and "Face Off" on page 72). This is a fundamental difference from group videoconferencing, where participants gather in rooms that are connected to other videoconferencing centers. DVC systems keep collaborators in touch with important data that's accessible from their desktop systems.

According to a 1994 survey by Forward Concepts, a market researcher based in Tempe, Arizona, DVC most commonly connects workers within the same company. To date, most collaborative



KEN COFFETT © 1995

Videoconferencing systems from different vendors can now talk to each other, thanks to a standard called H.32x

users have been in aircraft, automotive, and other industries with intensive engineering efforts that require visual communication among numerous workgroups. Intercompany videoconferencing requires standards to solve interoperability and networking issues.

Visions of ubiquitous videoconferencing existed even before the videophone turned heads at the World's Fair. The breakup of the standards logjam in recent months is cause for optimism over the technology's commercial potential. The ITU ratified H.320 in 1990 to cover switched digital networks. H.320 covers a wide range of network bandwidths. Audio signals can range from 16 to 64 Kbps. The video specification spans from one 64-Kbps ISDN link to 30 inverse-multiplexed 64-Kbps ISDN links.

But many vendors resisted H.320 and claimed their own algorithms offered better video quality. H.320 gained widespread acceptance last spring once the Intel-led Personal Conferencing Working Group backed off from its competing proposal based on

Intel's Indeo compression family.

However, H.320 is tied to ISDN, which is excellent technology for sending video but remains mired in rollout problems (see "Implementing ISDN," April BYTE). Attention now is moving to the other networks that connect PCs and workstations. H.324 is significant because it will eventually use a newer compression algorithm than that of H.320 and because it leverages the latest price and performance advances in silicon to promise high levels of audio and video quality. Like H.320, H.324 covers audio, video, and call-control procedures (see the figure "What's Under the H.32x Umbrella" on page 71).

Both H.320 and H.324 are umbrella standards; they don't define technologies in themselves but specify the collection of ITU standards for digital and analog networks. In addition to POTS, the ITU is

developing new recommendations for guaranteed-bandwidth packet-switched networks, such as IsoEthernet, and non-guaranteed packet-switched networks, such as ordinary Ethernet.

The Big Squeeze

The essential element in both standards is the H.261 video codec specification, a video-compression algorithm designed specifically for videoconferencing. Like MPEG, H.261 compresses images using discrete cosine transform (DCT). H.261 allows systems to fully encode certain key frames and encode only the differences among other frames. The main elements of the H.261 source coder are prediction, block transformation (spatial to frequency domain translation), quantization, and entropy coding. Here's how it works.

H.261 divides images into 8- by 8-pix-

el blocks and into macroblocks consisting of four luminance blocks and two corresponding chrominance blocks. The H.261 encoder starts by compressing and quantizing data to form *intramode* blocks; an intramode macroblock must be transmitted at least once every 132 frames in a process known as *forced updating*. The encoder also decodes results and subtracts the resulting image block (which is what the receiver sees) from the input video. If the differences are small, the block is not transmitted.

If there has been sufficient change, the encoder transforms, quantizes, entropy-encodes, and transmits the differences. The definition of "sufficient change" can vary from block to block. Change typically results from motion, but transmission noise can cause the video system to falsely infer change. As a result, commercial

In Your Face

Desktop videoconferencing (DVC) products are available for Windows, Macintosh, and Unix machines for circuit-switched digital WANs (ISDN), circuit-switched analog WANs (POTS), and packet-switched LANs.

H.320-compliant videoconferencing kits typically include a camera, a microphone/telephone handset, a codec, an ISDN interface board, and data-conferencing software. They range in price from \$1500 to \$2000. The lower-priced kits may use software for decompression or for both compression and decompression. Because software solutions rely on the host computer's processor, the faster the CPU, the better the performance users will see.

ISDN service providers may offer kits for less than \$1000 as part of a service-con-

tract bundle. You can also purchase DVC systems in the form of high-end computers with videoconferencing hardware and software already installed. This tends to be the most expensive alternative, with prices hitting \$6000.

ISDN Choices

AT&T, Intel, and PictureTel offer complete H.320 kits for ISDN-based conferencing under Windows. AT&T's Vistium 1300 system includes a dedicated processor for compression/decompression; the less pricey Vistium 1200 relies on the host processor for decompression. Both are available as board kits or prepackaged with AT&T desktop systems.

Intel's Proshare, which recently added H.320 support, uses the host CPU for decompression. PictureTel Live PCS 100 features a high-quality audio connection and full-duplex speakerphone.

Apple's QuickTime Videoconferencing and competing products from Sagem USA bring H.320 support to the Mac.



PictureTel's Live PCS 100 kit supports ISDN and includes a camera, a full-duplex speakerphone, and software.

Vivo Software, which announced the first software-only H.320 codec, offers TeleWork-5, a less expensive superset of the

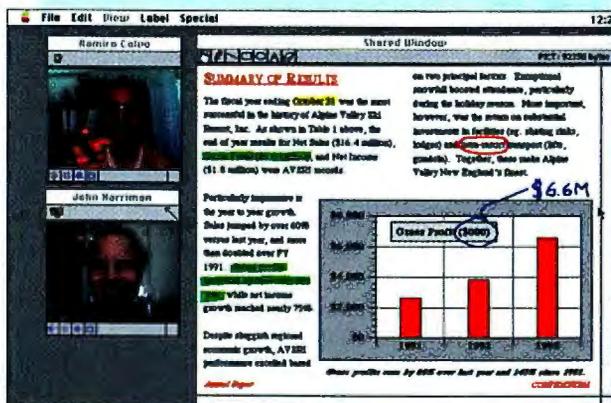
original Windows product. The package now includes workgroup software, Internet access, remote LAN access, and fax modem emulation.

Many OEMs use Zydacron H.320 boards, which support 128- to 384-Kbps communications. Zydacron offers a low-level videoconferencing application as well as hooks for other, more comprehensive collaborative software packages.

Macintosh users can find H.320-compliant solutions from Apple, which supports the standard within the QuickTime extensions to the Macintosh OS. Sagem USA sells a NuBus H.320 codec board and separate ISDN board.

Gone to POTS

The upcoming H.324 standard and the new chips that perform the H.263/G.723 codec functions promise to combine improved quality with the convenience of POTS. Today, Creative Labs has both PC



H.261 products can offer video-signal noise filters to differentiate themselves from the competition, although these filters are outside the scope of the standard.

Macroblocks carry a flag to indicate whether they are predicted or intraframe macroblocks and a second flag to indicate whether the data should be transmitted or not. The criteria for choice of mode and for transmitting a block are not detailed by the recommendation and may be varied dynamically as part of the control strategy.

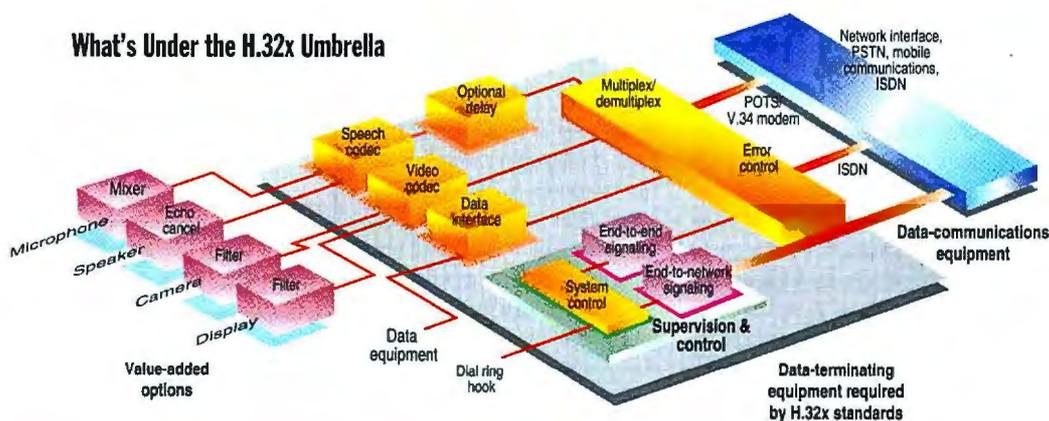
The standard requires H.261 devices to encode only the difference between a frame and the previous frame. Vendors

and Macintosh solutions for POTS connections, and the two are interoperable. VCC offers a proprietary Windows-based POTS product using one to four V.34 modems for high bandwidth. Intelligence at Large sells a Mac solution that works across both WANs (POTS and ISDN) and TCP/IP LANs. Complete kits cost approximately \$2000; the stand-alone software costs \$100 to \$300.

LAN versions of Proshare, PictureTel's LiveLan, and competitors from Invision, Viewpoint, and Insoft, use proprietary audio- and video-coding algorithms. But LAN conferencing standards do not yet exist, and H.320 does not work in a packet-switched network. Cornell University's CU-SeeMe software for Windows and Macs works over TCP/IP networks, including the Internet. Sun, HP, and Silicon Graphics also provide LAN conferencing equipment.

C-Phone from Target Technologies and Minx from Datapoint move analog video over a dedicated network and often use vacant wires inside standard Ethernet cables. For WAN connections, a shared server provides the required H.320 codec functions. Uncompressed analog video offers superior quality and does not stifle LAN data traffic. However, the scheme is not compatible with Ethernet or Token Ring bridges, routers, or switches. These products cost \$2000 to \$2500 per desktop, not including the required dedicated server, switch, and hub.

What's Under the H.32x Umbrella



can provide higher video quality and faster transmissions with optional motion-compensation and loop-filtering capabilities. Motion compensation analyzes macroblocks to identify a group in the previous frame that best matches a group in the current frame. The system then codes the difference along with a vector that describes the offset.

Unlike JPEG and MPEG, which are resolution- and image-size independent, H.261 specifies two image sizes. Common interchange format (CIF) is 352 pixels by 288 pixels. Quarter CIF (QCIF) is 176 pixels by 144 pixels. Like MPEG, H.261 uses prediction and motion estimation to reduce temporal redundancy, but it takes a different approach. MPEG maintains picture quality with maximum compression; H.261 minimizes encoding and decoding delay while achieving a fixed data rate.

What does this mean to videoconferencing users? H.261 makes a trade-off between frame rate and picture quality. As the motion content of the images increases, the codec has to do more computations and usually has to give up on image quality to maintain frame rate (or vice versa).

For an H.261 subsystem to meet the peak range of the standard—30 frames per second with full-motion estimation and loop filtering—it must execute approximately 8 billion operations per second. Most of this is for the optional motion estimation. However, designers can reduce operations at the expense of picture quality. For example, by applying a motion-estimation algorithm, codec designers can bring the system requirements down to about 1.5 billion operations per second (and thus let users do their videoconferencing on less-expensive hardware). Designers could also limit the video to 15 fps, which is a limit that ISDN bandwidths may impose.

Dedicated H.261 processors have reduced the complexity, development cycle,

The H.320 and H.324 recommendations for videoconferencing terminals (center area) specify the means for audio and video coding, call control, and interfacing to data equipment. The standards include base-level requirements as well as optional specifications. Value-added opportunities (on the left) such as sound mixing, noise filtering, and video smoothing may be implemented by vendors to improve quality, but they are outside the ITU recommendations.

and costs of videoconferencing systems while providing better quality. The newer devices, such as AT&T's AVP III, support not only H.261 but an enhanced version (called H.263) and MPEG on the same chip.

Motion Sickness

H.263, which is backward-compatible with H.261, offers improved picture quality by using a half-pixel new-motion estimation scheme rather than H.261's integer-estimation approach. The half-pixel technique is noticeably better at predicting changes to low-resolution images than H.261's motion-estimation technique is. Also, the Huffman coding table used in H.263 is optimized for low-bit-rate transmissions and provides superior imagery at 28.8 Kbps, the speed of high-end modems. The ITU is considering incorporating H.263 support into the H.320 standard.

H.263 allows (but does not require) implementation of predictive frames as well as the I (DCT-coded) frames in the codec. This is similar to MPEG's approach. While predictive frames stress the computational load and increase the frame delay, they also add quality to the video stream by raising the frame rate. These hooks give the standards room to grow. Developers can maintain compatibility and interoperability, while the quality of audio and video can improve with improvements in silicon price and gains in performance.

The rise of videoconferencing standards means vendors must find ways of differ-

FACE OFF

Desktop videoconferencing (DVC) users often refer to the 90/10 rule to describe DVC's value: Data sharing accounts for 90 percent of the information content, while talking-head video accounts for the remainder. But video drains about 90 percent of the price and bandwidth resources for DVC systems. Also, without video, data conferencing is POTS-friendly, another point in favor of cost consciousness.

Early collaborative software provided a static whiteboard visible to all conference participants. Data from documents and spreadsheets appeared on the whiteboard, and changes made during a session had to be reentered in the original application. Newer versions give collaborators a shared program window, and users can make changes within the program window via keyboard or mouse commands, even if only one system has the application installed.

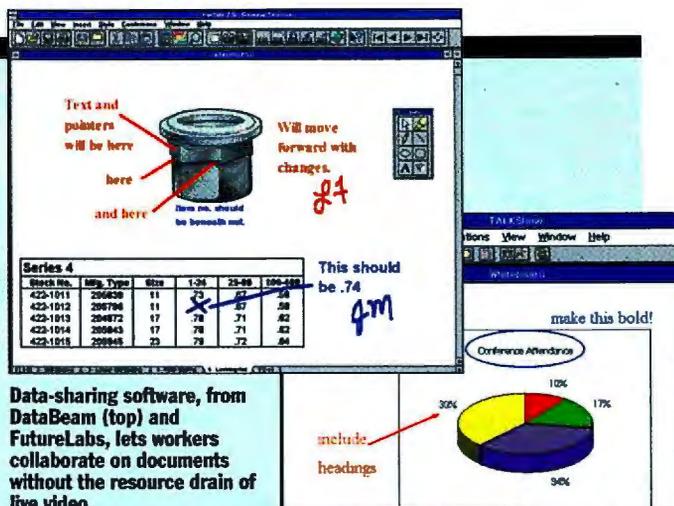
Stand-alone data-sharing products

today range in price from \$50 to \$200, depending on their feature set and support for multiple LANs and WANs. Titles include Farsite, from DataBeam, which is bundled with many voice-and-data modems, and TalkShow and Vis-a-Vis from FutureLabs. These compete against data-conferencing versions of full-blown videoconferencing applications.

Proprietary R.I.P.

The collaborative computing market is in the throes of two transitions. Customers are demanding solutions that comply with standards. The T.120 standards, first promulgated by the International Multimedia Teleconferencing Consortium and now submitted to the ITU, have been endorsed by virtually all conferencing vendors. This essentially ends the future for proprietary products.

DataBeam, which markets stand-alone software, is licensing T.120 technology to its erstwhile competi-



Data-sharing software, from DataBeam (top) and FutureLabs, lets workers collaborate on documents without the resource drain of live video.

tors and has signed up AT&T, British Telecom, Microsoft, PictureTel, and Vtel. IBM's Lakes architecture, middleware that allows multiple types of data streams to be serialized and synchronized across multiple hardware and software platforms, will also be compliant with T.120.

Equally important is the shift from data conferencing as a stand-alone application to an embedded OS technology. Future OSes will have an abstraction layer for real-time, multipoint, multimedia communications. Note MI-

crosoft and PictureTel's plan to develop voice- and data-conferencing APIs for independent software vendors. The APIs will provide access to multipoint data communications capabilities based on T.120.

OS/2 already includes Person-to-Person software. The Mac OS uses the QuickTime Conferencing extension, a foundation used by Apple's Media Conference Application and by Crosswise's Face-to-Face software, a cross-platform document-conferencing solution.

entiating themselves without offering proprietary technologies. Opportunities to add value come not from designing proprietary codecs but from applying pre-filters and post-filters to the video stream to make the codec more efficient and raise the quality of the decoded picture. Vendors can also add echo cancellation and sound mixing to the audio streams, or they can create API-smart software.

Now that vendors don't have to fight

interoperability battles, they can concentrate on price and performance. We're already seeing positive signs. Prices of H.320-compliant videoconferencing kits have fallen from \$6000 to less than \$2000 in the past two years, while audio and video quality have improved noticeably. These kits benefit from a new generation of low-cost codec chips with higher processing power and support for multiple audio- and video-compression algorithms. Some

computer makers now sell systems that come with conferencing hardware, so users can buy configured systems and avoid installation hassles.

Visual Support

Standards and new chips may help DVC evolve into an essential tool for business. Some vendors envision videoconferencing as an embedded technology. Already, one manufacturer of printing presses is showing a videoconferencing component that links printshop workers with technical staff, so they can get help if the press goes down. When talking heads venture from the Future Pavilion of the World's Fair to the nuts-and-bolts world of a shop floor, videoconferencing will be ubiquitous. ■

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Richard Schaphorst, president of Delta Information Systems (Horaham, PA) and an ITU official for Very Low Bitrate Visual Telephony, provided technical assistance for this article.

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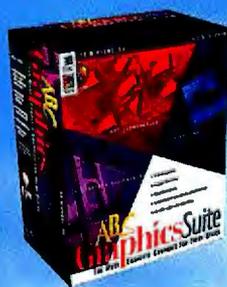
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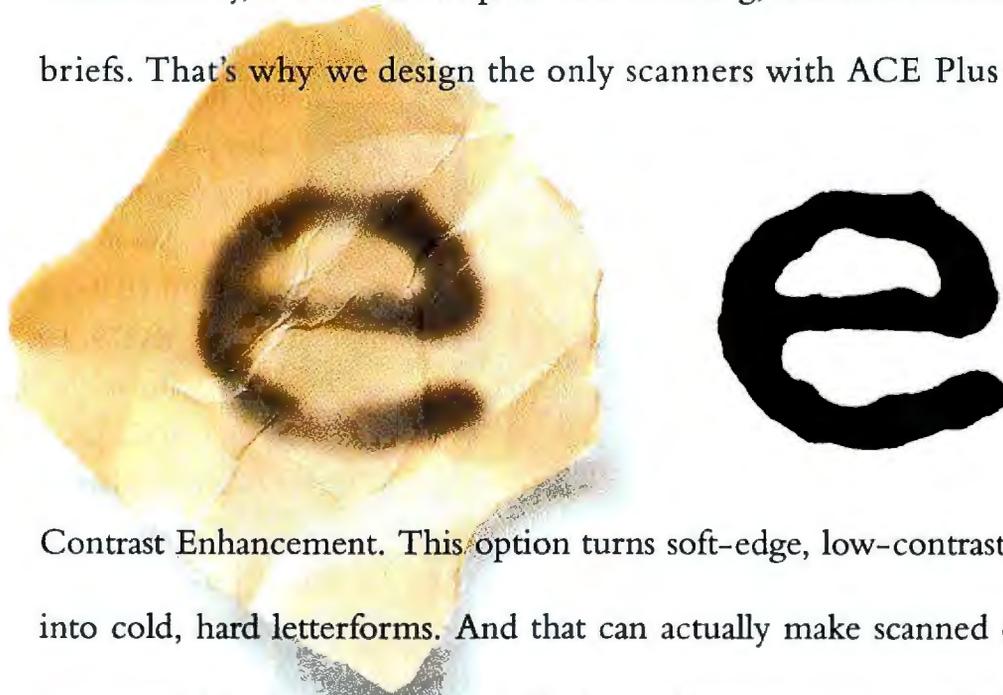


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Picking the Crypto Locks

PETER WAYNER

How secure is your encrypted data? Advances in mathematics and increased computing power mean you need longer keys and stronger algorithms if you still want to keep your secrets. Both private-key encryption (which uses a single key for coding and decoding) and public-key systems (which use separate keys for encryption and decryption) are increasingly vulnerable to determined attack. But do these weaknesses represent a real threat to encrypted data, or are they still just intriguing research results?

Unfortunately, when we try to assess the effectiveness of today's popular cryptographic systems, we run into a problem of mathematical ignorance. Most people who are familiar with mathematics can work in two directions, forward and backward, like the simple algebraic equation $a = b + 1$. We can determine the value of the first variable from that of the second and vice versa. Crypto systems, however, generally rely on mathematics that works only in one direction. People assume these systems are secure because no one has yet shown how to work the mathematics backward and break open the message. In general, we determine the strength of most cryptographic systems by seeing how well they avoid the attacks we know have been used on other systems. If none of the past attacks seems to work, then we deem a system secure. For now.

Let's look at how today's codebreakers work, the resources and time they need, and what we require in the way of new systems and longer keys. Recent assessments of the strength of private-key crypto systems involve looking for theoretical holes and measuring the time needed for a brute-force attack. Finding the holes can be devilishly hard, calling for deep mathematical insights. Brute-force attacks are easier to mount if enough computational hardware is available, but they're also easy to defend against.

The most important development in the realm of data encryption in recent years is Eli Biham and Adi Shamir's *differential cryptanalysis*. They showed how to mount a limited attack on



DOUG FRASER © 1995

A new technique called differential cryptanalysis can break even DES quickly

today's most widely used cryptosystem, DES (the federal Data Encryption Standard), which is also the basis for Unix's password system.

Imagine that you had access to your victim's DES cipher "box" (the common term for an enciphering system) with preloaded keys. Your goal is to determine the 56-bit key, so that you can decrypt the other messages your victim had encrypted with the box. Biham and Shamir

showed that you could infer the hidden key if you could pass 2^{47} messages through the box and observe what came out. This *chosen plaintext attack* builds up a statistical model of the cipher, and it needs this many plaintexts to produce an answer with confidence.

Most intriguing, this work exposed flaws in many DES substitutes. Because the U.S. government classified the details behind DES's design, many assumed that there might be a trapdoor through which the government could eavesdrop. To circumvent these potential trapdoors, some folks designed their own variations of DES. Most of these new ciphers, however, fall even faster to Biham and Shamir's mathematical machinery. FEAL-4, a faster replacement, for example, takes only four well-chosen plaintexts.

continued on page 80

Factoring in Public-Key's Future

Long thought nearly unbreakable, public-key cryptography is yielding to attack. The secret of security here is key length.

BY BRUCE SCHNEIER

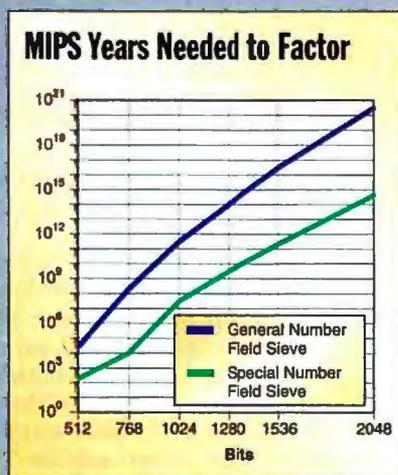
Factoring large numbers is hard but not as hard as it used to be. This has grave implications for the effectiveness of public-key cryptography, which relies on the difficulty of factoring long keys for its security. But how long is long enough?

In 1976, Richard Guy wrote: "I shall be surprised if anyone regularly factors numbers of size 10^{80} without special form during the present century." In 1977, Ron Rivest said that factoring a 125-digit number would take 40 quadrillion years. In 1994, a 129-digit number was factored. The lesson here is that making predictions is foolish.

Today, 512-bit keys are common. Factoring them, thus destroying their security, is well within the range of possibility for today's computing resources. A weekend-long worm on the Internet could do it.

Computing power is measured in MIPS-years: a million-instructions-per-second computer running for one year, or about 3×10^{13} instructions. A 100-MHz Pentium is about a 50-MIPS machine; a 1600-node Intel Paragon is about 50,000 MIPS.

In 1983, a Cray X-MP supercomputer



factored a 71-digit number in 0.1 MIPS-years, using 9.5 CPU hours. That's expensive. Factoring the 129-digit number in 1994 required 5000 MIPS-years and used the idle time on 1600 computers around the world over an eight-month period. Although it took longer, it was essentially free.

Those two computations used what's

called the *quadratic sieve*, but a newer, more powerful algorithm has arrived. The *general number field sieve* is faster than the quadratic sieve for numbers well below 116 digits and can factor a 512-bit number over 10 times faster—it would take less than a year to run on an 1800-node Intel Paragon.

And the process gets still faster. Mathematicians keep coming up with new tricks, new optimizations, and new techniques. A related algorithm, the *special number field sieve*, can already factor numbers of a specialized form (not generally used for cryptography) much faster. So we can probably optimize the general number field sieve to run that fast. For all we know, the National Security Agency is already doing it.

The figure "MIPS Years Needed to Factor" gives the number of MIPS-years required to factor "special" and "general" numbers of different lengths.

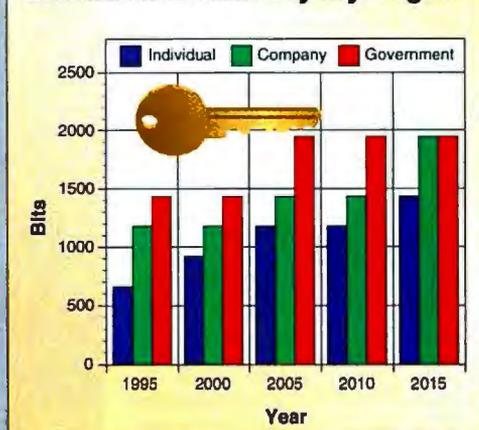
How Big Is Big Enough?

The wise cryptographer is ultraconservative when choosing key lengths for a public-key system. You must consider the intended security, the key's expected lifetime, and the current state of the factoring art. Now you need a 1024-bit number to get the same security you got from a 512-bit number in the early 1980s. If you want your keys to remain secure for 20 years, 1024 bits is probably too short.

Consider these assumptions from the mathematicians who factored RSA-129: We believe we could acquire 100,000 machines without superhuman or unethical efforts and without an Internet worm or virus. Many organizations have several thousand machines on the Net. Using their facilities would require diplomacy but should not be impossible. Assuming an average power of 5 MIPS and one year elapsed time, we could reasonably embark on a project that would require half a million MIPS-years. The project to factor the 129-digit number harnessed an estimated 0.03 percent of the Internet's total computing power. A well-publicized project might be able to harness 2 percent of the world's computing power for a year.

My recommendations for public-key lengths are given in the figure "Recommended Public-Key Key Lengths" according to how long you require the key to be secure. There are three key lengths given for each period—one secure against

Recommended Public-Key Key Lengths



an individual cryptanalyst who can get his hands on 10,000 MIPS-years, one against a major corporation that could harness 10^7 MIPS-years, and the third secure against a major government and 10^9 MIPS-years. These figures assume that computing power will increase by a factor of 10 every five years and that mathematical advances will let us factor numbers at the speeds of the special number field sieve.

Not everyone will agree with these final recommendations. The National Institute of Standards and Technology has mandated 512- to 1024-bit keys for its Digital Signature Standard. PGP has a maximum RSA key length of 1280 bits. Arjen Lenstra, the world's most successful factorer, refuses to predict beyond 10 years. There's always the possibility that an advance in factoring will surprise me as well, though I tried to factor everything into my calculations. But why trust me? I just proved my own foolishness by making predictions. ■

Bruce Schneier is the author of *Applied Cryptography* (John Wiley), the second edition of which is due out in December. He can be reached on the Internet as schneier@winter.net, or on BIX cloditors@bix.com.



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STRENGTHS AND WEAKNESSES OF CRYPTO ALGORITHMS

ALGORITHM	COMMENT	STRENGTHS	WEAKNESSES
DES	Standard, widely accepted	Long-tested	Has yielded to DC
FEAL-4	DES substitute		Easily broken by DC
GDES, NewDES	DES-like		Easily broken by DC
Khufu	DES-like	Secure against DC	New, unknown
Blowfish	DES-like	Secure against DC	New, unknown
RC-4	Proprietary	Variable-length key	Unknown
RSA Public Key	Widely used	Long-tested	Vulnerable to advances in factoring
Skipjack	Classified	Considered strong	Algorithm must remain secret to preserve law-enforcement trapdoor

DC = differential cryptanalysis

Recently, the IBM scientists who originally designed DES revealed that they anticipated Biham and Shamir's attack and optimized DES to resist it. Because other nongovernment cryptographers didn't know about this attack, they couldn't design their software to resist it. Now the information is public, and there are new ciphers that hold up well against these attacks. Ralph Merkle's Khufu and Bruce Schneier's Blowfish are two private-key ciphers that are similar to DES but resist differential cryptography. They do this by creating new S-boxes for each encryption, using the key to randomize them. (S-boxes are the essential scrambling elements of DES-like ciphers. Think of them as lookup tables or nonlinear functions; their outputs should be as random as possible.) Differential cryptanalysis works only if the attacker knows what's in the S-boxes.

This work also revealed some stunning counterintuitive results. Key length is usually taken as a rough measure of a system's security. DES uses 56-bit keys; a brute-force attacker might need to try all 2^{56} keys to find the right one. A longer key would mean a longer brute-force attack. However, Biham and Shamir showed that even if DES used longer keys, it would hardly be any stronger against differential cryptanalysis. The statistical model would still be solvable if DES used the maximum of 768 bits.

Applying this knowledge to other types of ciphers is tricky. RSA Data Security markets a proprietary algorithm called RC-4 that accepts a variable-length key; this algorithm is used in many products. The flexible key length can be an advantage in some situations. For example, the government allows general export of software using RC-4 with a 40-bit key, but similar software using a longer key must stay within the U.S. While we don't know if differential cryptanalysis can be applied to RC-4 directly, because of the algorithm's proprietary nature, the results with

DES suggest that more key is not necessarily stronger.

Men and Machines

Mathematical tools like differential cryptanalysis can be the most powerful attack against a cipher system. Brute-force attacks are normally a last resort, rare in practice because cipher designers routinely use long key lengths specifically to preclude them. But times are changing. We're reaching a point at which a large machine can quickly search the entire keyspace of DES. DES is still in wide use; it's been the commercial and governmental standard for nearly two decades. Replacing such standards can be a painfully slow process.

DES users should be thinking about what can be done with off-the-shelf hardware.

Brute-force attacks simply use large machines that try all possible passwords in parallel. It's even possible to produce native chips that run DES. Michael Wiener of Bell Northern Research described how to build a \$1 million machine using a pipelined DES processor that could cruise through all possible keys in about 7 hours.

Massively parallel machines can also attack the problem. Some of the most promising emerging machines distribute small, 1-bit processors directly onto the memory chips. Some have 1024 processors on a chip with 42 bits of memory per processor. (Before it entered Chapter

11, Cray Computer was building for the National Security Agency a special Cray 3 with such processor-embedded memory.) In 1992 I designed a machine using 1 million associative processor memory chips (standard DRAM densities) from Coherent Research (Syracuse, NY) that could attack all of DES in one day. This machine could be reprogrammed to attack other DES-like ciphers. Linden Technology (Austin, TX) is currently exploring manufacturing new

4-Mb DRAMs with the 1024 associative processors built onto the chip.

The effect of brute-force attacks on DES is also important for Unix security, which stores each password after passing it through DES 25 times. At log-in, you type your password; it's encrypted 25 times and the result compared against the password file. If it matches, the system grants you access. Because the password file doesn't contain the passwords themselves, unauthorized users can't use the file to recover them directly. They must

use a brute-force machine. However, the brute-force attack can be relatively successful against Unix, because the keyspace is smaller. Most users limit their passwords to alphabetic characters, occasionally adding numbers. This makes searching for passwords much faster; it could be done quite quickly with an associative-memory parallel processor. One estimate suggests that a computer using 512 of Linden's chips could test all six-character alphanumeric passwords in 15 minutes. Clearly, the Unix password structure needs to be rethought in light of today's machines and code-breaking techniques.

Because of this new vulnerability, you may want to explore other, newer ciphers, such as Merkle's Khufu or Schneier's Blowfish. The classified Skipjack algorithm buried inside the U.S. government's Clipper and Capstone encryption chips also uses S-boxes, but little is known about their design. There's little reliable public information about RSA Data Security's RC-4. Anyone who uses these algorithms must be prepared to trust the wits of the designers, because the algorithms have not undergone the intensely thorough and long-time public scrutiny given to DES.

Many organizations have opted to continue with DES, but the current state of the art is triple-DES—three passes of the algorithm with either 112- or 168-bit keys. This effectively guards against

both brute-force and differential analysis attacks. These users can rest assured that, paradoxically, all the attacks focused on DES continues to keep it strong. ■

Where to Find

RC-4
 RSA Data Security, Inc.
 Redwood City, CA 94065
 (415) 595-8782
 fax: (415) 595-1783
Circle 1060 on Inquiry Card.

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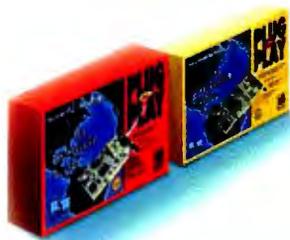
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SALVATORE SALAMONE

Programming rule number 1 is, Understand the end user's needs. But can you go too far? One programmer recently learned how to saddle up a horse, don a riding helmet, and fly off across a steeplechase course with the snap of a riding crop. While hanging on, he made notes about how to process scores so that they can be colated and displayed in three-tenths of a second. He's part of the programming team that is helping to create the massive technical infrastructure for the 1996 Summer Olympic Games in Atlanta.

This team is the ultimate example of technology convergence. Network administrators study grand prix racecourses to design the

Neal, director of IS services for ACOG (Atlanta Committee for the Olympic Games).

Meeting the Challenge

Much of the technology used for what Olympic officials boast is the "largest peacetime event in history" can be directly applied to commercial businesses. This is one reason IBM is donating much of the approximately \$40 million technology cost of the project. Besides the promotional benefits of being a technical sponsor, Big Blue hopes to learn new tricks by tackling information management hurdles surrounding athletes who must jump more traditional hurdles. Lessons learned may help commercial banks with a large number



of branch offices develop autonomous client/server loan-processing systems that tap into customer information residing on central mainframes.

However, Olympic officials face some challenges that few corporations ever encounter. Besides the temporal nature of the event, the Olympics is staggering in its magnitude. If sports in general are a statistician's dream, the Olympics is nirvana. Consider this: The Games encompass 10,000 athletes, 26 sports, 30 competition venues, and 17 days of competition. What kind of technical muscle lies behind this? There are 105 programmers (with 15 more to come later), 7000 PS/2s and ThinkPad notebooks, 80 AS/400s, 250 LANs, three IBM System 390 mainframes, and approximately 160,000 E-mail accounts.

As if size isn't challenge enough, there's one more overriding pressure: Everything must work when the Games begin. The technical staff can't roll back the start-up date because of software bugs, hardware incompatibilities, or the desire to add one more feature to an application. Small delays in system operation can't be tolerated. TV broadcasters want to display an athlete's time and picture on the screen as he or she crosses the finish line, not 10 seconds later.

To lessen the risk of system failures, ACOG, for the most part, chose proven technology. And in areas where vastly different systems must interact, ACOG

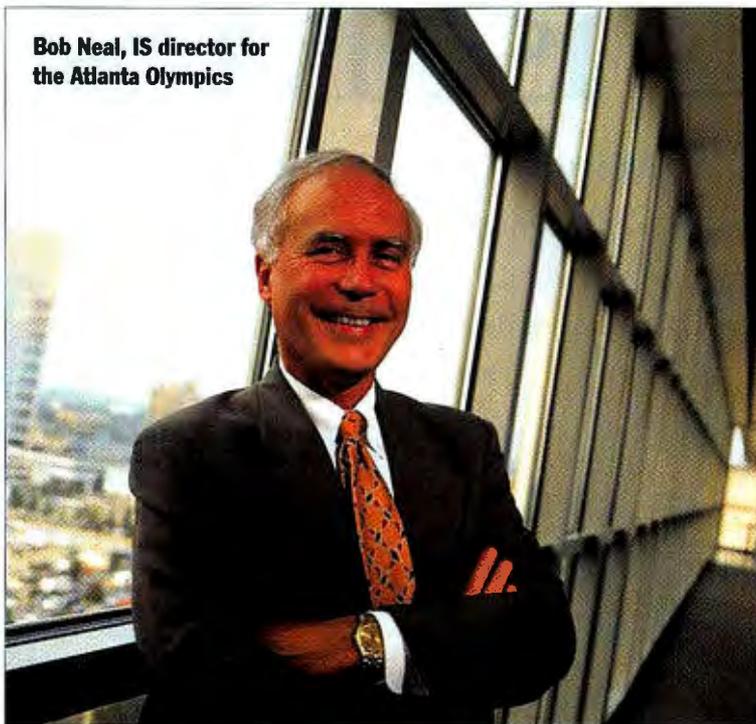
uses its own testing lab, where interoperability snags can be worked out before equipment is deployed.

Three Tiers

The Atlanta information system consists of three main components that are being developed separately:

- A results management system, which collects raw data, performs necessary calculations, and makes the results available to the spectators, Olympic officials, and the press.
- Info'96, which provides athletes, their families, the press, and dignitaries with event and transportation scheduling, results, weather reports, Olympic news, and athlete biographies.

Bob Neal, IS director for the Atlanta Olympics



PHOTOS: ANN STATES © 1995

best systems to monitor bicycling events. UI (user-interface) gurus attend triathlons to help figure out how on-air commentators can call up athlete biographies fast enough to make TV viewers think broadcasters know everything.

The system being implemented for the Olympics centers around a distributed database that gives officials the flexibility to change how pertinent data is assembled, displayed, and disseminated at each sporting venue. At the same time, the system provides enterprise-wide control over the data to ensure its integrity.

To accomplish this feat, the Atlanta Olympic Committee along with its technology partner, IBM, developed a distributed database system with one unusual twist. "We're putting together a Fortune 500 enterprise with a going-out-of-business strategy," quips Bob

IBM and Olympic officials prepare for the herculean task of information management at the 1996 Summer Games

- An operations management support system, which handles accreditation for more than 150,000 people.

The first test of the results management system took place during a 120-mile grand prix bicycle race in May. At that time, the systems that processed and disseminated results worked without a hitch. The first large-scale test of the results system was scheduled for a rowing national championship held in June. After that, a number of small trials throughout the year will test the integration of the systems.

The key was settling on a common system architecture. Officials sought an architecture that was reliable, flexible, and fast enough to meet the needs of the Olympics. The search for such an architecture began in the fall of 1991, soon after Atlanta learned that it would be the host city. Neal, who has IT (information technology) experience but no previous Olympic experience, contacted the International Olympic Committee to see what was used in the past. "We got lots of war stories but not a lot of usable systems," he recalls. Neal benefited most from the 1992 Winter and Summer Games held in Albertville and Barcelona. From studying and working at them, he found patterns to guide the Atlanta efforts (see the figure "Third Time's a Charm" on page 80NA 6 for illustrations of all three systems).

For example, the system used in Albertville had a strong mainframe component but was weak on the venue side. Essentially, the host was used to store, manipulate, and disseminate all the information, while the venues were little more than LAN-based front ends to the data on the hosts. This system provided a common database for all the information of the Games. However, if the host or the lines connecting a venue to the host were unavailable, the people at the venues were on their own.

Additionally, this setup lacked the flexibility to make quick changes, because any modification required mainframe programming. Unfortunately, changes are a fact of life in the Olympics. The international federations for the various sports regularly change requirements or scoring systems on the fly. And during the 1992 Olympics, there was a more unpredictable change: Athletes from what was then the crumbling Soviet Union arrived at the Games as new countries were forming. This required new tables to be created in mainframe databases.

Client/Server Muscle

In contrast to the host-centered architecture used in Albertville, the Barcelona systems were strong at the venue level but weak on the host side. Thus, venues had autonomy, but the separate databases maintained at venues led to discrepancies in data. For example, an athlete's name might be spelled Smyth one day and Smith the next—quite an identity crisis.

Neal and his group combined the best of both architectures. An

CHALK TALK

The Challenge

- Develop information systems with the performance and flexibility to handle the largest competitive sporting event ever staged.
- Systems must work as designed and without fail.



The Problems

- A hard deadline with no room for rollout dates to slip.
- Massive amounts of scores, schedules, and other data must be available almost instantaneously.



The Solutions

- A distributed database system that uses client/server technology for autonomy and flexibility.
- A host enterprise server that distributes data to news services and to people not at the locations where events take place.



The Benefits

- Autonomy of venues ensures that they can operate even if the host is unavailable.
- A common host-based database ensures data consistency and allows for intelligent use of data by many systems.

Lessons Learned

- Rely on both a strong host component and a strong client/server component for distributed databases, such as those for large companies with a number of branch offices.

IBM mainframe acts as a common database and repository to store all pertinent information about the athletes as well as the final event results. Additionally, the IBM host functions as an unbelievably large enterprise server that acts as the switch through which all results are distributed to the world. At the same time, the system gives venues autonomy and responsibility for virtually all the processing and preparation of results. The venues also distribute the final results to on-site people, such as event officials, spectators, and the media.

Additionally, the processed results data must be replicated from the venue database to the IBM host database for further dissemination. This replication is done using standard DB2 data transfer technology, where the venue data (collected and stored using DB2/2, which is a version of DB2 for OS/2) is passed to the mainframe using a product from IBM called Distributed Database Connection Services.

There are about 70 venues and 10 associated facilities (e.g., the press center, the administrative offices, and the athletes' village). They range in size from the massive primary Olympic Stadium to small temporary setups spread throughout the area. Despite the size differences, all venues share some common features. For example,





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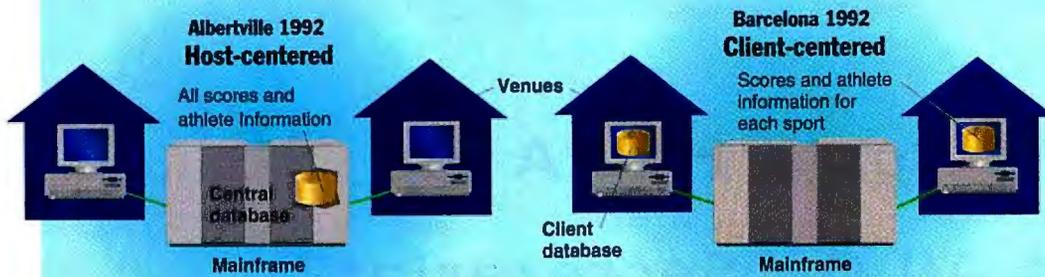
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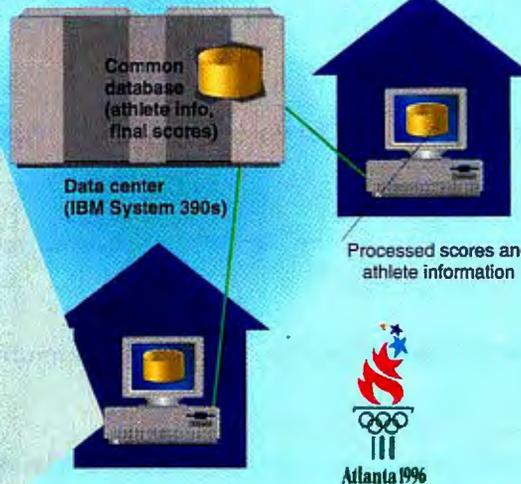
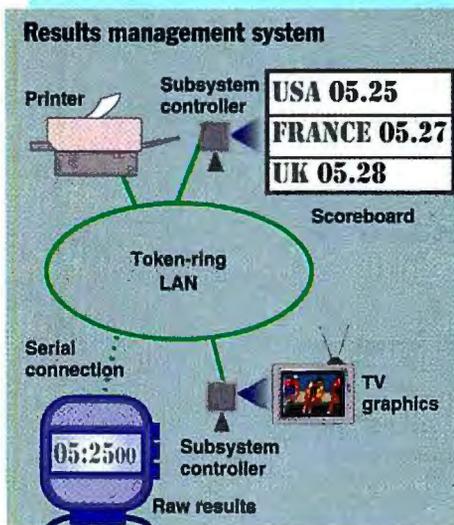
Third Time's a Charm



The Albertville information system relied on a central mainframe with a common database to store all athlete data and scores. Officials at the venues couldn't easily change how scores were collated or reported.

The Barcelona games used the opposite approach of autonomous venues, each with a database for individual sports. Separate databases led to discrepancies in data.

Atlanta 1996 Central data center with autonomous clients



The Atlanta games will use the best elements of the Albertville and Barcelona systems. The results management system in each venue receives raw performance data and processes it into final scores according to the criteria for each sport. Scores are then distributed on-site to officials, the press, and spectators, as well as replicated to the central data center, which maintains data integrity.

they all must deal with data acquisition, processing, and printing results for officials and the press.

The hardware in the venues consists of PS/2s, AS/400s, and Lexmark 4039 printers. The standard results management system venue configuration (see the figure above) is a token-ring LAN with a results server running OS/2 LAN Server, OS/2 Warp, and DB2/2 server and client software. Attached to the token-ring network is an event management workstation, which runs OS/2 Warp and DB2/2 client software. Additionally, each venue has workstations that act as subsystem controllers that drive scoreboard displays, feed the results to TV graphics systems, and pass the results to a press data system.

Because the system can't tolerate failures during an event, redundancy exists in the system, including dual token-ring networks. Additionally, each venue has LAN-attached Lexmark printers to produce the results for event officials and the press. Also attached to the LAN is a CIS (commentator information system) control sta-

tion, which makes results available to TV commentators so they can better describe the action on the field.

One challenge in developing the results management system is that the results for each sport are so different—points versus seconds, for example. "We have 26 sports and 37 different subprojects," says Jim Thompson, project manager for IBM results timed sports.

Selecting a common database architecture for all sports simplified matters. However, it still required knowledge of all the sports to set up the appropriate database tables and structures. To help the developers, every sport submitted a set of requirements spelling out the types of information needed during an event and what constitutes official results.

For each sport, an ACOG competition manager (usually a member of that sport's international federation or governing body) helped the developers interpret the rules of competition. Some developers really got into their sports, including the programmer who took up horseback riding to get a better understanding of equestrian

events. Besides having different results requirements, the results systems have to handle different types of raw data.

For the track, cycling, and swimming events, the incoming data is typically the time it takes each participant to finish a lap. Swiss Watch (Swatch) is responsible for the timing systems. It feeds this information over a serial link to the results management system in the venue. Pen-based laptops were developed for recording other types of results (see the text box "Getting Into the Action" on page 80NA 8).

Regardless of the form of the raw data, once it is passed to the results management system, it is handled in much the same way. The raw data is imported into a DB2/2 DBMS. Any calculations and manipulations required to turn the raw data into official results are then performed at the venue.

Performance counts in the venues. Many of the systems that use the results have very stringent time requirements. For example, the CIS and the TV graphics systems need the information virtually in real time. Specifically, the results



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management system must take the raw data, process it, put it into the appropriate format, and make it available to the CIS and the TV graphics display systems in three-tenths of a second. In the racing sports, printed results must be in the hands of the press 5 seconds after each lap. The system can have printed intermediate results, such as the lap times of the top 10 or 20 athletes, in the hands of people in 2 minutes.

Distributing Information

The results must also be made available to people in other venues and to news agencies. To accomplish this takes a sophisticated infrastructure that includes use of public and private frame-relay and ISDN circuits, an ATM (asynchronous transfer mode) backbone (between three sites) that serves as a communications hub for the smaller venues, and lots of redundancy.

Processed results are replicated (using Distributed Database Connection Services) to a DB2 mainframe database. Once on the mainframe, several things happen to the results. They are replicated to two more mainframes. One of the two is a backup system (in the data center) that normally runs network applications. It can be called into action in a matter of minutes if there is a problem with the first system.

The data is also shipped off-site to a remote location in the event the data center is lost. If that happens, the estimated time for recovery is 1 hour. In all previous Games, it was 24 hours. The significant improvement is because past Games relied on tapes that were dumped at the end of each day and transferred off-site. For Atlanta, any time there are changes on a volume, a system uses extended remote copy procedures, where the changes are automatically sent over a high-speed link to the disaster recovery site.

At the same time the printing is being performed, the results are also passed to an RS/6000 with serial communications cards that connect to news agencies. Each agency has a different serial-data format that must be taken into account. The RS/6000 was selected for its processing power and because it can accommodate 32 serial ports. Compared to other options, this offered a consolidation of equipment. The results are also distributed to the Info'96 system. The results pass down from the mainframe to AS/400s scattered throughout Atlanta, and

Getting Into the Action

Many of the team sports, such as water polo, handball, and baseball, require lots of player information to be gathered during the event. For instance, we want to know how many shots on goal a player has taken or how many strikeouts a pitcher has recorded.

In the past, collecting and analyzing this type of information was tedious manual work. Scorers would sit with paper and pen and record the information. Then this information had to be entered into a database for it to be analyzed, printed, and distributed. Not only tedious, this method also introduced delays. For the 1996 Games, the results management team has developed a program that runs on an IBM ThinkPad and uses a pen-based entry device to record this raw data. While all the sports have different criteria for scoring, the developers made a common interface for all team sports. Each sport has a graphical representation of its playing field surrounded by a player list and icons representing such things as a shot on goal, a turnover, or a penalty (see the screen).

The system is easy to use. For example, to record a shot attempted but missed, the official scoring the event tags the player's name with the pen, tags the missed icon, and indicates where on the playing field the shot was taken from. Because the official has to be close to the field to record this information (and because it would not be a good idea to have cables on the playing field), the notebooks use a wireless link into the results management system LAN in the venue where the event takes place. The wireless link is also used to download (to the notebook from the LAN server) the list of participants in the event.



then the scores can be displayed on any of the 2000 kiosks connected to the AS/400s.

Intelligent Information

With such diverse systems, there is a tendency to keep them separate. Neal wanted to avoid duplication of efforts by using information intelligently—reducing redundancy. The idea is to save time by taking advantage of natural synergies.

For example, every athlete must be accredited before the games. Rather than requesting this information numerous times, this information is used by several of the systems. For one, this information is used to create lists of athletes for the venue databases. Each morning, the venues tap the host database and pull down a list of participants for each event in that venue. This saves time at the venue because the names do not have to be entered each day. Besides saving time, this ensures that all participants' names are spelled correctly (or at least consistently) from day to day—something that was a problem previously when the venue databases were not synchronized with the host.

Information about each athlete is also used by Info'96 and the CIS, both of which let people look up biographical details

about each participant. Additionally, much of the information gathered in the accreditation process is used by the operations management support system to give athletes access to facilities. When an athlete registers in Atlanta, personal information is encoded onto an ID card chip. This card allows access to all the facilities as well as to the sports venues.

In more secure areas, such as the athletes' village, a biometric measurement of hand geometry is required before entry is permitted. (A hand-geometry measurement is taken when the athlete registers and is stored on the ID card.) Although access verification happens locally, a host component runs a security check to make sure the athlete has access rights to the facility. This jibes with Neal's desire for strong host and venue elements.

By tapping the strengths of host-based DBMSes and client/server development environments, IBM and ACOG hope the computer systems at the Olympics perform at the same world-class level as the athletes. ■



ID cards encode athletes' data on a chip.

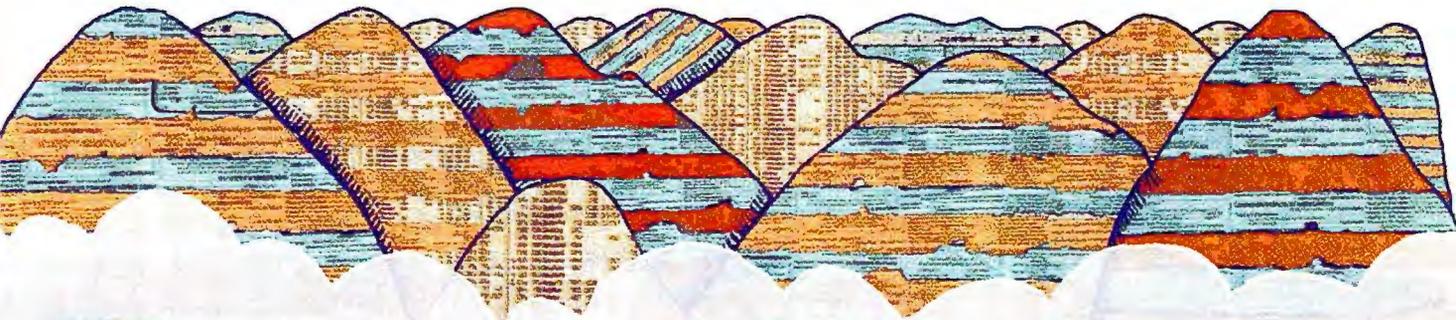
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Salvatore Salamone is a BYTE news editor in the New York City bureau. You can reach him on the Internet or BIX at ssalamone@bix.com.

DATA MINING

Turn computers loose on your data, and you don't know *what* they'll come up with—that's the whole point



There's gold in your data, but you can't see it. It may be as simple (and wealth-producing) as the realization that baby-food buyers are probably also diaper purchasers. It may be as profound as a new law of nature. But no human who's looked at your data has seen this hidden gold. How can you find it?

Data mining lets the power of computers do the work of sifting through your vast data stores. Tireless and relentless searching can find the tiny nugget of gold in a mountain of data slag.

In "The Data Gold Rush," Sara Reese Hedberg shows the already wide variety of uses for the relatively young practice of data mining. From analyzing customer purchases to analyzing Supreme Court decisions, from discovering patterns in health care to discovering galaxies, data mining has an enormous breadth of applications. Large corporations are rushing to realize the potential payoffs of data mining, both in the data itself and in marketing their proprietary tools.

In "A Data Miner's Tools," Karen Watterson explains the three categories of software to perform data mining. Query-and-reporting tools, in vastly simplified and easier-to-use forms, require close human direction and data laid out in databases or other special formats. Multidimensional analysis (MDA) tools demand less human guidance but still need data in special forms. Intelligent agents are virtually autonomous, are capable of making their own observations and conclusions, and can handle data as free-form as paragraphs of text.

"Data Mining Dynamite" by Cheryl D. Krivda shows how to facilitate the data-mining process. Data is handled far faster after it has been cleansed of unnecessary fields and stored in more convenient forms. Housing data in data warehouses reduces the load on production mainframes and supports client/server analysis. Parallel computing speeds the search process with multiple simultaneous queries. And any activity handling this volume of data requires consideration of physical storage options.

In the short term, the results of data mining will be in profitable if mundane business-related consequences. Micro-marketing campaigns will explore new niches. Advertising will target potential customers with new precision.

In the not-too-long term, data mining may become as common and easy to use as E-mail. We may direct our tools to find the best airfare to the Grand Canyon, root out a phone number for a long-lost classmate, or find the best prices on lawn mowers. The software will figure out where to look, how to evaluate what it finds, and when to quit. Our knowledge helpers may become as indispensable as the telephone.

But it's the long-term prospects of data mining that are truly breathtaking. Imagine intelligent agents being turned loose on medical-research data or on subatomic-particle information. Computers may reveal new treatments for diseases or new insights into the nature of the universe. We may well see the day when the Nobel prize for a great discovery is awarded to a search algorithm. ■

—Edmund X. DeJesus, Senior Editor

The Data Gold Rush

From molecular chemistry to mortgage credit checks, there are many uses for data mining.....**83**



A Data Miner's Tools

You can choose from query-and-reporting tools, multidimensional analysis tools, and intelligent agents ...**91**



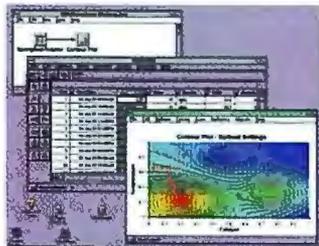
Data-Mining Dynamite

Massively parallel computers and RAID subsystems: What you should do to facilitate data mining**97**





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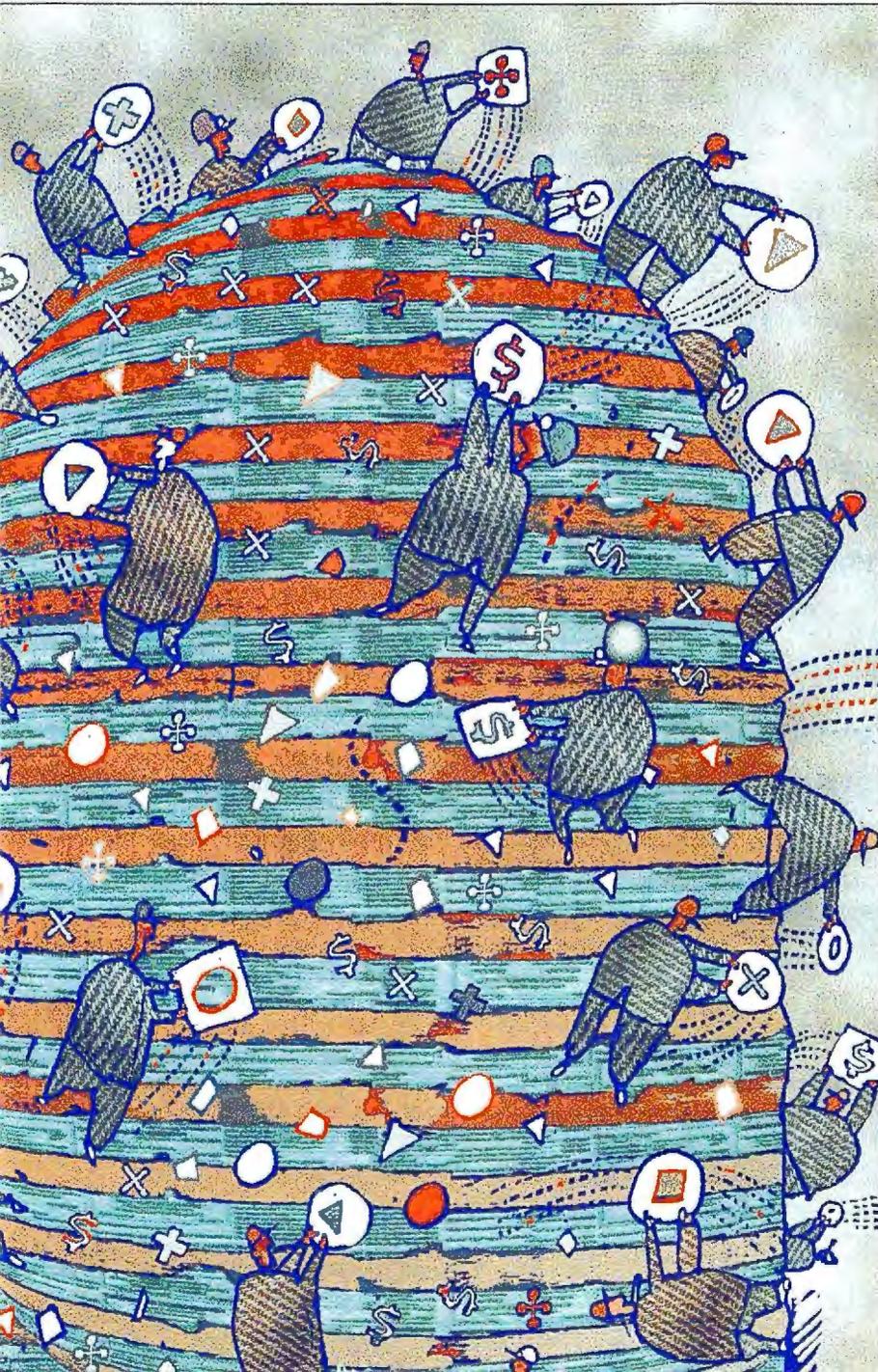
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THE DATA GOLD RUSH

Smart data miners are cashing in on valuable information buried in private and public data sources

SARA REESE HEDBERG



It's in there. The discovery, the fact, the one piece of the puzzle that will blow away the competition, propel your company to the top, and stick a "VP" after your name. It's right there, in your database. But you can't see it. Yet.

The amount of information stored in databases is exploding. From zillions of point-of-sale transactions and credit card purchases to pixel-by-pixel images of galaxies, databases are now measured in gigabytes and terabytes. In today's fiercely competitive business environment, companies need to rapidly turn those terabytes of raw data into significant insights to guide their marketing, investment, and management strategies.

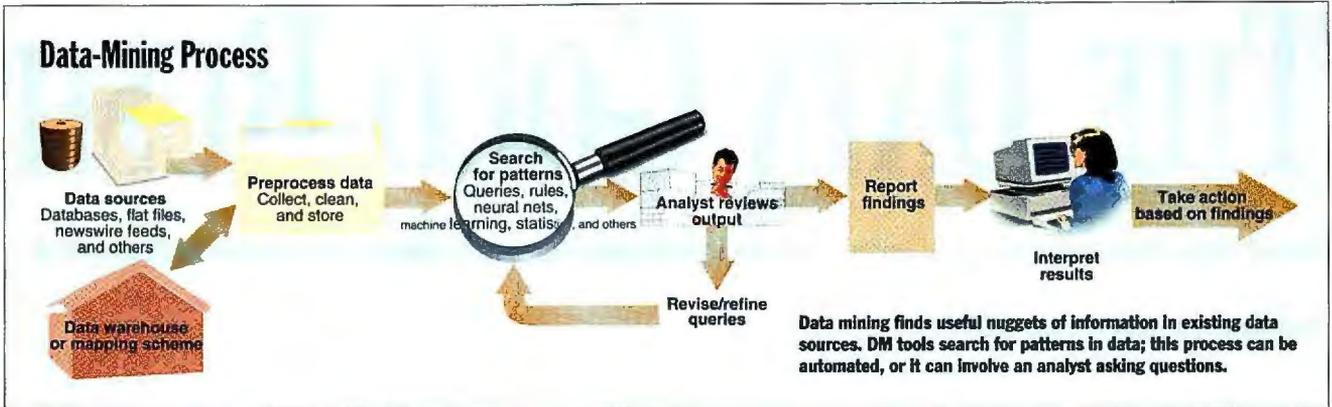
It would take many lifetimes for an analyst to pore over 2 million books—the equivalent of a terabyte—to glean important trends. But analysts have to. For instance, Wal-Mart, the chain of over 2000 retail stores, every day uploads 20 million point-of-sale transactions to an AT&T massively parallel system with 483 processors running a centralized database. At corporate headquarters, they want to know trends down to the last Q-Tip.

Luckily, computer techniques are now being developed to assist analysts in their work. Data mining (DM), or knowledge discovery, is the computer-assisted process of digging through and analyzing enormous sets of data and then extracting the *meaning* of the data nuggets. DM is being used both to describe past trends and to predict future trends.

Mining and Refining Data

Experts involved in significant DM efforts agree that the DM process must begin with the business problem. Since DM is really providing a platform or workbench for the analyst, understanding the job of the analyst logically comes first. Once the DM system developer understands the analyst's job, the next step is to understand those

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data sources that the analyst uses and the experience and knowledge the analyst brings to the evaluation.

The DM process generally starts with collecting and cleaning information, then storing it, typically in some type of data warehouse or datamart (see the figure "Data-Mining Process"). But in some of the more advanced DM work, such as that at AT&T Bell Labs, advanced knowledge-representation tools can logically describe

the contents of databases themselves, then use this mapping as a meta-layer to the data. Data sources are typically flat files of point-of-sale transactions and databases of all flavors. There are experiments underway in mining other data sources, such as IBM's project in Paris to analyze text straight off the newswires.

DM tools search for patterns in data. This search can be performed automatically by the system (a bottom-up dredg-

ing of raw facts to discover connections) or interactively with the analyst asking questions (a top-down search to test hypotheses). A range of computer tools—such as neural networks, rule-based systems, case-based reasoning, machine learning, and statistical programs—either alone or in combination can be applied to a problem.

Typically with DM, the search process is iterative, so that as analysts review the output, they form a new set of questions to refine the search or elaborate on some aspect of the findings. Once the iterative search process is complete, the data-mining system generates report findings. It is then the job of humans to interpret the results of the mining process and to take action based on those findings.

AT&T, A.C. Nielsen, and American Express are among the growing ranks of companies implementing DM techniques for sales and marketing. These systems are crunching through terabytes of point-of-sale data to aid analysts in understanding consumer behavior and promotional strategies. Why? To increase profitability, of course.

Similarly, financial analysts are plowing through vast sets of financial records, data feeds, and other information sources in order to make investment decisions. Healthcare organizations are examining medical records in order to understand trends of the past; they hope this information can help reduce

their costs in the future. Major corporations such as General Motors, GTE, Lockheed, Microsoft, and IBM all have R&D groups working on proprietary advanced DM techniques and applications.

Software

Hardware and software vendors are extolling the DM capabilities of their prod-

MARKETING

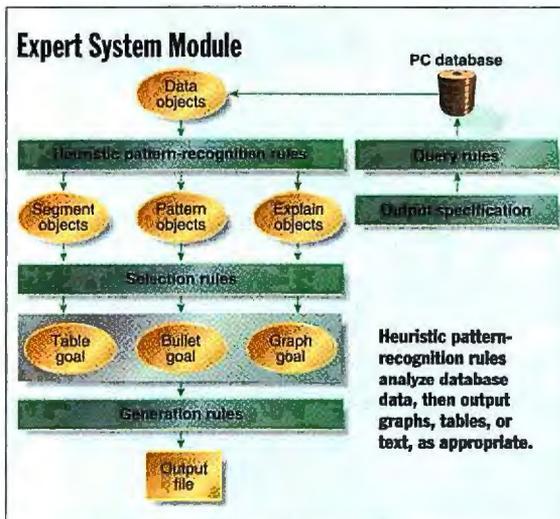
Many marketers believe one of the most powerful competitive weapons is understanding and targeting each customer's individual needs. To this end, more companies are harnessing DM techniques to shed light on customer preferences and buying patterns. With this information, companies can better target customers with products and promotional offerings.

A.C. Nielsen's Spotlight is a good example of a DM tool. Nielsen clients use Spotlight to mine point-of-sale databases. These terabyte-size databases contain facts (e.g., quantities sold, dates of sale, prices) about thousands of products, tracked across hundreds of geographic areas for at least 125 weeks. Spotlight transforms tasks that would take a human from weeks to months to do into tasks a computer can do in minutes to hours. Nielsen says it has sold about 100 copies of Spotlight (DOS and Windows) to U.S. clients, who have in turn deployed it

to field-sales representatives in multiple regional centers. The software frees analysts to work on higher-level projects instead of being swamped by routine, laborious chores.

In the past two years, a global group at Nielsen has changed the U.S. version of Spotlight for use in other countries. "Spotlight is the most widely distributed application in the consumer packaged-goods industry," claims Mark Ahrens, director of custom software sales at Nielsen.

American Express is analyzing the shopping patterns of its card holders and using the information to offer targeted promotions.



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The collage displays various features of the STATISTICA software, including:

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- Bar charts and pie charts.
- Data tables and spreadsheets.
- Statistical analysis windows with various options and results.
- Interactive graphs with brushing and zooming capabilities.
- Word processor-style report editors.
- Quality control charts and process capability analysis.
- Experimental design (DOE) analysis windows.
- World maps and geographical data visualizations.

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STATE OF THE ART The Data Gold Rush

ucts—whether they have true DM capabilities or not. This hype cloud is creating much confusion about data mining. In reality, data mining is the process of sifting through vast amounts of information in order to extract meaning and discover new knowledge.

It sounds simple, but the task of data mining has quickly overwhelmed traditional query-and-report methods of data analysis, creating the need for new tools to analyze databases and data warehouses intelligently. The products now offered for DM range from on-line analytical processing (OLAP) tools, such as Essbase (Arbor Software) and DSS Agent (MicroStrategy), to DM tools that include some AI techniques, such as IDIS (Information Discovery System, from IntelligenceWare) and the Database Mining Workstation (HNC Software), to the new vertically targeted advanced DM tools, such as those from AT&T Global Information Solutions. (See "A Data Miner's Tools" on page 91 for more information on DM products.)

Many people argue that the OLAP tools

are not "true" mining tools; they're fancy query tools, they say. Since these programs perform sophisticated data access and analysis by rolling up numbers along multiple dimensions, some analysts still include them in the category of top-down mining tools. The market has yet to see much in the way of more-advanced mining tools, although the spigot is being turned on by application-specific DM tools from AT&T, Lockheed, and GTE.

Let's Get Vertical

One major DM trend is the move toward powerful application-specific mining tools. "There is a trade-off in the generality of data-mining tools and ease of use," observes Gregory Piatetsky-Shapiro, principal investigator of the Knowledge Discovery in Databases Project at GTE Laboratories. "General tools are good for those who know how to use them, but they



The U.S. Internal Revenue Service has developed a system to detect fraud and improve tax collections. The prototype system runs on PCs and includes KnowledgeSeeker (Angoss Software), ModelWare (TeraNet), and AIM (AbTech).

Beverly Cook, a researcher at the University of Wisconsin-Milwaukee, used IDIS to evaluate the death penalty-related votes and opinions of Supreme Court Justice Byron White. She found that his behavior was related to his affiliation with the conservative bloc of the Court and that his voting patterns were linked to the race of the accused.

really require lots of knowledge to use them."

AT&T, for example, recently introduced Sales & Marketing Solution Packs to mine data warehouses. They're tailored to vertical markets in retail, financial, communications, consumer-goods manufacturing, transportation, and government. These programs provide about 70 percent of the solution, with final tailoring required to



GTE Laboratories has built an advanced DM system to evaluate health-care utilization costs for GTE's employees and dependents. Health-KEFIR (KEy Findings Reporter) pinpoints groups whose costs are likely to increase in the coming year, finding areas where specific intervention strategies are likely to save the most money.

The system can slice and dice the data in thousands of different ways—by business units, age groups, or types of care, for instance. It can consider multidimensional factors for each subcategory of data, such as payments per day per hospital stay within various segments. (See the figure "The KEFIR System.")

Health-KEFIR selects only those medical conditions that are "interesting"; in other words, those for which there is a known procedure that improves health outcomes and decreases costs. An increase in normal pregnancies, for example, will not be flagged, while an increase in premature births will be flagged, since there are standard medical in-

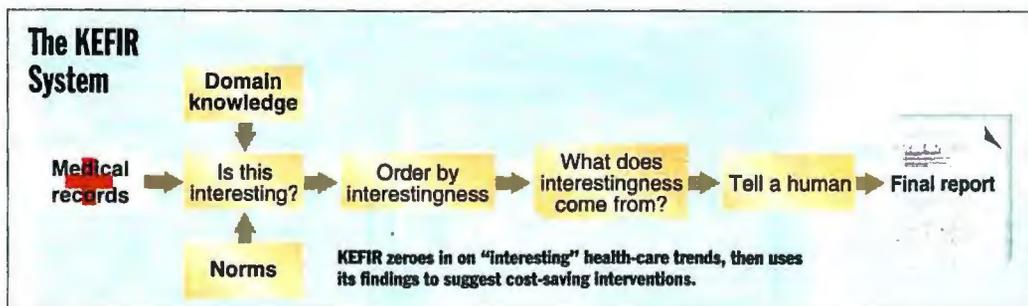
terventions in prenatal care taken to reduce the premature birth rate.

"KEFIR's reports are more comprehensive, generated in less time, and significantly cheaper than comparable medical consultant reports," claims Gregory Piatetsky-Shapiro, principal investigator of the Knowledge Discovery in Databases Project at GTE Laboratories.

KEFIR is written in tcl and C, with a SQL interface to ensure portability. It currently runs on a Sun SparcStation 20 workstation with Informix DBMS. Instead of a paper report of hundreds of pages, KEFIR's output is on the network in hypertext markup language (HTML) and GIF files, accessible by Web client software such as Netscape's Mosaic. Deployment to GTE regional managers across the country is scheduled for late 1995. GTE is now evaluating proposals to turn Health-KEFIR into a commercial product. It is also considering applying KEFIR to marketing and customer-analysis tasks.

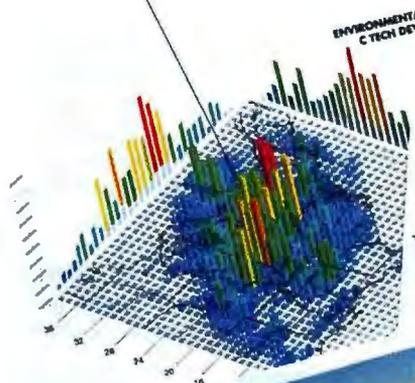
Southern California Spinal Disorders Hospital in Los Angeles is using IDIS (IntelligenceWare) on PCs to discover subtle factors affecting success and failure in back surgery.

A coach in the U.S. Gymnastics Federation is using IDIS to discover long-term factors that contribute to an athlete's performance. This information will be used in order to treat potential problems early on.



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 *PC Magazine, Nov. 22, 1994, Annual Printer Review.

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SCIENCE

DM techniques are starting to assist humans in scientific discovery. By traversing enormous data sets, they are finding patterns in molecular structures, genetic data, global climate changes, and more.

NASA-Jet Propulsion Laboratory and Caltech have developed SKICAT (SKy Image Cataloging and Analysis Tool), an advanced DM system to automatically analyze and catalog the second Palomar Sky Survey of the northern heavens. (SKICAT is written in C, runs under Unix, and employs custom algorithms and a Sybase DBMS.) When complete, the survey will catalog more than 50 million galaxies, about 2 billion stars, and 100,000 quasars. The survey will produce some 3 terabytes of data, which will be reduced to a galaxy catalog.

SKICAT recently discovered nine new quasars. With previous search techniques, it took three years to discover a similar number of the same type of quasars. With SKICAT, Caltech astronomers performed the same feat in less than six months using at least an order of magnitude less of observing time.

fit the individual client's needs, AT&T says. Complete with AT&T parallel hardware, software, and some services. Solution Packs start at around \$250,000.

Both GTE and Lockheed Martin may shortly follow suit. GTE is already entertaining proposals to turn its Health-KE-FIR (KEy Findings Reporter) into a commercial product (see the "Health Care" text box on page 86). The Artificial Intelligence Research group at Lockheed Martin has been investigating and developing DM tools for the past 10 years. Recently, the Lockheed group built an internal application-development tool, called Recon, that generalizes their DM techniques, then

creating a marketing DM hybrid. HNC Software's Falcon detects credit-card fraud; according to HNC, the program is watching millions of charge accounts.

Invasion of the Data Snatchers

The need for DM tools is growing as fast as data stores swell. More-sophisticated DM products are beginning to appear that perform bottom-up as well as top-down mining. The day is probably not too far off when intelligent agent technology will be harnessed for the mining of vast public on-line sources, traversing the Internet, searching for information, and presenting it to the human user. Microelectronics and

applied it to application-specific problems. A beta version of the first vertical packages—for finance and marketing—will be available in 1996. The system has an open architecture, running on Unix platforms and massively parallel supercomputers. It interfaces with existing relational database management systems, financial databases, proprietary databases, data feeds, spreadsheets, and ASCII files.

In a similar vein, several neural network tools have been customized. Customer Insight Co., for instance, has built an interface to link its Analytix marketing software with HNC Software's neural network-based Database Mining Workstation,

Computer Technology Corp. (MCC, Austin, TX) has been pioneering work in this area, developing a platform, called Carnot, for its consortium members. Carnot-based agents have been successfully applied to both top-down and bottom-up DM of distributed heterogeneous databases at Eastman Chemical.

"Data mining is evolving from answering questions about what has happened and why it happened," observes Mark



FINANCE

Although there are reportedly a number of financial applications using

DM techniques, the financial community is understandably tight-lipped about them. Numerous investment companies, for example, pick stocks with advanced DM systems, while some financial institutions have implemented systems designed for prevention and detection of fraud.

Security Pacific/Bank of America uses DM to help with commercial lending decisions and to prevent fraud.

Ahrens, director of custom software sales at A.C. Nielsen. "The next generation of DM is focusing on answering the question 'How can I fix it?' and making very specific recommendations. That's our focus now—our Holy Grail." Meanwhile, the gold rush is on. ■

MINING OTHER DATA-MINING RESOURCES

Information about DM research, applications, and tools can be found on the Knowledge Discovery Mine Website at <http://info.gte.com/~kdd/>.

Advances in Knowledge Discovery & Data Mining, U. Fayyad, et al., editors; AAAI/MIT Press, 1995.

Proceedings of the First International Conference on Knowledge Discovery and Data Mining, U. Fayyad, et al., editors; AAAI Press, 1995.

Sara Reese Hedberg is a freelance writer who lives in Issaquah, Washington. She has written extensively about emerging computer technologies. She can be reached at editors@bix.com.

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A DATA MINER'S TOOLS

Intelligent agents, multidimensional analysis tools, and good old database queries all belong in the well-equipped data miner's toolbox

KAREN WATTERSON



Put down that pickax, Eugene. Mining the information nuggets from your data requires specialized tools. Some are brand new, and some are borrowed from other sources; some are as dumb as bricks, and some seem to have minds of their own.

Even if your job description doesn't say anything about data mining (DM)—yet—the fact is that most information workers spend much of each day performing DM. The right tools can give your data miners that extra edge. As Don Keough, former president of Coca-Cola, might add to any discussion of DM, “Who[ever] has information fastest and uses it wins.” So grab your helmet and check out what the well-equipped data miner is using.

Talk to My Agent

Remember Bill Gates's vision of “information at our fingertips”? Well, the truth is that most of us have information up to our eyeballs and probably receive more in a week than we could process in several lifetimes. One challenge of DM is to develop intelligent agents that can prioritize and/or filter the data bombarding us daily, including our overflowing E-mail. But DM is also about revealing new relationships and patterns and using software agents that will do the mining for us, often performing the screening and fetching functions of yesterday's secretaries and clerks.

The notion of harnessing computers to perform tedious chores is as old as science fiction. Have you ever tried to identify buying patterns of high-margin customers? Or look for patterns that may be indicators of fraud? Do you use an Internet clipping service to provide you with a personal news summary? Or alert you to wire-service announcements related to a key competitor? If the answer to any of these questions is yes, you're already dealing with the tasks of intelligent agents.

Several categories of intelligent agents

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STATE OF THE ART A Data Miner's Tools

are available. Some are launched manually to perform specific queries or to search for patterns in data. Others fire off automatically at predefined intervals, performing a task or monitoring a condition in the background and returning an alert as required. Most intelligent agents are simply short programs that say "if this happens, do that."

A handful of DM tools are sometimes lumped together under the rubric information discovery or knowledge discovery. They often have a resemblance—algorithmically speaking—to expert systems or AI. Most of these autonomous tools are low-touch but high-tech.

As Adam Szladow, president of Reduct Systems, a firm that markets rule-generating software, says, "One wants to get strong, repetitive patterns, patterns that occur with some frequency." One Reduct customer discovered rules for predicting business creditworthiness based on a database that had only a few hundred cases.

Mining for Dollars

For some people, intelligent agents are the sine qua non of DM. Barry Mason, who is a principal with IBM's Consulting

Intelligent Agents



Intelligent agents can sift bales of point-of-sales records, hypothesize connections, and report discoveries.

Group, defines DM as "discovery tools which take large amounts of detailed transaction-level data and apply mathematical techniques against it, 'finding' or discovering insights into consumer behavior."

For Mason, DM is the first step in a series of activities that can lead to new actionable business intelligence. IBM has proprietary, patent-pending techniques to analyze gigantic data sets for cross-marketing or affinity marketing and look for patterns. These patterns may be so nonobvious as to appear almost nonsensical, such as that people who have bought scuba gear are good candidates for taking Australian vacations.

Other products, such as the DataEngine from MIT GmbH, use fuzzy logic and neural-network algorithms to do DM that helps analyze and control real-time technical processes. DataEngine, a programmer's tool not intended for casual end users, includes a visualization component that can provide hints about process bottlenecks, for example.

Reduct's Data/Logic products also ferret out patterns, automatically generating rules that can be probed using varying degrees of boundary "roughness," a technique akin to fuzzy set analysis. Wall Street analyst Murray Riggiero Jr. used Data/Logic in conjunc-

tion with neural-network software to generate rules for his trading system.

IntelligenceWare's automatic information-discovery tool, IDIS, also looks for correlations. It forms, tests, and modifies its own hypotheses until classification rules or rules with intervals, or more inexact rules, emerge. IDIS has been used successfully in applications ranging from fraud detection to consumer loan analysis to optimizing production lines.

Most humans are better at detecting anomalies than inferring relationships from large data sets, and that's why information discovery can be so useful. Rather than relying on a human to come up with hypotheses that can be confirmed or rejected based on the evidence (i.e., data), good discovery tools will look at the data and essentially generate the hypotheses.

A Dimension of Mine

Do you use your spreadsheet's crosstab or pivoting features? Have you explored data using slice-and-dice techniques to examine it from different perspectives and in varying amounts of detail? If so, you've encountered another part of the DM toolbox: multidimensional analysis (MDA), or on-line analytical processing (OLAP), tools.

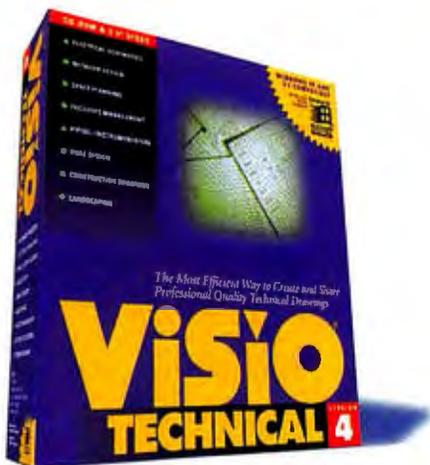
Bruce Love of the Gartner Group has described DM as "an intensive search for new information and new combinations pursuing defined paths of inquiry and allowing unexpected results to generate new lines of analysis and further exploration." Love is clearly thinking of iterative exploratory techniques of data surfing using MDA or OLAP tools. MDA represents data as *n*-dimensional matrices called hypercubes. OLAP and related hypercubes

Selecting Data-Mining Tools

Intelligent agents require some expertise to set up but need little direction. Some work directly on text. Best used for turning up unsuspected relationships. Don't turn these things loose on production systems, though.

Multidimensional-analysis (MDA) tools can have simple graphical interfaces for nonexpert use. Work on databases but really zip with multidimensional hypercubes of data (special setup). Best use: iterative, interactive, hands-on exploration of data.

Query-and-reporting tools require close direction to frame queries (many simplify the process with graphical interfaces). Require a database structure. Best use: asking specific questions to verify hypotheses. Legendary for their ability to bog down production systems.



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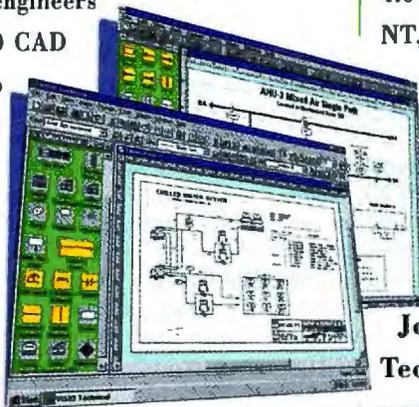
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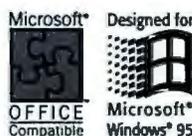
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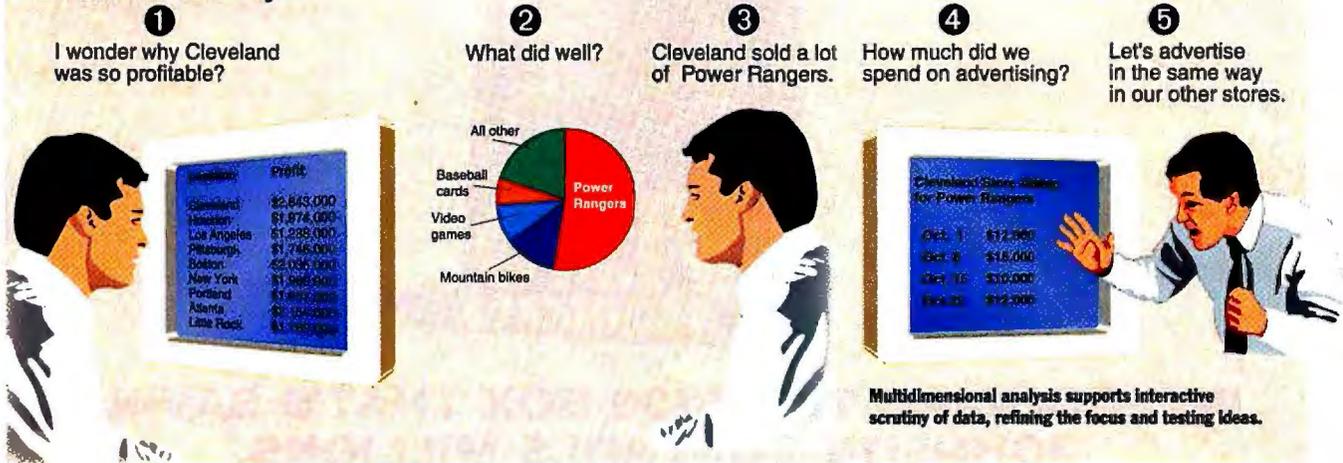


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Multidimensional Analysis



let users iteratively calculate metrics such as sales, revenue, market share, or inventory over a subset of available data, by exploring combinations of one or more dimensions of data.

The idea is to load a multidimensional server with data that is likely to be combined. Imagine all the possible ways of analyzing clothing sales: by brand name, size, color, location, advertising, and so on. If you fill a multidimensional hypercube with this data, viewing it from any 2-D perspective— n -dimensional hypercubes have $n*(n-1)$ sides, or views—will be easy and fast.

That's the appeal of products from vendors such as Arbor Software (Essbase), Comshare (Commander OLAP), Oracle/IRI Software (Express EIS), and Pilot Software (Lightship). Karl Stephan, a senior financial manager in Sears's planning analysis section, remembers when it took hours to assemble the data he needed into a spreadsheet. Using Essbase, it takes just seconds. Delta Airlines has used OLAP to gain insights into its frequent-flyer program. Using Planning Sciences' Gentium, it's consolidated data from a 100-GB Teradata database into six far more accessible multidimensional databases totaling a mere 6 GB.

OLAP servers are great for time-series analyses, recursive calculations (e.g., how to allocate overhead as a percent of revenue contribution by product line), and data with up to about 15 dimensions. Beyond that, most multidimensional servers fail under the sheer weight of their own indexes. Michael Saylor, president of OLAP vendor MicroStrategy, segments the DM market into three parts. He recommends spreadsheets and query tools for

slice-and-dice data mining on databases of up to about 1 GB, departmental OLAP servers for up to about 20 GB, and enterprise warehouses for anything above that.

George Zagelow, program manager for data-warehousing solutions at IBM, concurs that most businesses need more than a single DM tool. "Multidimensional databases, OLAP products, DM, and traditional decision-support tools all belong in your toolbox right alongside standard relational databases."

For example, rather than use an OLAP or hypercube tool, you're better off creating a warehouse using a relational database if you have lots of data or are facing complex loading and consolidation from multiple data sources. Why? Because there's a mature utility market to support those activities. However, don't expect mining operations that represent joins across many multirow tables to be fast. That's where OLAP servers shine, providing blindingly fast results to queries along predefined dimensions.

Hypercubes vs. Killer Queries

Let's say you decide to mine your existing database to find the customers most likely to respond to a mail-order promotion. You might try using a query-and-reporting tool such as Information Builders' Focus Reporter or Software AG's Esperant to construct the SQL query, "How many credit-card customers who made purchases of over \$100 on sporting goods in August have at least \$200 of available credit?" If the number is too big, you might refine it: "Narrow it down to customers under 40 who live within 30 miles of a store in a coastal state."

Although you can construct queries such

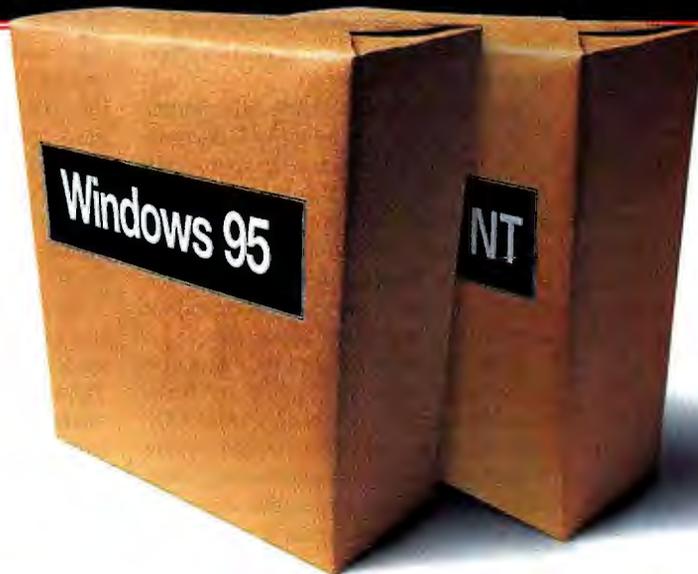
as these using query-and-reporting tools that work with relational databases, such unfettered querying can bring a production system to its knees. That's why DM operations are usually made against data that's been warehoused, either in a traditional relational database or consolidated into a multidimensional hypercube.

Although the relational/OLAP wars may continue for another year, chances are we'll see some convergence. Already, relational warehouses and virtual OLAP servers based on the relational model are adding support for star schemata. The idea is to mimic multidimensionality by creating special tables that contain roll-up data. For example, you might have a central fact table with sales data, surrounded by star tables with location, time, and product data. An innovation from Cross/Z International uses fractals to store warehouse data. The idea behind Fractal Database Mining System is to provide OLAP-style responses for huge data warehouses.

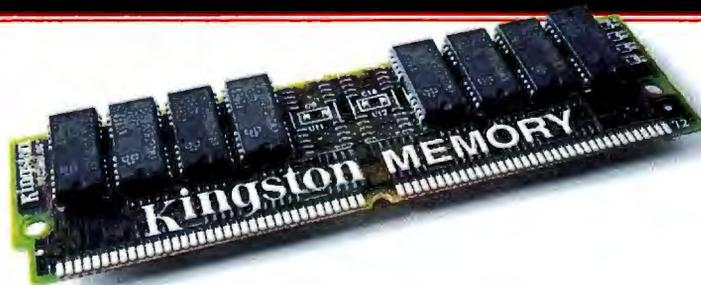
Because adding intelligent-agent capability to software isn't that complicated, most of today's OLAP products and query-and-reporting tools (e.g., Brio Technology's BrioQuery, Comshare's Commander OLAP with Detect and Alert, Information Advantage's NewsLine 3.0, and Trinzic's Forest & Trees) have this sort of intelligent agent built in. Comshare's Detect and Alert "robots" monitor news feeds or even Lotus Notes databases for keywords and stock quotes from Dow Jones News/Retrieval for predefined values.

With Forest & Trees, an administrator sets up alarms for trigger values. Many warehouse and middleware products (e.g., Trinzic's InfoPump) include intelligent agents that schedule data transfer from

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production systems to decision-support databases.

Mining with Query Tools

If you don't have an OLAP server or an enterprise data warehouse, don't despair. Lots of mining can be done from the desktop using client/server generation query-and-reporting tools. With many products available (e.g., Business Objects, Powersoft's InfoMaker, and Crystal Service's Crystal Reports), it's hard to differentiate among them. They range from traditional spreadsheets to products from vendors such as IQ Software and Cognos that provide strong support for MIS oversight.

Most of these tools come with graphing components. Some even support a degree of multidimensionality, such as pivoting, intelligent drilling, crosstab reporting, and time-series analysis. A few are beginning to offer easy-to-use intelligent-

agent support (versus alerts that can be established programmatically). If you need to select a new query-and-reporting tool and need to support a mixed environment of PCs and Macs, be sure to make that a feature on your checklist.

You should think of query-and-reporting tools as generic mining tools. They generally support direct access to source data and may offer cross-database joins, but their unbridled use can wreak havoc with production systems. And, given the challenges of performing joins across systems, it may be hard for end users to know if the answer they're getting is accurate.

Query tools can be used for interactive exploration, especially against relational data. Most query tools construct SQL queries for the data miner and can be slow if the source data is scattered among many tables—especially large ones, on multiple databases, that are poorly indexed.

Tooling Up

DM is such a hot concept that it's showing up in nonspecialized tools. For example, high-end financial and statistical analysis, decision-support, and EIS vendors are adding DM capability (or, at least, labeling) to their products. Also, enterprise database vendors such as IBM and Hewlett-Packard are creating data-warehouse suites (IBM's Visual Warehouse) or virtual-warehouse frameworks (HP's Open Warehouse) that include—you guessed it—DM tools.

Converging from the desktop are spreadsheets and query-and-reporting tools associated with client/server applications. These tend to be high-touch tools, although many let users set up hands-off intelligent-agent alerts.

IntelligenceWare's Kamran Parsaye views DM and decision support as a set of fairly distinct spaces, each with its own set of algorithms. This includes an aggregation space containing precomputed OLAP data (to answer such questions as "What is the trend in Joe's sales by product and by month compared with average sales figures?"), an influence or discovery space (where relationships are discovered and refined), and a related variation space (for questions such as "How have weekly changes in prices varied over the last year?").

Because information-discovery tools have only recently gained widespread attention as DM tools, they still tend to be rather technical and best suited for analysts with strong mathematical backgrounds. Look for explosive growth in this area of DM tools as better user interfaces make them easier for end users to harness. As for intelligent agents, especially agents as Internet gofers and E-mail filters, within a year, you'll wonder how you ever lived without them.

The popularity of DM shows that businesses are looking for new ways to let end users find the data they need to make decisions, serve customers, and gain a competitive advantage. If your workers aren't asking for better mining tools, you'd better ask why. ■

Karen Watterson is an independent San Diego-based writer and consultant specializing in client/server issues. She is the editor of two newsletters and the author of Visual Basic Database Programming and Client/Server Technology for Managers (both from Addison-Wesley). You can reach her at 1119390@mcimail.com.

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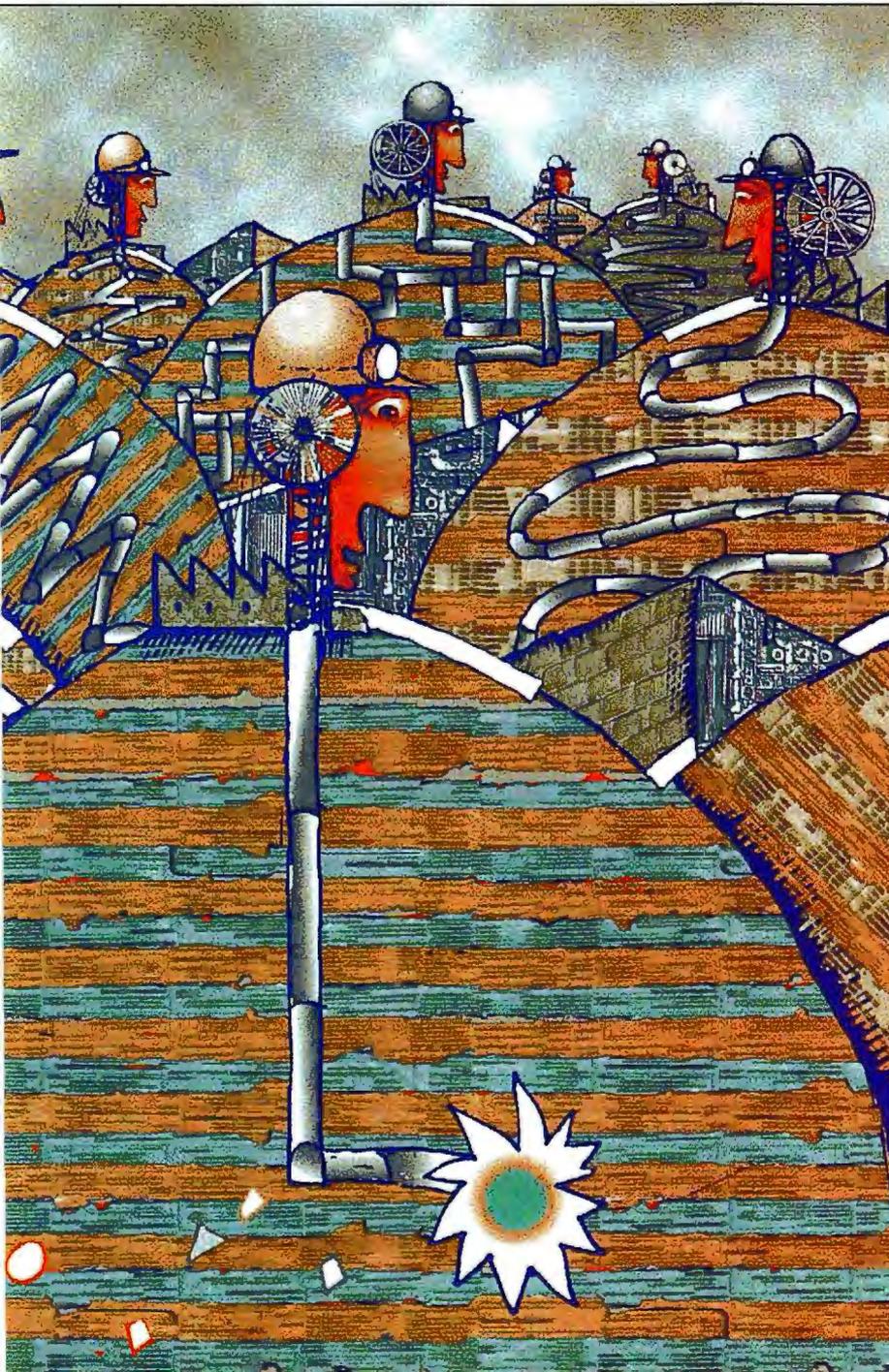
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DATA-MINING DYNAMITE

Blasting loose those buried nuggets of information requires clean data, warehousing strategies, powerful parallel processors, and heaps of hard disk space

CHERYL D. KRIVDA



Nothing loosens up that pesky nugget like a well-placed stick of dynamite. Similarly, there are ways in which you can significantly speed up and simplify your data-mining activities. Data-cleansing and data-fusion tools can transform bales of operational data into error-free, consistently formatted information. Data warehouses support storage and access on specialized servers. Parallel-processing techniques accelerate data mining's complex queries. And, when you have terabytes of data to stash, storage considerations are important, especially as the price of disk space plummets.

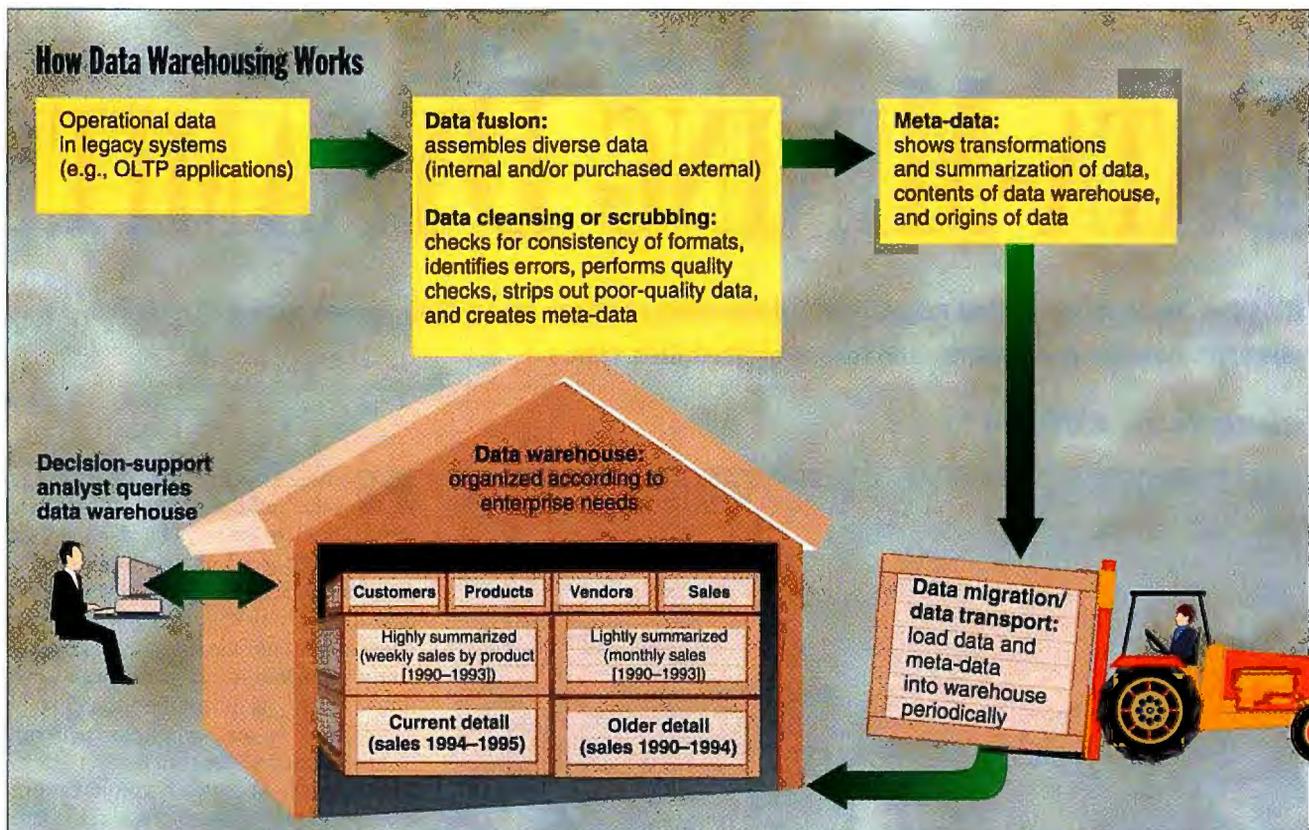
Why bother? Remember: The whole point of data mining is to reveal hidden information for prompt decision-making and action. And there's also the matter of the 1000 percent return on investment that some data-mining pioneers are enjoying.

Clean and Scrubbed

While preparing to initiate some data mining, one New York City merchant bank discovered that its databases contained up to 13 different representations of some customer's names, such as Andrew B. Jones/Mr. A. Jones. This is but one example of a common problem: Databases storing a company's lifeblood information about customers and transactions are commonly rife with errors, duplicate data (or worse), and information that would not necessarily be useful to data-mining applications. One bank has already saved \$170,000 per month that it had been spending on duplicate mailings by cleaning up its customer data and then housing it with associated account information, according to Peter Kastner, an analyst with the Aberdeen Group, a Boston-based market-research and computer-industry consulting firm.

For data-mining applications to produce valid results, data has to be cleaned of errors and "scrubbed" to create consistent formats (e.g., 1s and 0s become male and

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female). The process can be a slow one. Although reasonably priced tools are available to reformat data, cleanse it, and prepare it for eventual migration to a data warehouse (explained later), information-systems (IS) management must also dedicate time to the effort of determining which format to use and how data should be represented before warehousing it.

The payoffs can be dramatic. One telephone company was able to mine its cleaned and warehoused data to identify 10,000 supposedly "residential" customers who spent more than \$1000 per month on their phone bills. Investigating more closely, the telephone company discovered that these customers were really small businesses trying to avoid paying business rates for their service.

A Place for Everything

The mainframe: A nice place to visit, but you wouldn't want to mine there. For one thing, production mainframes often support day-to-day business activities (e.g., airline reservations) that you probably do not want to impede with your killer queries. In addition, you probably want a well-behaved data server that you can hang your mining clients from. Besides, the data structures on your mainframe probably aren't the best for the data-mining activities you want to perform.

Enter the *data warehouse*, a server-based replication of a mainframe's data. The server receives updated information from the mainframe periodically—monthly, weekly, or even daily, depending on needs. The database on the data-warehouse server then fields data-mining queries from the client machines independently of the mainframe.

A data warehouse provides an effective structure for data mining, explains Bill Inmon, cofounder of Prism Solutions (Sunnyvale, CA) and widely considered the originator of the data-warehousing concept. Without first warehousing its data, a company has lots of information that is not integrated and has little summary information or history. The effectiveness of mining such data, he says, is limited.

Think data warehousing sounds easy? In actuality, the difficulty of getting a data warehouse operational is one of the many reasons why sites building them typically engage outside expertise to facilitate the project. Although consultants with experience in designing and populating data warehouses are few and far between, and expensive when available, they are typically worth the investment, especially for high-profile projects.

Still, convinced that data cleansing and warehousing sound like jobs that their best

analyst will be able to handle, some companies elect to go it alone. "We see a lot of cheap science projects," says Chuck Bufum, general manager of the decision-support business unit for Tandem Computers (Cupertino, CA).

One Fortune 100 company IS manager waited three years for his staff to complete a high-profile data warehouse, relates Dr. Kamran Parsaye, CEO of Information Discovery (Hermosa Beach, CA). When poor warehouse design prevented the company from successfully populating the warehouse with clean data, the IS manager directed his staff to mine the production data and deep-six the warehouse plans. "It was success by declaration," Parsaye says.

1000 Percent Return on Investment

For all the warnings about the dangers involved in building a useful data warehouse, the possibilities for competitive advantage and other market gain seem equally endless for those who build one successfully. Some retail companies have achieved a payoff of 10 to 70 times their initial investment of \$350,000 to \$750,000, notes David Gardie, manager of commercial markets for IBM's RS/6000 Division (Somers, NY). At the high-priced end of the hardware spectrum, one customer who invested \$20 million in a complete system achieved a

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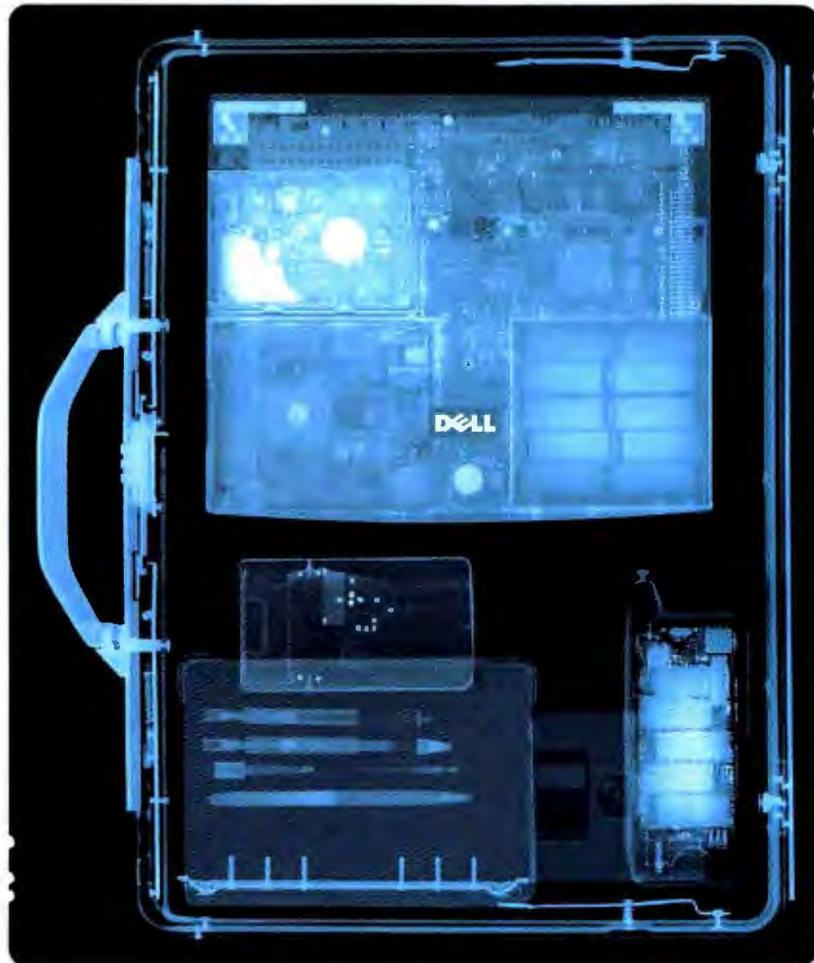
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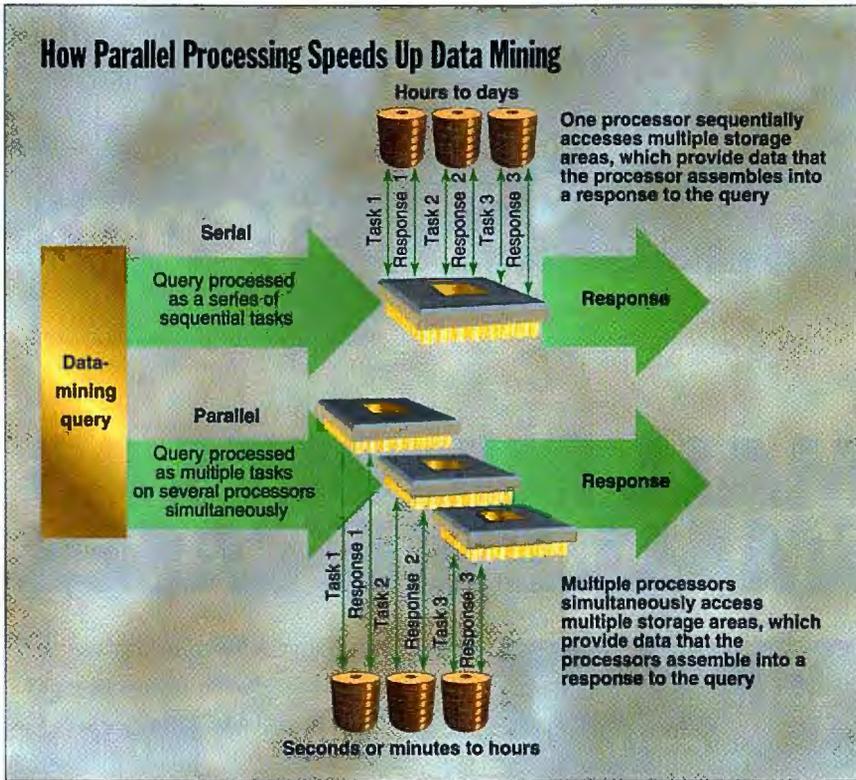


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How Parallel Processing Speeds Up Data Mining



payoff in just four months.

Kastner is not at all surprised by these phenomenal ROI figures. "The first thing you do is skim the cream off the top," he says. "And in this market, there's lots of cream."

The propensity to mine additional profits or a competitive advantage from well-designed warehouses has some advocates talking about the so-called One-Query Theory. Buffum states that "there exists in every shop one query that—if you figure out what it is and implement the knowledge derived from it—will pay for the entire data-warehousing and data-mining system."

Warehouse Sandwich

Parsaye is well known in the data-warehousing field for what's known as his Sandwich Paradigm, a philosophy for building data warehouses that encourages acceptance of the probability that the first iteration of a data-warehousing effort will probably require substantial revision.

Instead of recommending that users buy



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hardware and software, build a data warehouse, and then load their data, the Sandwich Paradigm advises that they pre-mine the data to determine what formats and data are needed to support a data-mining application, build a prototype mini-data warehouse (the "meat" of the sandwich) with most of the features anticipated in the final product, revise the strategies as necessary, and finally build a full warehouse. In this way, problems with poor-quality data or ineffective designs can be rectified before thousands or even millions of dollars are wasted. Often users realize that their data structures are ill-designed, or they gain so much experience with the prototype that they realize that a second chance at building the system could add value that would justify the expense.

To support newly cleansed data, experts advocate maintaining a collection of information about the transformation process. This *meta-data* describes the contents of the data warehouse; where the warehoused data originated; and the trans-

lations, aggregations, table lookups, and other transformations that occurred in the warehousing process. For many data-warehousing users, this information becomes critical after the migration is completed, when more detail is needed about a particular group of data or when errors in the warehoused data become evident.

Specific information about successful data-warehousing efforts is sparse, partly because such an effort is complex and extensive, and partly because the companies that succeed are loath to divulge what they perceive as a competitive advantage. It is known, however, that successful data warehouses are usually only half as large as is necessary to support the number of users and applications that quickly become "critical."

When a data warehouse succeeds, more users than initially planned want to employ data mining to their advantage. Data-warehousing and data-mining applications are usually installed with a specific motive in mind, such as fraud detection or profit generation, says Kastner.

But once a data warehouse is installed, the number of users almost always increases with the success of the system. For instance, one department-store chain based in the U.K. implemented a data-mining system to better understand customer-buying trends. Within six months, one of the biggest users of the system was the chain's accounting department, which began tracking profit and loss leaders. Analysts discovered that the shoplifting of batteries, film, and midpriced pens cost the chain \$60,000 a month. These products were moved to a more secure store location, saving the chain over \$700,000 annually.

One offshoot of the fast-growing data-warehousing and data-mining market is that tool and database vendors are announcing partnerships in record numbers. But "they're not worth the paper they're printed on," warns Kevin Strange, research director for industry analyst the Gartner Group (Stamford, CT). With rare exceptions—such as Platinum Technology (which is creating synergies by acquiring companies such as Trinzie) and Software



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DATA-WAREHOUSE CONSTRUCTION TIPS

- ↑ **Accept that your first try will require revision.**
- ↑ **Examine your data: What formats and specific data are needed to support your application?**
- ↑ **Bite the bullet and clean up your data before using it in the warehouse.**
- ↑ **Build a prototype mini-data warehouse as a learning experience and then revise strategies as necessary.**
- ↑ **Plan on more users' taking advantage of a successful data warehouse than you initially expected.**
- ↑ **Keep storage options in mind: Your data is only going to grow.**

AG (which is creating an initiative among several vendors)—industry partnerships in this market do not benefit customers. But the good news here for buyers is that the efforts made by Software AG and Platinum will force other vendors to create alliances, Strange says, probably by the end of the year.

Parallel Power

Parallel processing speeds up the work of decision-support systems such as data mining by dividing a complex query into multiple parts and assigning each part to

a separate processor. The processors work concurrently, unlike serial processors, which address one process after another.

While data mining is unquestionably being driven by the affordability of highly powerful parallel-processing computers, interest in data mining is also driving parallel sales; it's a synergistic effect. Once the province of the scientific community and its deep-pocketed sponsors, parallel-processing machines have dropped in price by 30 percent to 40 percent annually for the past several years, bringing them into the realm of the affordable.

Parallel-processing systems are available in two distinct flavors: symmetric multiprocessing (SMP) and massively parallel processing (MPP). SMP systems share a common memory among clusters of machines. MPP systems are often called "shared nothing" or distributed-memory systems, because each processor has its own memory.

SMP systems are typically used for smaller data warehouses holding 100 GB of data or less, while MPP machines are necessary once a data warehouse hits 500 GB. The gray area in between is something of a battleground among vendors, who argue points of scalability, cost, and performance.

Clustered SMP systems are well suited to applications with *lumpy data*, which is heavily used for data-mining queries. Because the processors are clustered and memory is shared, no one processor is exclusively assigned to access the key data, thus preventing bottlenecks. In contrast, MPP vendors suggest that sites planning for many users or heavy data volumes use

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MPP systems rather than clustering multiple SMP systems.

Sales of SMP-based systems are projected to be larger than those of MPP systems for the foreseeable future, predominantly because of their lower cost and better scalability, explains Howard Richmond, a vice president of the Gartner Group. Yet the MPP market is also experiencing significant growth, he adds.

Storage: Not the Final Frontier

The last enabling data-mining technology is storage. Once a no-brainer, data storage is now so important that some sites actually keep their storage devices and data under the protection of armed guards.

With data warehouses storing gigabytes and terabytes of data, and projections calling for warehouses holding hundreds of terabytes within five years, affordable storage technology is key to serious data mining. Disk-storage prices, which had been falling an average of 30 percent to 40 percent annually, are falling even faster so far this year, and storage vendors are run-

ning hard to stay even.

Like processing, storage technologies such as RAID (an acronym for redundant arrays of independent disks) are becoming increasingly parallel. The concern of many industry watchers is the lack of a faster technology for reading data off a storage disk. There are no new storage technologies on the horizon as yet, which could make storage a bottleneck for data-mining applications as queries become more complex, storage volumes increase, and parallel machines get faster.

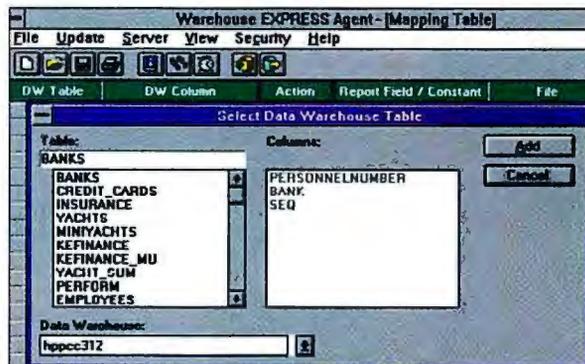
Pot of Gold

Every business will have a data warehouse in 10 years, predicts Kastner, whether it's the company's custom warehouse or one that's available through wideband networks connected to desktop systems. The benefits of knowing one's business and customers will become so critical that the technology will

be positively pervasive, he adds.

Previously unrelated technologies are coming together to support data mining. That can only make data mining easier. ■

Cheryl D. Krivda is a technical journalist based in Perkasie, Pennsylvania, specializing in information-technology topics. She can be contacted on the Internet at 5309513@mcimail.com or on BIX c/o "editors."



Software AG's SourcePoint Administrator lets a user select a table from the warehouse and map columns to fields from the extract process.

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BOMB's AWAY

Smuggled onto your PC, in the guise of a multimedia viewer, your World Wide Web browser is actually an all-purpose client that runs applications on a vast global network. Likewise, your Web server, justified to your company's controller as a marketing tool, can act as an applications server that connects you to customers, suppliers, and business partners.

One of the most popular uses of this new client/server model is the on-line survey. If you read *BYTE* in the 1970s and/or 1980s, you may recall *BYTE*'s Ongoing Monitor Box, more commonly known as the BOMB. It was a page that reported how readers ranked the previous month's articles, together with a postcard that solicited feedback on the current issue.

The BOMB fizzled years ago, and we've missed it. The advent of the *BYTE* Web site set the stage for a 1990s remake. To try it, surf on into <http://www.byte.com> and go to any article in our archive. Along with the standard links across the top of each page, you'll find one labeled "Comment." Click on it to invoke a Hypertext Markup Language (HTML) form with multiple-choice questions and space for comments.

Our archive isn't just an electronic publication now; it's also an application. What follows is a look at how we put it together and how you can build one like it.

Step 1: Make the Form Context-Sensitive

The first task was to make the Web BOMB context-sensitive. If you're reading a story on-line and decide to comment on it, the form that pops up when you click on the Comment button will display a title such as "February 1995 / News & Views / Optical Drives." These same three items—the story's issue, section, and title—will also appear in the database record that's created when you submit the form.

Since the archive has 1500 documents, must there also be 1500 forms? Actually, there are none. As is common practice, the Web BOMB relies on a Perl script to print the forms on demand. What activates that Perl script? The Comment link on each of the 1500 pages. So, while I didn't have to write 1500 forms, I did need to write 1500 links that look like this:

```
<a href=/cgi-bin/perl.exe?\  
cmt1.pl+9502+News_&_Views+\  
Optical_Drives>Comment</a>
```

This code says: "When the Comment link is clicked on, launch the Perl interpreter, feed it the HTML-form-writing Perl script `cmt1.pl`, and in turn feed `cmt1.pl` three arguments—the issue, section, and title of the current article."

These links are far more concise than the forms that `cmt1.pl` generates, but it still wouldn't have been practical to write 1500 of them by hand. But then, I don't write any of the archive's HTML source by hand. An Epsilon Extension Language (EEL) program (see part A of the

figure "Anatomy of the Web BOMB" on page 106) does that for me, and one additional `printf` statement was all it took to put a context-sensitive comment link on every page in the archive. Part B of the figure shows the EEL program's output—the HTML source for a page. Part C illustrates how a browser renders that HTML source.

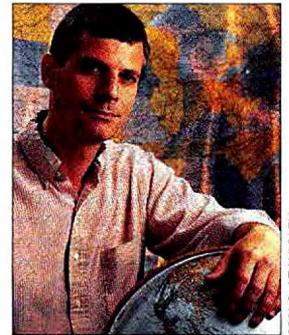
Step 2: Print the Form

When you click on the Comment button, the Web server invokes `cmt1.pl` and relays its output—an HTML form—back to your browser. The `cmt1.pl` script begins as shown in part D of the figure. The first line prints the standard Common Gateway Interface (CGI) header. The second line saves the uniform resource locator (URL) of the article that prompted the comment, so the form-processing script (`cmt2.pl`) can offer the user a link back to the article.

`HTTP_REFERER` is the charmingly misspelled CGI environment variable that contains the URL of the referring document—in this case, the article on which the Comment link appears. Note how the name `HTTP_REFERER` keys into the associative array (i.e., the list of name-value pairs) that Perl uses to represent environment variables. Each of the next three lines takes an argument from the Perl command line, saves it in a variable, and turns underscores (which are inserted at the EEL stage to make multiword arguments behave atomically) back into spaces.

The `cmt1.pl` script then prints the HTML document that your browser renders as the Comment form. It incorporates the issue, section, and title variables into the document's header. Then it begins writing the form as the body of the document. The opening phrase of the HTML form element says: "On completion of this form, launch the Perl interpreter, feed it the form-processing script `cmt2.pl`, and in turn feed `cmt2.pl` four arguments. Transmit the data collected on the form to `cmt2.pl` by way of a file (`method=post`) rather than on the command line (`method=get`)."

The rest of `cmt1.pl` completes the form. HTML can describe interactive GUI controls, such as check boxes, radio buttons, drop-down listboxes, and single- or multiple-line text boxes. The Web BOMB just uses a series of check boxes for the multiple-choice questions, and a multiline text box for the free comments. The figure shows some of the HTML source that creates the multi-



AL KARVEY © 1995

**Here's how
BYTE remade
a postcard-
based reader
survey into
a Common
Gateway
Interface-
based Web
application**

ANATOMY OF THE WEB BOMB

Common Gateway Interface (CGI) programming involves peculiar flows of control and data. Follow the solid black arrows to trace the

flow of control from programs to documents to programs to documents as the Web BOMB works. Follow the red, numbered circles to trace

the flow of the three items of data—the article's issue (1), section (2), and title (3)—that make the Web BOMB context-sensitive.

Don't even think about publishing a large collection of documents on the Web unless you can automatically generate those documents.

I recently used Perl for this job, but Epsilon's EEL seems even better. I like how EEL supports both declarative and navigational text processing. You can do the same kinds of global regular-expression searching and replacing that Perl can do. But you can also programmatically wield all the navigational and interactive powers of a text editor: searching forward and backward, inserting text, and jumping to locations.

HTML, like PostScript, is a language that should mostly be written by programs rather than by humans. Unlike PostScript, though, HTML is easy to write. That makes Web development very convenient.

When you want to use a program-generated form like this one, first write it out by hand and test it in your browser. When it works the way you want, you've got a specification for the document that your program must write.

You launch a CGI program by clicking on a link. Here the link is textual—in the *Comment*. To create this kind of link, you write HTML source like this:

```
<a href="/cgi-bin/perl.exe?cmt2.pl+arg1+arg2">Comment</a>
```

Alternatively, you can make the link graphical. To do that, you write HTML source like this:

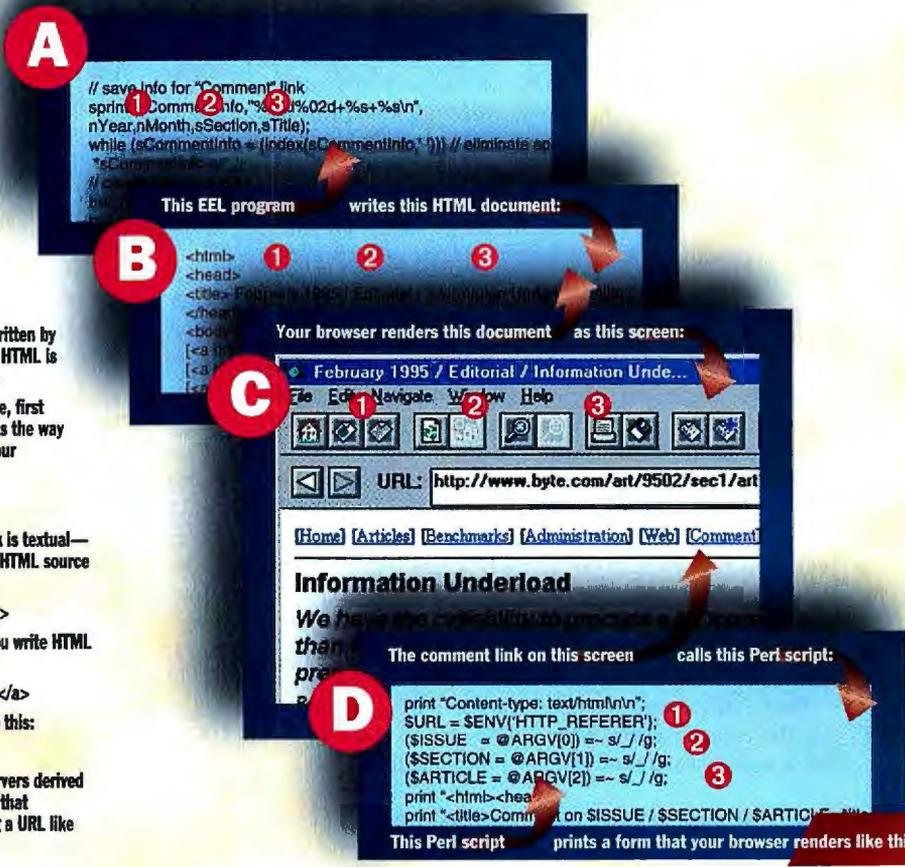
```
<a href="/cgi-bin/perl.exe?cmt2.pl+arg"></a>
```

Note: With most Web servers, the CGI link actually looks like this:

```
<a href="/cgi-bin/cmt2.pl?arg">
```

Invocation of the Perl interpreter is implicit. However, NT servers derived from EMWAC's code require explicit invocation of Perl. Isn't that dangerous, I wondered? What's to keep a user from entering a URL like http://www.byte.com/cgi-bin/perl.exe?e+unlink+*

using Perl's "enter a line of script on the command line" feature to trash a bunch of files—or worse? Process Software agreed this is a problem, and it will have a fix in Purveyor 1.1.



Web servers communicate a number of environment variables to back-end CGI programs. Here, Perl gets the referring article's URL from the `HTTP_REFERER` variable. It will be a string like this:

```
http://www.byte.com/art/9502/sec1/art1.htm
```

Separately, Perl saves the issue, section, and title information passed to it on the command line.

ple-choice questions (part D) and the resulting form as displayed in a browser (part E). The `cmt1.pl` script ends this way:

```
print "<input type=submit value=
    Send><input type=Reset>
    </form></body></html>";
```

The input tags specify two buttons. The first submits the form to `cmt2.pl` for processing, and the second resets the form. The final three tags close the form element, the document's body, and the document.

Step 3: Process the Form

When you fill out the form and click on the Send button, the Web server launches the back-end CGI program named in the form's `action=` statement: `cmt2.pl`. Its first two lines (see part F of the figure) say: "Include CGI support routines; call

one of them, `ReadParse`, to locate the file in which the server placed the completed form's data; and transfer the name-value pairs stored there into a Perl associative array called "input." Using the names of form variables as keys into the array, `cmt2.pl` then takes the values of the form variables and puts them into Perl variables, as shown in part F of the figure.

With the form data in hand, `cmt2.pl` can now rule on whether to accept the form. The Web BOMB presents a form in three parts—questions about the article, questions about the reader, and free comments—but requires only that you complete the first section. If you don't, at least one of that section's form variables will be null. The `cmt2.pl` script notifies you if that's the case.

How? A conventional GUI program pops up a dialog box, but CGI programs

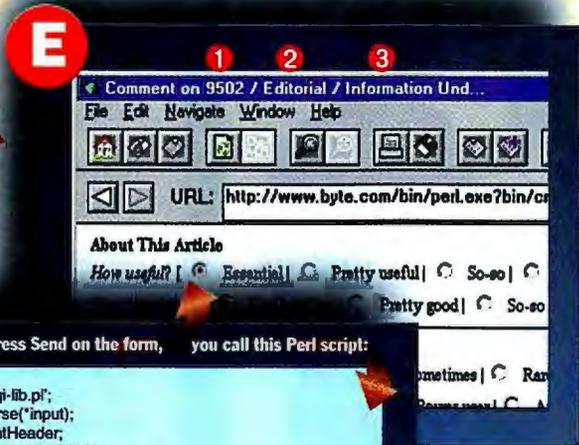
BOOKNOTE



Build a Web Site, \$34.95
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A fat cookbook full of useful recipes. Shows how to acquire and set up the CERN (the European Laboratory for Particle Physics) and National Center for Supercomputing Applications (NCSA) Web servers. Discusses HTML 2.0 and 3.0, teaches basic CGI programming, and offers an advanced tutorial on rolling your own Web clients and servers.

can communicate with users only by way of HTML, so `cmt2.pl` must format its "need more info" message as an HTML



Widgets that the HTML forms language supports include radio buttons, check boxes, single-line text boxes, multiline text boxes, drop-down listboxes, and command buttons. Of these, the Web BOMB uses only three: radio buttons for the multiple-choice questions, a multiline text box (not visible here) for the free comments, and command buttons (not visible here) to send or reset the form.

Be sure, as always, to check the look of your form in a variety of browsers. This layout, with vertical bars separating the choices, looks fine in Netscape, but not so hot in Mosaic.

I found the NT version of Perl 4 that I'm using here on Process Software's ftp site, ftp.process.com. The CGI library, cgi-lib.pl, is there, too.

Intergraph originally ported Perl to NT, so you can also find NT Perl stuff at ftp.intergraph.com.

F

```
require 'cgi-lib.pl';
&ReadParse("input");
print &PrintHeader;
print "<html><head>\n";
print "<title> Your Comments </title></head><body>\n";
$URL = @ARGV[0];
$ISSUE = @ARGV[1];
$SECTION = @ARGV[2];
$title = @ARGV[3];
$USEFUL = $input["useful"];
$INTERESTING = $input["interesting"];

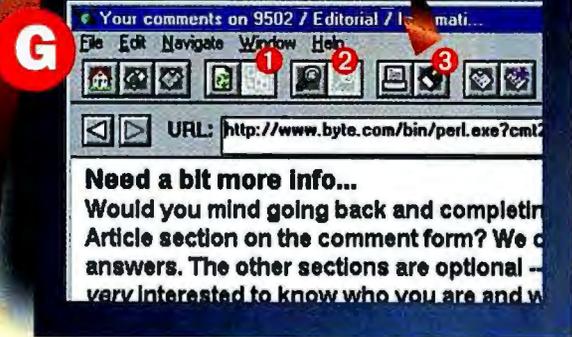
```

This Perl script either rejects the form or accepts the form.

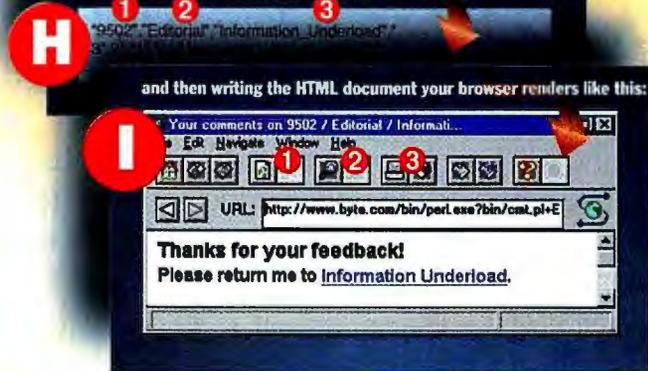
I could have fed the results into a live database back end, but that wouldn't have been as easy as modular, or as portable.

The solution creates a file for each comment record. Off-line, I can scoop up the comments, turn them into a database import file, and run SQL queries on them.

It rejects the form by writing the HTML document your browser renders like this:



It accepts the form by logging this record to this file:



and then writing the HTML document your browser renders like this:

In the Web/CGI environment, it's easy to return the user to a form that hasn't been completely or correctly filled in. Just tell the user to go back—something all browsers can do. No programming required here!

Here's where the original article's URL, obtained from the HTTP_REFERER variable, finally gets put to use. Clicking on it returns the user directly to the original article.

TOOLWATCH

Submit It

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plete the form to cmt2.pl's satisfaction, it logs the data (part H) and returns a "thanks for your input" document (part I).

From there, you could unwind the document stack using the "go back" function, but it's more convenient to jump straight to the article that prompted the comment, so cmt2.pl supplies a link to it. This is where the article's URL, which cmt1.pl got from the HTTP_REFERER environment variable and passed to cmt2.pl, finally comes into play.

Step 4: Log the Data

When I first envisioned the Web BOMB, I thought it should pump the survey results into a relational database. This client/server scenario, in which clients connect through HTML forms to relational servers, represents the most compelling (and, to vendors of SQL front-end toolkits, the

most frightening) aspect of Web/CGI technology. Since a survey isn't a transactional application, though, implementing the Web BOMB this way seemed like overkill. Users would pay an unnecessary performance penalty, and I'd end up with an application that was more complex and less portable than it had to be.

Instead I opted for a simpler, more modular solution. Rather than inserting a record into a database, cmt2.pl logs data by writing a line of text to a file, as shown in part H of the figure. As my Perl mentor Ben Smith likes to say, "If every record is a file, record locking isn't a problem."

How do you analyze the data? That's easy. Combining all the comment files yields a comma-delimited ASCII import file that FoxPro, dBase, or almost any other database program can read. Then you can answer questions such as "How did

document that it relays back to you by way of the server.

How does the Web BOMB redisplay the form so you can complete the required fields? That's easy. The "need more info" document (part G of the figure) tells you to use your browser's "go back" function, which reloads the form. When you com-



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THE BYTE NETWORK PROJECT

the interest in reviews vary by month?" or "What were the top 10 articles?" with straightforward SQL queries.

Next-Generation Client/Server?

Like the thousands of CGI programs on the Internet, the Web BOMB exhibits four desirable properties: *client-server*, because your browser interacts with our server; *cross-platform*, in that Windows, OS/2, Mac, and Unix clients can connect to any of these flavors of servers; *WAN*, since clients connect to servers over the Internet; and *rapid application development (RAD)*, because it's a snap to build.

Web technology isn't just a way to publish electronic documents. It's also a way to build networked applications that work within and across corporate boundaries. But it isn't yet a client/server developer's dream. I realized this when, in parallel with the Perl version of the Web BOMB, I prototyped a Visual Basic version using the nifty Windows CGI that's unique to O'Reilly and Associates' WebSite.

In principle, this sounds great: VB, the preeminent RAD tool, has to be the ultimate enabler for Web development, right? Well, maybe not. It's true, as O'Reilly's documentation says, that VB's a great way to get at data that's available through Windows APIs, such as OLE and Open Database Connectivity (ODBC).

But that's not necessarily a VB exclusive. A Win32 version of Perl, for example, could also wield these strategic APIs. On a level playing field, I'll choose Perl: For the text-processing chores typical of CGI applications, Perl's far more capable than VB.

What makes VB great are its plug-in user-interface (UI) components, such as the data-bound controls that have revolutionized client/server database development. However, Web-aware VB custom controls (VBXes) and OLE custom controls (OCXes) don't exist yet, and even if they did, today's browsers couldn't host them.

Browsers and components will evolve in this direction. Meanwhile, Sun Microsystems' Java/Hot Java technology has the potential to trigger a revolution like the one that VB touched off. Java's a language that describes Web applets; Hot Java's a browser that has the ability to download and run them. One way or another, strategic networked applications will increasingly run on the Web. ■

Jon Udell (judell@bix.com) is BYTE's executive editor for new media.

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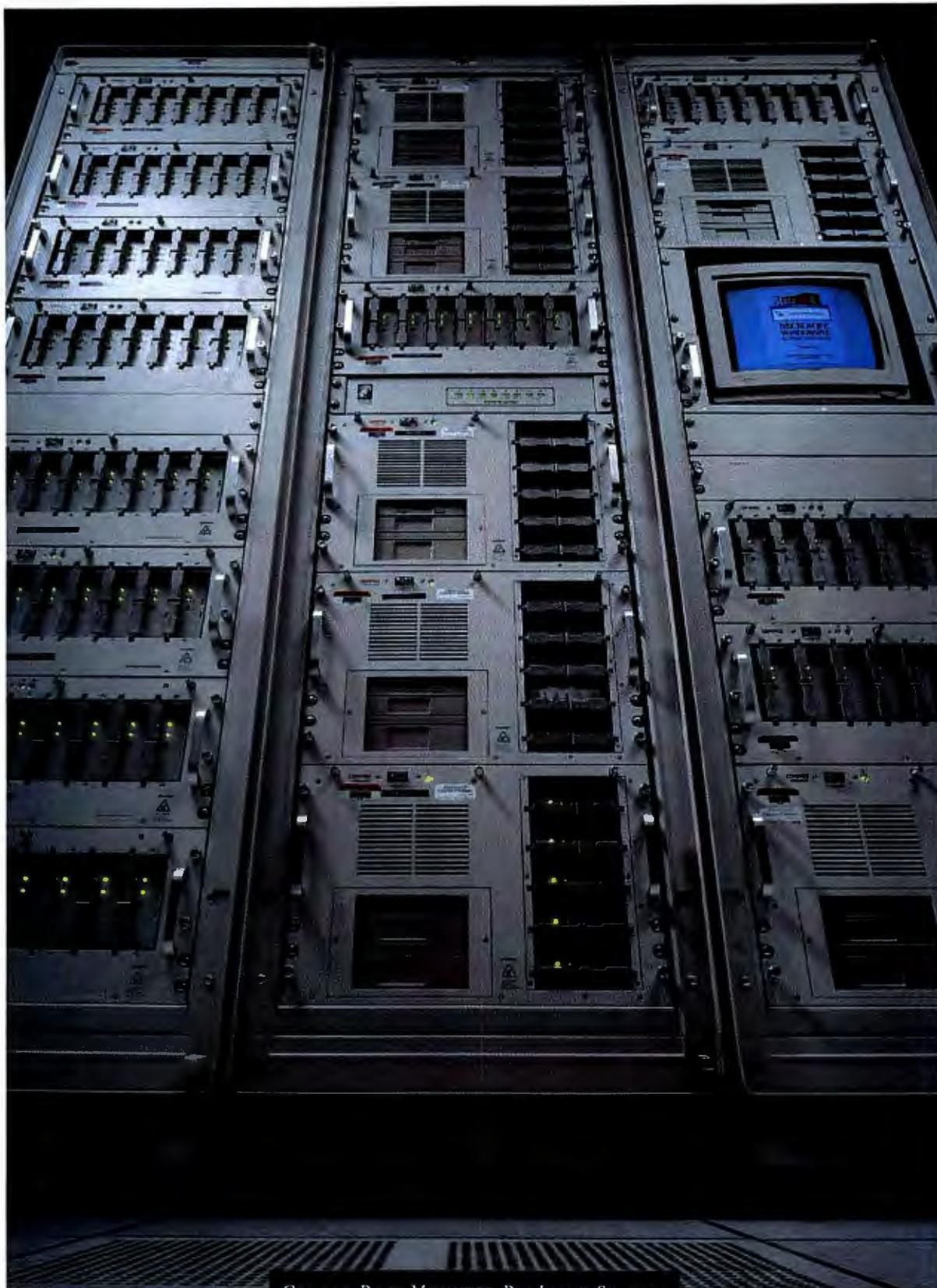


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Windows 95: The Numbers

The new Windows architecture delivers enhanced performance, but as **BYTE** testing reveals, there are strings attached

STANFORD DIEHL

The wait is not yet over for Windows 95. Yes, it has finally shipped, but we still don't have applications that take full advantage of its 32-bit, multithreaded architecture. In extensive testing of the shipping Windows 95 code, we came to a few solid conclusions:

- You won't see a dramatic performance improvement when running your existing 16-bit applications under Windows 95.
- Those 32-bit applications that are not fully optimized for Windows 95 will realize only marginal performance enhancements under the new platform.
- Applications that load large files (e.g., multimedia, imaging, and databases) take full advantage of 32-bit data paths and display the greatest performance gains.
- The Windows 95 environment multitasks applications much more smoothly and with greater stability than Windows for Workgroups 3.11 (WfWG) does.
- Windows 95 requires more memory than previous versions of Windows to run optimally, but for most office applications, the performance gains level off at 16 MB.

The graph of indexed performance (right) charts the big picture. Office applications (i.e., Word and Excel) display no speed enhancement on the new platform, even when tested with the shipping 32-bit

applications. The speed improvements stand out on the tests that take advantage of 32-bit data paths.

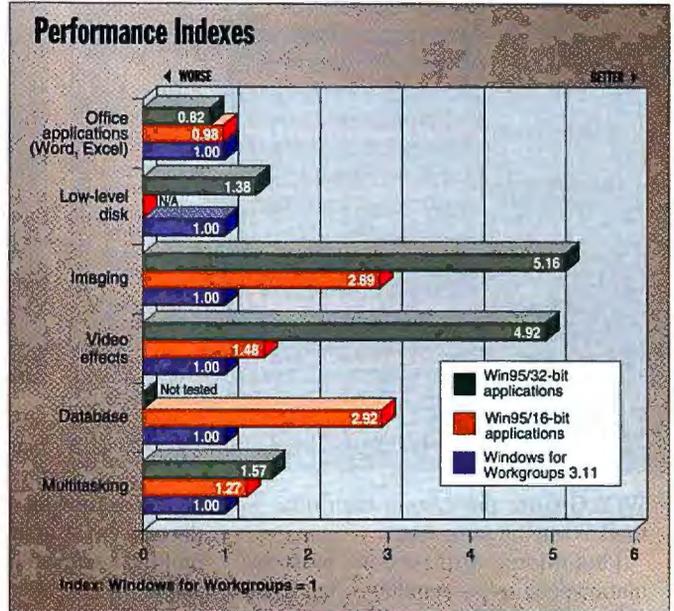
Required RAM

Don't even try to deploy Windows 95 on systems that pack less than 8 MB of RAM. And if you can afford the upgrade to 16 MB, you will appreciate the improved performance.

Of course, if your applications require a large memory footprint, then 16 MB of RAM may not hack it; but for most office applications, 16 MB is sufficient. Upgrading beyond that level won't buy you much additional speed. For testing memory configurations, NSTL used a Digital Equipment Celebris SL 590 (a 90-MHz Pentium); all other tests in this report were run at BYTE on a Gateway 2000 486DX2/66 with 16 MB of RAM.

32 Bits Is Not Enough

The performance of 32-bit Office 95 applications is disappointing, but this is not the best indicator of overall Windows 95 performance enhancements. Once Microsoft turns its attention to 32-bit optimization for its suite, the performance numbers should improve. "Microsoft has optimized the Office applications like crazy for the 16-bit architecture of Windows 3.1," Andrew Hudson points out. He is president of North Coast Software, an imaging company that develops extensively for Windows 3.1, Windows 95, and multiple NT platforms, including Power-

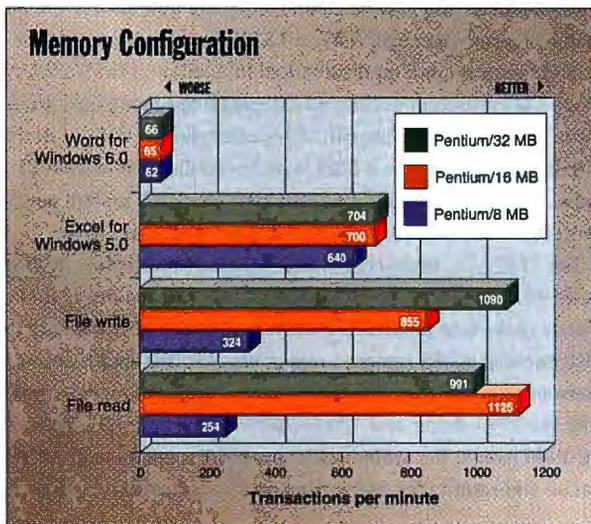


PC. "They just haven't had the time to do the same optimizations for Windows 95," he adds.

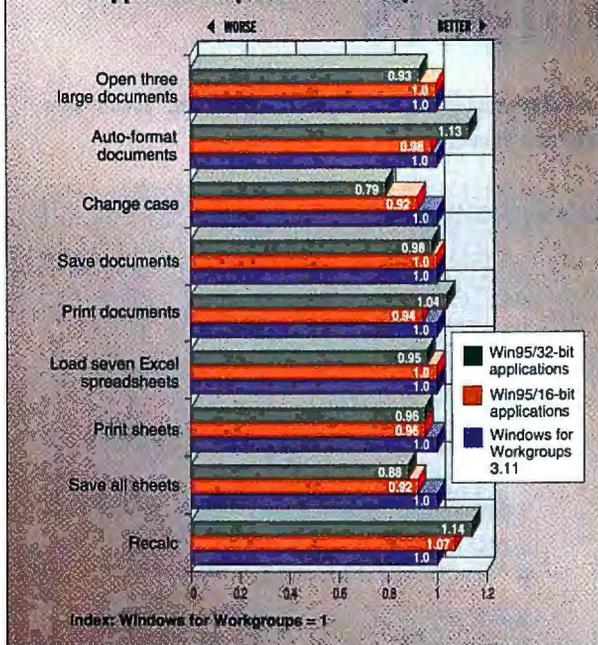
Even with the current Office 95 release, you should notice snappier operation because of improved multitasking and features such as on-the-fly spell-checking and threaded print services. In future Office releases, Microsoft plans to move additional processes into independent threads. These enhancements, along with aggressive optimization, are the kinds of improvements that applications vendors will have to make to boost performance. The OS alone won't do the trick.

Imaging and Multimedia

The most striking performance gains of Windows 95 came in our imaging and multimedia tests. Picture Publisher 6.0 not only supports 32-bit data paths but also spawns threads for each image loaded, letting you resume work more quickly. When we loaded five 24-bit images with Picture Publisher 6.0, the mouse was free after just 8 seconds, giving us control of the system to multitask. Under the same scenario using WfWG and Picture Publisher 5.0, we didn't get mouse control for over 2 minutes. In another show of stability, Windows 95, and multiple NT platforms, including Power-



Office Applications (Word and Excel)



WfWG froze the system each time we tried to run the same test.

PhotoMorph displayed the most dramatic speed improvements when it was upgraded to the Windows 95 version. The video-effects creation tool uses extensive 32-bit moves and floating-point calculations (an area Microsoft reportedly focused on in Windows 95 after the Pentium bug was revealed).

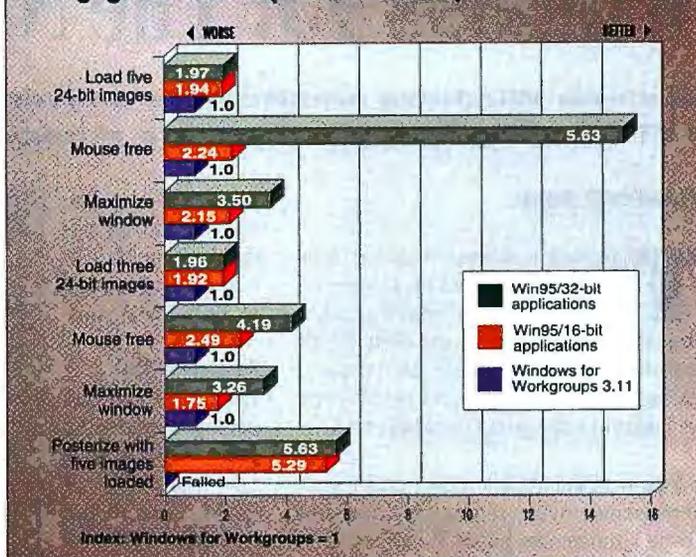
Multitasking: The Big Win

Anyone who has ever experienced an "application is not responding" crash under Windows will appreciate the improved multitasking of Windows 95. Our multi-

tasking tests show only a marginal improvement in the speed of multiple applications running under Windows 95; but the new environment, with its preemptive multitasking architecture, is clearly more stable.

For our first multitasking suite, we loaded three Word documents, seven linked Excel spreadsheets, and three 24-bit images. We formatted one of the Word documents and saved it while recalculating the linked spreadsheets. WfWG froze each time we ran the suite, crashing one of the three loaded applications in each case. We reran the test with two images loaded (instead of three) and still could not complete the test under WfWG. WfWG finally ran the suite with a single 24-bit image loaded;

Imaging Performance (Picture Publisher)



the timings are recorded as suite 2.

For suite 3, we copied approximately 20 MB of files from a double-speed CD-ROM drive to the hard disk while compiling a video effect with PhotoMorph 2. Suite 4 included loading a document into Word and recalculating our linked Excel spreadsheets while building a 7-MB archive with WinZip.

Under both testing environments, we left 80 MB of disk space free and defragmented the disk before launching a multitasking test. We created the largest permanent swap file that WfWG would allow and kept the default settings of Windows 95 to enable the new dynamic cache (see the Technology Focus box "The Installable File System" below). In all cases, we ran the WfWG tests and the Windows

The Installable File System

A key architectural component of Windows 95 is its layered installable file system (IFS). Under MS-DOS and Windows 3.1, applications and system components that needed to handle file I/O requests had to hook into INT 21h to examine and evaluate those requests. Windows 95 supports file-system drivers as ring 0 components, instead of as real-mode MS-DOS drivers. In addition to the performance and reliability advantages of a 32-bit protected-mode architecture, the IFS can support multiple network redirectors for simultaneous access to different networks. Windows 3.1 could support no more than two network redirectors at a time.

The IFS supports the 32-bit virtual file allocation table (VFAT) driver, the 32-bit CD-ROM file system (CDFFS) driver, and integrated 32-bit network redirectors for Windows NT and NetWare servers. With an IFS, third-party vendors can add file systems under the IFS Manager—for example, to support other network OSes (NOSes).

Applications and system components can now access the hard disk file system through VFAT, a 32-bit protected-mode driver that is reentrant and multithreaded. In addition, the Windows 95 block I/O system supports a 32-bit, protected-mode port driver for communicating to specific drive controllers. For SCSI devices, Windows 95 integrates a SCSI layer to handle high-level SCSI calls. The combination of VFAT and the block I/O system opens a protected-mode 32-bit code path to hard disk files.

The VFAT also supports the new caching architecture of Windows 95. VCACHE, a 32-bit protected-mode cache driver that replaces real-mode SmartDrive, dynamically allocates memory for disk caching. CDFS replaces real-mode MSCDEX and requires no conventional memory. The CDFS cache shares its memory pool with the VFAT driver and, like VCACHE, is dynamic. During heavy CD-ROM usage, the system allocates more memory to the CDFS cache and returns the memory when an application requires it.

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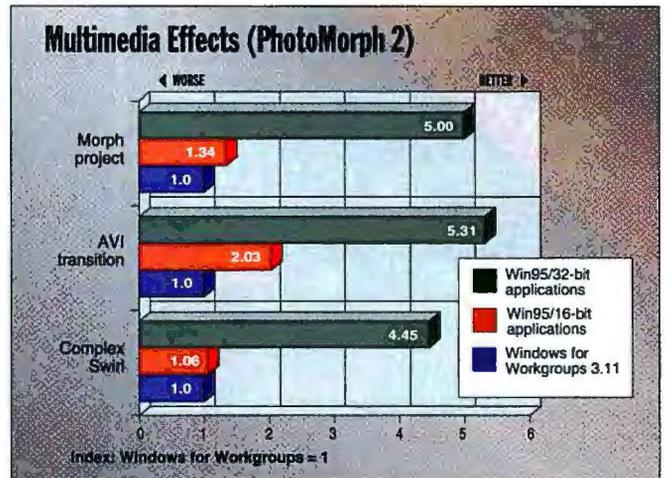
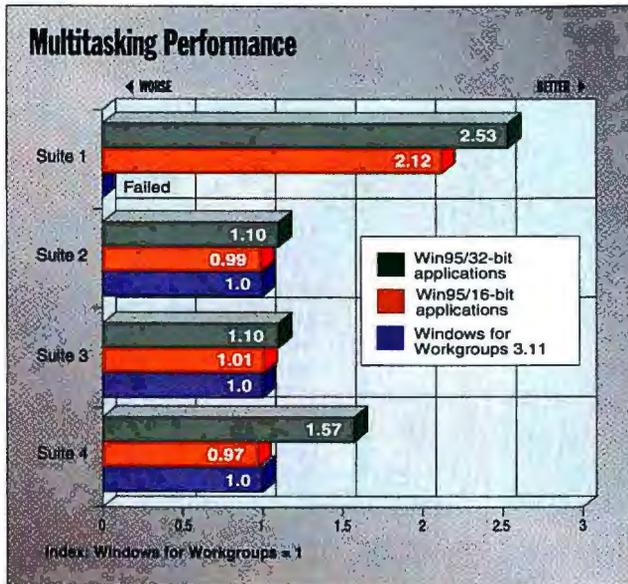
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REVIEWS Windows 95: The Numbers



95/16-bit tests with shipping 16-bit applications. The Windows 95/32-bit multitasking suites were run entirely with 32-bit applications (i.e., gold code of Word and Excel for Windows 95; beta code of PhotoMorph 2, Picture Publisher 6.0, and WinZip32).

optimized applications, Windows 95 looks like a clear performance winner over Windows 3.1. The bigger win is stability, which has long been a sore point for all of us who do serious work with Windows. As developers start optimizing 32-bit code for Windows 95 and supporting multi-

threaded processes, the performance will only get better. ■

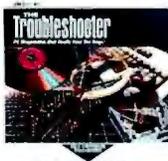
If You Build It, They Will Come

With the right memory configuration and the right memory configuration and optimized applications, Windows 95 looks like a clear performance winner over Windows 3.1. The bigger win is stability, which has long been a sore point for all of us who do serious work with Windows. As developers start optimizing 32-bit code for Windows 95 and supporting multi-

Stanford Diehl is the director of BYTE product reviews. He has been testing and evaluating computer software and hardware for over 10 years. Before coming to BYTE, he developed computer-based training and database applications for a large industrial contractor. You can reach him on the Internet or BIX at sdiehl@bix.com.

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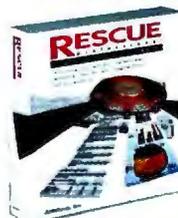
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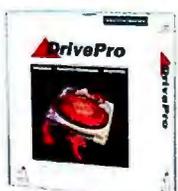


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Applications 95 Arrive

Hot new programs that make Win95 worth the upgrade

STANFORD DIEHL

It was classic. At last June's Reviewers Workshop in Seattle, the Microsoft spin doctors downplayed the hype (that they had helped fuel over the last two years or so) surrounding Windows 95 and tried to lower expectations. It's just an OS, the line went, "not a cure for cancer." They are right, of course: It is just an OS, and—as IBM learned—no OS can thrive in a vacuum.

Only powerful productivity applications can infuse a new platform with value. And Windows 95 has the applications to bring it all together. By the traditional definition of a killer app—high-profile productivity software that drives the acceptance of a new technology or system—the beta applications covered here can rightly claim killer-app status. This new software taps into the unique features of Win95 and performs tricks that weren't possible under Windows 3.1.

Microsoft Office for Windows 95

The updated Microsoft Office suite delivers all the basic applications you'll need to become immediately productive in your new operating environment. The applications not only conform to Windows 95—32-bit architecture, multithreading (printing in Word, queries in Microsoft Access), consistent Win95 interface across all applications, long filenames, cross-application drag-and-drop, shortcuts (including creating shortcuts to a specific page in a Word document or a worksheet in Excel), and Briefcase support—but they also include new features worthy of version-number upgrades.

The most striking enhancement to the suite is the new Microsoft Office Binder.

Visual Voice for Win32 enables more robust telephony applications under Windows 95, thanks to an integrated TAPI interface, multithreading, support for more telephone lines, and unimodem drivers.

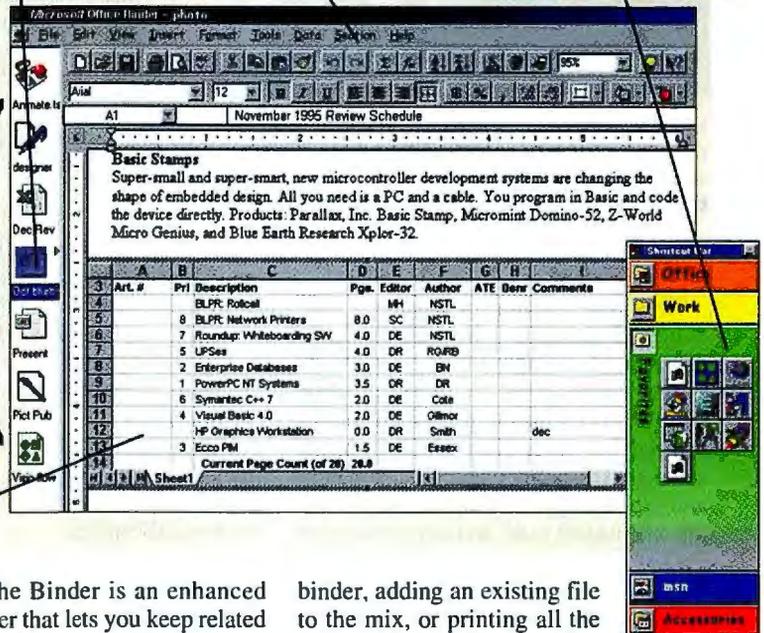
Sections in the active binder. Click on an icon to edit the section in place using the creating application.

Binder menu doesn't change; only the options under the Section menu do.

The Microsoft Office shortcut bar supports auto-hide, multiple toolbars, and docking.

Binder-compatible applications include Visio, Picture Publisher, and TriSpectives.

In-place editing



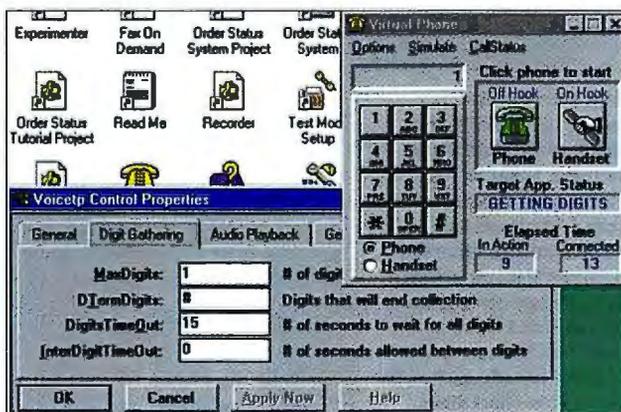
The Binder is an enhanced OLE 2 container that lets you keep related documents within a single file structure. You can organize a project's electronic files within a binder, much as you would organize paper within a three-ring binder. Each section of the binder can contain a different file type (a Word document, a PowerPoint presentation, or any other file format that is Binder—not just OLE 2—compatible). You can then reorganize the sections by dragging the section icons (see the screen), dragging a section into another

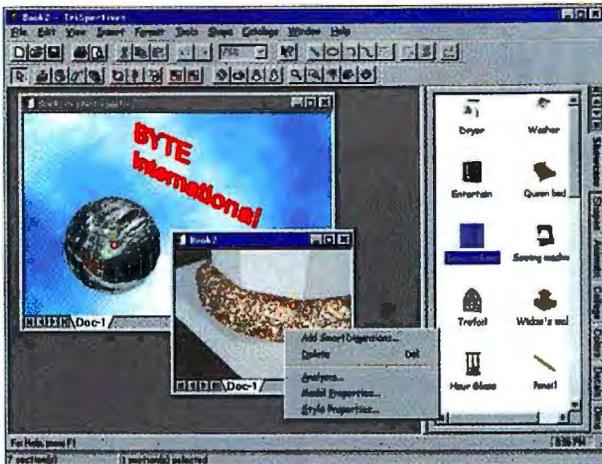
binder, adding an existing file to the mix, or printing all the documents in a binder using consecutive page numbering. Application vendors are already joining the Binder bandwagon, including Visio, Micrografix, and 3D/EYE.

If you already use Office, there is no learning curve, except when dabbling in new features like the Binder. Given the remarkable market penetration of Microsoft Office, the jump it now has on the competition in supporting Win95, and third-party Binder support, Office 95 is clearly the suite to beat.

32-bit OLE Custom Controls

Microsoft's promise of an open, standard interface for reusable object components will finally blossom under Windows 95. Microsoft has announced that all its development tools will support 32-bit OLE controls across Windows 95 and NT, and it's worked hard to ensure a healthy component market with such incentives as Custom Control Wizards and extensive developer support. Soon an explosion of OLE controls is sure to hit the market, delivering reusable components for telephony,





TriSpectives Professional offers easy-to-use, sophisticated features. From the tabbed catalog on the right of the screen, you can drag objects onto either 3-D scene on the left. Right-click on an object to bring up tabbed dialog boxes for model properties and style properties.

imaging, communications, and other add-on functionality.

Long at the forefront of component technology, Stylus Innovation has announced its 32-bit OLE implementation of Visual Voice. Visual Voice for Win32 provides the developer with interfaces for recording and playing voice files, sending and receiving faxes, prompting for dial-pad input and processing the touch tones, answering and placing calls, and integrating with PBXes and multiline telephony boards. Visual Voice enables a wide variety of telephony-based applications, including fax-on-demand, Interactive Voice Response, and multilayered voice mail.

Windows 95 will greatly extend the capabilities of Visual Voice applications. The new OS will ship with native TAPI support, unimodem drivers, and multithreaded telephony services.

TriSpectives Professional

If you're looking for brand new software that deserves the killer-app label, check out TriSpectives Professional. It combines 3-D modeling, 3-D illustration, and 3-D animation with the drag-and-drop template model of Visio. TriSpectives implements OLE 2 from the ground up, is fully compatible with the Microsoft Office Binder, and relies on the improved performance of the Windows 95 graphics architecture.

You start with a 3-D scene (or a 3-D page) and a multitabbed catalog (see the screen above). You can select objects from any of the catalogs and drop them onto the scene. You can then drop

The ABC Graphics Suite includes Micrografx Designer, ABC FlowCharter, Picture Publisher (above), and the new Media Manager (right, sitting on top of a PowerPoint presentation). From the Media Manager, you can drop objects onto any OLE-compatible application or drag new objects into the Media Manager palette. It's a great way to manage clip art, logos, or other reusable objects. Picture Publisher's Image Task Manager tracks the progress of active threads, such as file loads or complex special-effect filters.

colors or surfaces onto the object or rotate the object freely in 3-D space. Right-click on the object, and you get a tabbed dialog box for changing the object's properties: Give it a shinier finish, reflect a bit-map image off it, or add a decal of your choosing. Once you've created a model, you can drag and drop animation effects onto it (e.g., Y-move, Z-move, Fly In, or Grow) and access motion properties with a right-click.

The TriSpectives workspace acts as an OLE 2 container, and all the catalog items are independent OLE 2 objects. You can drag OLE objects—such as an Excel chart—from other applications and drop them into a 3-D scene or into a TriSpectives catalog. Once you've devised your own models, you can drag them into a catalog for future use or export them to other modeling formats (including exporting them as Visual Basic text files to generate code for creating models in Visual Basic).

Feature for feature, TriSpectives stacks up well against some high-end 3-D pack-

ages like 3D Studio, but its broader appeal stems from the ease-of-use features. It may help move 3-D illustration into the mainstream, enabling nonengineers to incorporate 3-D logos and animation effects into business presentations or product brochures.

ABC Graphics Suite

Micrografx is the latest software vendor to become possessed by value-bundle mania. The company is packaging Micrografx Designer, ABC FlowCharter, Picture Publisher, and a new media-manager utility as an integrated suite and marketing it as an ideal companion product for Microsoft Office. The applications now conform to the Office 95 interface (as with all the Office 95 applications, only the application-specific menu item is unique), and all but FlowCharter are compatible with the Office Binder.

The applications are all 32-bit, and they fully support the Windows 95 interface. The Media Manager is an OLE 2 container for holding libraries of clip-art images and symbols. In fact, ABC FlowCharter uses the Media Manager as its symbol palette. You drag symbols from the palette and drop them into your flow charts, just as you can drop Media Manager clips into any OLE-compatible application. You can also drag any image (e.g., the company logo or a bit-map signature file) onto the

Media Manager for use in other applications. The Media Manager supports a wide variety of formats, and it imports and exports them on the fly.

ABC FlowCharter now includes SnapGraphics, a template-based utility for building such business diagrams as time lines, pyramids, and target charts. Drop a diagram into Word or PowerPoint and edit it in place. FlowCharter incorporates OLE 2 automation, so you can build custom applications or use FlowCharter objects in any application that supports Visual Basic.

Of all the new applications we've seen so far, Picture Publisher has the best Windows 95 implementation of multithreading. Time-intensive processes like loading files or applying special-effect filters get



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CorelDraw 6 includes four integrated applications, nine utilities, and a boatload of Corel extras. Shown is Photo-Paint with its roll-up dialog boxes and object palette for tracking objects in the active image. CorelScript is an OLE automation script editor and debugger.

their own thread. The Image Task Manager (see the screen on page 118) tracks the progress of each thread as you go about your work. The architecture showed up first in Picture Publisher for NT but could not be deployed under Windows 3.1. With elegant floating (and dockable) toolbars and intelligent interface design, Picture Publisher and Micrografx Designer meld smoothly into an Office 95 environment.

CorelDraw 6

Corel has always been the Swiss Army knife for Windows-based graphics design. Corel 6 bundles four integrated applications—CorelDraw, Corel Photo-Paint, Corel Presents, and CorelDream 3D (Corel has pulled Ventura from the bundle and will release a new version of the desktop publisher in November). All of the applications sport a 32-bit multithreaded architecture and conform fully to the Win95 interface: long filenames, uninstall modules, wizards, extensive right-mouse-button shortcuts, tabbed dialogs and property sheets, dockable toolbars, and rich OLE 2 functionality (in-place editing, drag-and-drop across applications, and OLE automation through CorelScript). The Corel suite goes a step further, enhancing the interface with dialog roll-ups, an excellent desktop-saving feature (see the screen above).

As always, the package includes utilities (a 3-D logo creator, a multimedia file manager, font management, an OLE 2 scripting language, a dialog editor, and four other utilities) and a gaggle of extras (e.g., 25,000 clip-art images, over 1000 fonts, photos, templates, 3-D models, sounds, objects, animation actors, and backgrounds). Windows

95 may solve one common complaint about Corel: its nonstandard interface. The bundle finally comes together nicely, delivering an integrated solution to Windows-based designers and illustrators.

The Gaming Platform

No bones about it: Microsoft wants Windows 95 to be a killer games platform. As a gaming environment, Windows 3.1 was a big, fat flop. Hard-core PC gamers are still firmly planted in DOS. But the Windows 95 architecture will change all that. Early betas of new games clearly portend a thriving Win95 games market.

Pitfall: The Mayan Adventure (below, right), is an arcade-style adventure game from Activision that has been hugely popular on Nintendo and other gaming systems. Pitfall now works like a charm under Windows 95. It is exactly the kind of game that once required DOS to run effectively. There's lots of fast motion, real-time interactive responses, and intensive graphics. Under Windows' old Graphical Device Interface (GDI) architecture, this level of responsiveness was not possible, but the Win95 DIBEngine lets game developers blast device-independent bit maps (DIBs) directly to the screen. Confirming its faith in the Win95 game market, Activision plans to release eight Windows 95 games by the end of the year and will no longer develop for the MS-DOS platform.

Educational titles should also prosper. The Freddi Fish title (shown below, left)

The new DIBEngine graphics architecture in Windows 95 should spurn a thriving games market that has long eluded Windows. Game developers can now bypass GDI and blast device-independent bit maps directly to screen. This architecture enables fast-paced arcade-style games like Pitfall (far right) and educational titles like Freddi Fish (right) to run smoothly under Windows 95.

The new DIBEngine graphics architecture in Windows 95 should spurn a thriving games market that has long eluded Windows. Game developers can now bypass GDI and blast device-independent bit maps directly to screen. This architecture enables fast-paced arcade-style games like Pitfall (far right) and educational titles like Freddi Fish (right) to run smoothly under Windows 95.



uses auto-run (a Win95 feature that automatically plays a CD-ROM when it is loaded) to avoid installation hassles altogether. You load the CD, and a splash screen pops up automatically. Click on the play button, and the game starts. With auto-run, Freddi Fish implements a "zero-footprint" design, moving files to the hard disk as needed and then removing them when the game exits. The graphics are sharp and colorful, the animation smooth.

An impending upgrade to Display Control Interface (DCI) will further enhance Win95 as a gaming platform, adding automatic support for multiuser games, MIDI sound, and digital joysticks.

Windows 95 Componentware

Componentware—small applets that deliver focused functionality to desktop applications—has been a hot topic, and an expected trend, for some time now. And yet fatware continues to thrive. Again, the clunky mechanism of OLE 1 and DDE under Windows 3.1 must assume part of the blame. Now, with its full integration of OLE 2 and OLE Automation, Windows

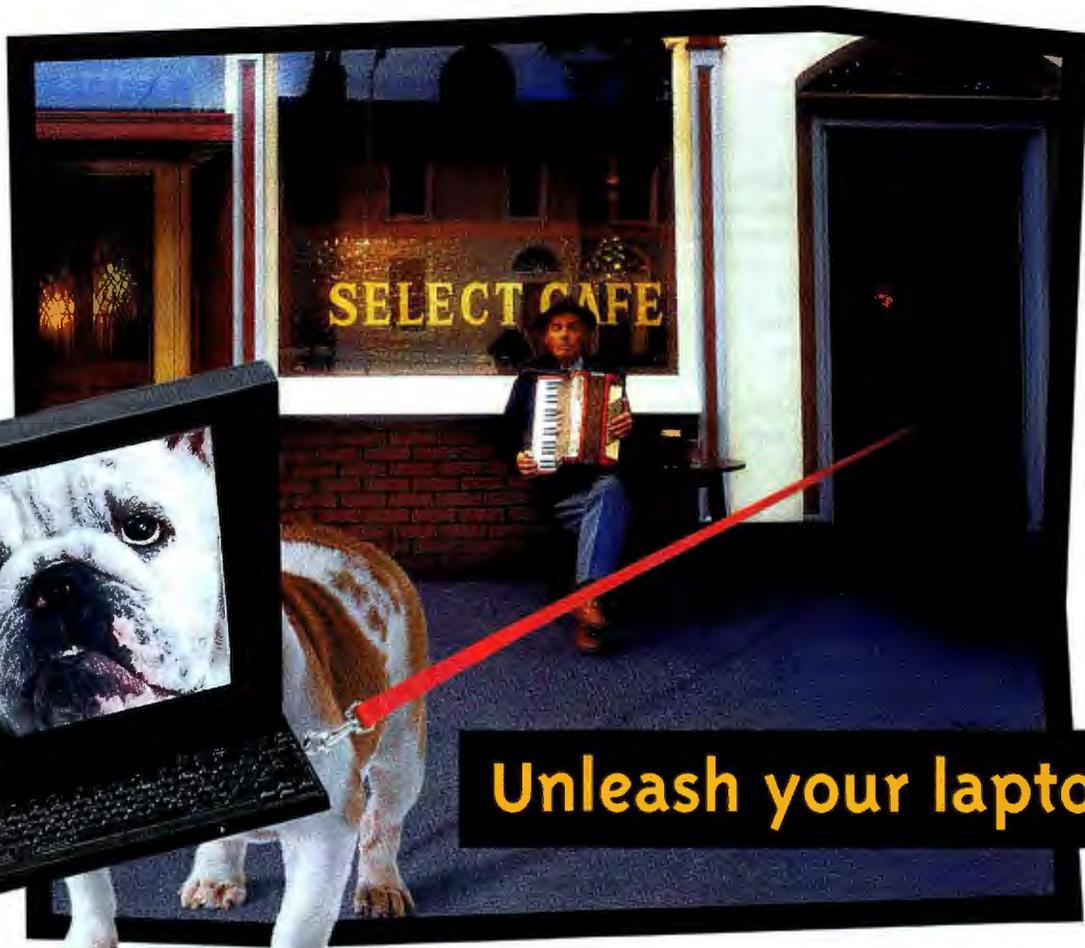
95 delivers an environment that will support robust component utilities. Some early announcements prove the viability of component technology; it's now up to the market to

determine the success of the componentware design philosophy.

Alphablox, a new company derived from Alpha Software, is shipping a set of five utilities, called Officeblox, that adhere to the componentware model. With Noteblox, you can post sticky notes onto

As a gaming environment, Windows 3.1 was a big, fat flop.





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OLE Structured Storage

The OLE 2 architecture and, specifically, OLE's Structured Storage model enable many of the most powerful features gracing the new wave of Windows 95 applications. The Office Binder, the "stencil" metaphor of both Visio and TriSpectives, and the componentware market all depend on the Windows 95 implementation of Structured Storage.

Application developers are accustomed to assigning file handles and reserving files for a single application, but compound documents allow many applications to write to a single file. Without an OS-level mechanism for handling compound files, the developer must keep track of multiple seek pointers and, in effect, build an internal file system.

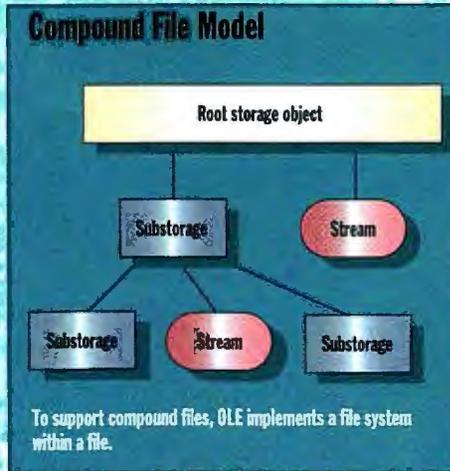
A Structured Storage implementation solves the problem of compound files by supporting a file system within a file. OLE 2 specifies a file structure that can contain two distinct types of objects—storage objects and stream objects. Streams hold data (such as the text in a Word file), while storage objects can hold within them any number of substorage objects or streams. Substorage objects (like subdirectories of a root

directory) can, in turn, hold other substorages or streams. Each of these object types expose interfaces (in this context, an interface is an array of functions that other objects or applications can call).

Structured Storage frees an OLE container application from managing its own file structure. Instead, the OLE container provides a storage object to any compound document (or other embedded object) that it hosts. The object then manages the streams and substorages under its control. The application container no longer has to manage the complexity of multiple file pointers. In fact, the application doesn't have to do any work at all. The storage object writes directly into the piece of storage under its control without any interaction with the container itself.

OLE Structured Storage also makes data exchange more robust. Under OLE 1, data was transferred through DDE's mechanism of global memory. OLE 2 applications simply

pass a pointer to a data object from the source application to the data recipient. This mechanism is implemented through the OLE 2 interfaces to storages and streams. Future versions of NT (Cairo) will use Structured Storage as its native file system.



any application or directly onto the Windows 95 desktop. Embed Calcbox into an application to enable quick calculations at the click of a button. Listbox lets you jot down to-do items, generate a quick expense report, or embed a simple list manager into your word processor.

Toolbox is the most interesting component. You can launch applications from

the toolbar or drag objects (applications, documents, images—i.e., any OLE object) onto it. You can even specify an application's exposed objects as a Toolbox item; for instance, when you drag the Excel icon onto the toolbar and edit the entry, a list box displays Excel's components. You can then select the Excel's calculation engine or its charting module as the launch-

able component. The toolbar's template icon brings up a wide variety of Officebox templates for quickly creating agendas, phone messages, meeting requests, or other memos.

Workbox will ship as a "trial" application in Officebox. Workbox, a tabbed OLE 2 container, gives you a convenient place to store objects or catalog your work.

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The Applications Cometh

When all is said and done, Windows 95 won't require a few killer apps to succeed. It is the sheer breadth of supported applications that drives the popularity of the Windows platform. But a wave of significant upgrades and new product announcements can only help fuel the acceptance of Windows 95 across the enterprise and in the home. ■

Stanford Diehl, director of BYTE product reviews, has been evaluating computer products for over 10 years. He holds degrees in English literature, computer science, and electronics technology. You can reach him on the Internet or BIX at sdiehl@bix.com.

Power Mac Gets PCI

The 9500 sports a top-of-the-line PowerPC 604 CPU and PCI bus, too

TOM THOMPSON

With the latest PowerPC 604 processor and a retooled I/O system, Apple's new Power Mac 9500 delivers great performance. Using the industry-standard PCI expansion bus, the latest Power Macs should spawn a wide selection of fast, lower cost Mac/PCI peripherals. Most important, the 9500 maintains software compatibility despite big I/O system changes.

The Power Mac 9500 comes in 120-MHz and 132-MHz versions: the 9500/120 and the 9500/132, respectively. Base RAM starts at 16 MB (expandable to 768 MB) with a 512-KB secondary RAM cache. Standard features include six PCI-bus slots, a 1- or 2-GB Fast SCSI drive, a quad-speed CD-ROM drive, two GeoPort serial ports, and two Ethernet ports (10Base-T and AUI). An internal bus supports SCSI-2 fast transfers, while the external SCSI bus (standard Macintosh DB-25) handles slower external devices.

Next-Generation Design

Apple created a second-generation architecture for the 604. First, there's that industry-standard, 33-MHz PCI expansion bus (see "Inside the PCI Local Bus," February 1994 BYTE). Most internal I/O subsystems use Open Firmware and the PCI bus for start-up configuration and data transactions. Currently, Open Firmware isn't required for PCI card firmware to operate on the 9500 except with boot devices (such as display or network cards). The

system also uses Open Transport, a Unix network standard, to implement its network interface and protocol stacks.

The 9500's memory subsystem is 16 to 20 percent faster than those of previous designs. Memory interleaving generates 128-bit-wide memory accesses. The memory controller is smarter about accesses as well; it monitors memory paging to reduce virtual memory overhead and uses DMA for block transfers. It also snoops memory accesses and can thus cache such previously uncachable transfers as I/O and video frame buffers. Finally, copy-back caching algorithms reduce bus traffic.

The memory bus speed is programmable (up to 50 MHz), which enables better synchronization of RAM accesses with the processor bus and allows CPU upgrades (up to a 150-MHz 604), because the 604 sits on a plug-in daughtercard.

It's important to note that the 9500 uses 168-pin JEDEC dual in-line memory modules (DIMMs) instead of the 72-pin SIMMs found in existing Power Macs. If you step up to a Power Mac from an older system with lots of memory, you have two options: You can pony up lots of cash for new DIMM memory, or you can use Newer Technology's DIMM Tree (\$69; (800) 678-3726), a slick little gizmo that plugs into the 9500's DIMM sockets and provides SIMM sockets for your old RAM (provided it's 70-nanosecond or faster).

Hard disk I/O has been a Power Mac bottleneck, but the 9500 fixes that with native code for the SCSI driver instead of 680x0 code. (However, file system software is still 680x0 code that undergoes emulation.) Last, the SCSI and other I/O subsystems use a descriptor-based DMA control that minimizes CPU involvement (see "Smarter DMA" on page 124).

The 9500 ships with a tuned up OS, System 7.5.2. Its faster 680x0 emulator uses dynamic recompilation (see "Building



The Apple of your dreams: a 132-MHz 604-based Power Mac.

CRAIG ALNESS © 1995

the Better Virtual CPU," August BYTE). Other OS optimizations include more native code (such as in the SCSI Manager), some device drivers, and network protocol stacks. Existing native portions of the OS, such as QuickDraw, the math library, and Memory Manager, are tuned for the 603 and 604.

Trial Run

We tested a Power Mac 9500/132 with 32 MB of RAM, a 2-GB hard drive, and ATI's Mac-adapted PCI display card. The ATI card uses QuickDraw's

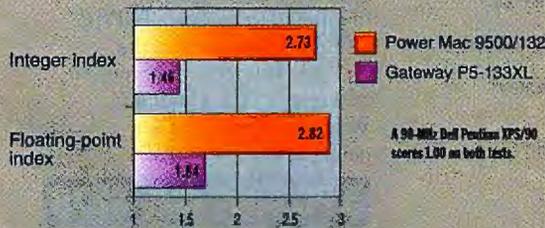
new acceleration API, which makes for snappy screen drawing. With the 604, the Power Mac pulls substantially ahead of similar-speed Pentium systems in both integer and floating-point performance, thanks to a faster CPU and compiler improvements (see the figure "PowerPC Surpasses Speediest Pentium"). An improved compiler enhances a system's performance in our native-mode benchmarks, just as it will enhance application speed.

Low-level 680x0 tests show that the 9500 memory subsystem is several times faster than that of a 110-MHz 601-based Power Mac. On application tests, disk I/O was also noticeably faster. Considering the complete overhaul of the Power Mac bus and network interface, there are surprisingly few incompatibilities. The usual

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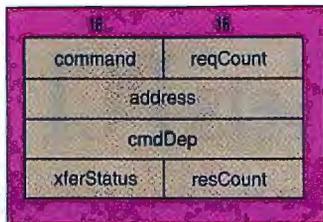
Running BYTE's Native Performance Benchmark at similar clock speeds, the PowerPC 604's integer performance is 87 percent faster than that of a 133-MHz Pentium machine, and floating-point performance is 72 percent faster. We used Motorola's latest PowerPC libraries to compile the test.

Smarter DMA

By handling memory transfers for the CPU, a good direct memory access (DMA) system improves overall performance. Still, moving large blocks of data between memory and a device, or vice versa, requires multiple DMA transfers. Typically, each transfer ends in an interrupt to the CPU, which must then drop what it's doing to set up the next transfer. To manage its 14 DMA channels without this overhead, the 9500 employs a descriptor-based DMA engine.

Descriptors serve as a simple instruction set for implementing DMA transfers. Glue logic around the DMA controller executes the instruction set, which supports branching, looping, and error handling. Each descriptor is a four-long-word data block with 16- and 32-bit fields that include the command, requested data size, buffer address, a device-specific instruction, status, information, and the resulting amount of data moved. Not all commands use all fields. By chaining descriptors into a mini-program, descriptor-based DMA moves large data blocks without interrupting the CPU.

Taking advantage of descriptor-based DMA requires device-driver modification. The driver must parse each I/O request for size and location and then place in memory sufficient descriptors to handle the transfer. SCSI, Ethernet, sound, serial, and floppy subsystems use this capability to reduce CPU overhead in the 9500.



By chaining DMA descriptors to describe and execute DMA transfers, the 9500 reduces CPU overhead.

loads using Aladdin's SITcomm terminal program. When a noisy connection caused this normally reliable program to abort a ZMODEM transfer, it failed to recover. We also discovered that an old SCSI tape drive would hang the system unless we switched on the drive after the 9500 booted.

It's now too soon to tell how well the first Mac-compatible PCI cards will work. Companies such as Rockwell (FDDI network card) and Diamond Multimedia (accelerated display card) should have products shipping by the time you read this.

Despite some teething pains, the 9500 provides plenty of horsepower for those who need it. You can expect vendors to correct problems and revise applications to make best use of the 604 processor. In addition, PCI peripherals will cost less and give you higher performance. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from the University of Memphis. He is also an Associate Apple Developer. You can reach him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.

assortment of applications, Control Panels, and Extensions—both native and 680x0—functioned as they should. Lotus's cc:Mail

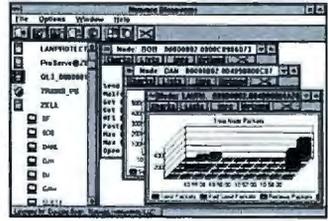
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Au Revoir, Mon Ami

Word Pro, formerly Lotus Ami Pro, touts innovative features, but they may not be enough to convert Microsoft and Novell users

KENNETH M. SHELDON

When Ami Pro first arrived on the scene, it was the leader among Windows word processors, thanks to such innovative features as WYSIWYG and style sheets. But it hasn't seen a major revision since July 1992, and its competitors—notably Microsoft Word for Windows and Novell's WordPerfect for Windows—have passed it in both power and popularity.

Still, die-hard believers have stuck with Ami Pro, hoping for a competitive upgrade. Finally, the faithful have been rewarded with so many new features that Lotus decided to give Ami Pro a new, if less original, name: Word Pro.

The Team Approach

The most significant new features in Word Pro stem from Lotus's cross-application

team-computing effort. Among these features are TeamReview and TeamConsolidate, which allows you to share documents with other people—each of whom can make edits and revisions—and then consolidate the changes into a final document.

The TeamReview Assistant feature enables you to specify who reviews a document, what kinds of changes are allowed, and through what medium the document is to be routed. Team members can make changes, highlight text, and add comments (including text, graph-

ics, and even sound and video clips).

Using TeamConsolidate (see the screen above), you can then merge all the changes and comments—all keyed and color-coded for each team member—into a single document. Word Pro's version control lets you maintain several versions of a document in a single file (see the Technology Focus box at left for more details).

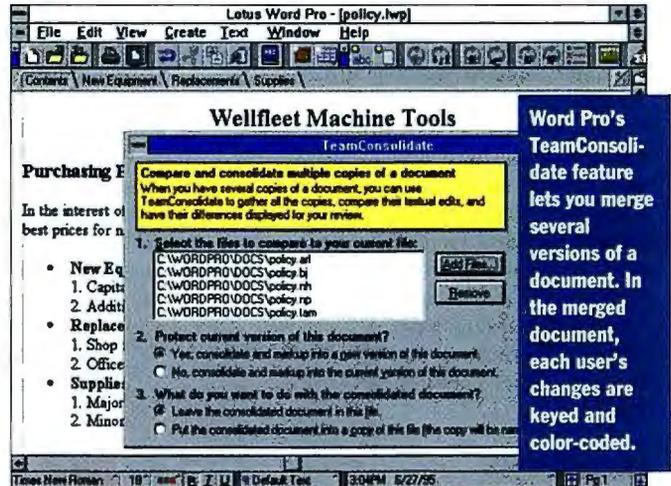
Lotus's team-computing philosophy is also evident in a feature called Notes/FX. This component allows Lotus Notes users to integrate Notes databases with Word Pro to create customized applications and documents.

Some Things Borrowed

Word Pro has adopted some slick features from other applications. For instance, divider tabs let you jump quickly to a specific section of your document. You can also link a divider tab to an external document or an OLE file.

Another borrowed feature, the InfoBox, originated in Lotus Improv and is now common across the Lotus SmartSuite applications. The InfoBox places all the editing and formatting tools for objects such as text and frames in a standardized, context-sensitive box.

The spelling checker, much improved, now supports interactive spell-checking as you edit. When you invoke Spell Check, it automatically highlights all the misspelled words in a document. You can quickly scan the document for true mis-



Word Pro's TeamConsolidate feature lets you merge several versions of a document. In the merged document, each user's changes are keyed and color-coded.

TECHNOLOGY FOCUS

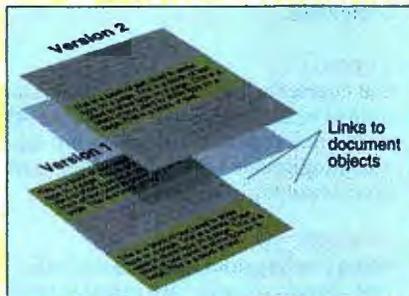
Object-Based Version Control: The Big Difference

Word Pro's version-control features rival the tools found in software development and document management programs. For example, the first time you save a document, Word Pro stores everything in a single read-only file. As you make and save changes, Word Pro saves only the changed portions of the original. A searchable history of the document is always available, and disk space is conserved.

To manage such changes, Word Pro turns major document elements into objects, which are then tracked in a coded list embedded in the file. Users can't view the list, although they can see an editable directory of versions. Versions share objects, including document properties, embedded or linked objects, OLE objects, equations, and charting objects.

A shared object is, in effect, externally linked to all file versions. For example, if you create a chart in a Word Pro document and then update it in a second version of the file, the second version does not contain a full copy of the chart. Instead, the copy is maintained in the original version and linked to the new portions in subsequent versions. When you change data, the original chart is modified, and all links are updated.

Reused objects must be maintained in a read-only state to avoid ripple effects in later versions. For getting around this limitation, Word Pro lets you cut and paste previous versions of a document into a new one. You can also save versions in separate disk files.



Versions of a document are pieced together from linked objects containing the most recently modified elements.

takes and edit them without deactivating the Spell Check dialog box.

Lotus has replaced the macro facility in Ami Pro with LotusScript, an object-oriented, cross-application scripting language that will eventually work across the entire suite of Lotus products. Unfortunately, you can't use it to run a macro from a keyboard combination. However, you can save scripts as external files or attach them to particular SmartMasters, the successors to Ami Pro's style sheets.

And, with Word Pro's script editor, you can link scripts to specific events, such as opening a document or clicking on a frame. Lotus says that Word Pro will run many Ami Pro macros. Given Microsoft's support of Visual Basic for Applications and WordPerfect's cross-application scripting, Lotus will certainly have a hard time differentiating its product line with LotusScript.

Playing Catch-Up

Some of Word Pro's features simply bring it up to

speed with its competitors. SmartCorrect, for example, corrects typos on the fly and lets you add words that your fingers commonly mistype. Multilevel undo now lets you undo nearly any change that you've made to a document, and the automatic timed-save feature now saves untitled documents.

As for performance, we found a late beta version of Word Pro poky running on a 66-MHz 486 (see the table "Measured Words"). Word Pro will not score any points for performance.

However, dedicated Ami Pro aficionados will like Word Pro. It adds plenty of new features and improvements while retaining a comforting familiarity. In addition, those who perform their computing tasks in groups—especially users of Notes, 1-2-3, and other Lotus applications—will undoubtedly welcome Word Pro's improved integration

MEASURED WORDS

	OPEN AND CONVERT 10-KB FILE (IN SECONDS)	FILE SIZE AFTER CONVERSION (IN KB)
Lotus Word Pro	8	19
Microsoft Word	1	18
Novell WordPerfect	1	11

with those programs.

Word Pro's chances in the overall word processing race are less certain. While features like TeamReview and TeamConsolidate are more powerful and easier to use than anything found in pre-Windows 95 versions of Word and Word Perfect, a number of Word Pro's flashiest features are merely different—not necessarily better—ways of doing things. Word Pro is good enough to hold on to its believers, but it may not be innovative enough to woo a new generation of converts. ■

Kenneth M. Sheldon is a freelance journalist and a former BYTE West Coast bureau chief. You can contact him on the Internet or BIX at ksheldon@bix.com.

Product Information

Lotus Word Pro\$105
 (estimated retail price)
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Digital Cameras for Real Work

New sub-\$1000 digital cameras strike a practical balance between price and image quality

**ALAN MORGAN
AND SCOTT WALLACE**

The benefits of digital photography—filmless cameras that feed images directly to your computer—have always been obvious, especially for field work such as insurance and real estate applications. The high cost of this new technology has been just as obvious. But now affordable digital cameras, priced just under \$1000, support new ways of using digital images in business, scientific, and publishing applications. Though they can't rival scanners in resolution or fidelity, they dramatically improve ease of use and reduce production time.

The trio of cameras reviewed here—from Apple, Kodak, and Logitech—are based on the same Kodak core. These 24-bit cameras are similar in form and function but differentiate themselves in storage capacity, operator controls, and approach to image processing. Casio's new QV-10 is a different breed altogether (see "Casio's

QV-10: Portable Presentations" below), and suggests the direction future digital cameras may follow.

The three Kodak-based cameras all share the lightweight feel of a point-and-shoot film camera, including built-in flash and removable batteries. The Kodak and Logitech cameras can also take some third-party lenses. All three store image data in EPROM flash memory, which retains images even when batteries go dead.

The bundled Macintosh or Windows software supports simple image manipulation as well as several compression protocols, such as JPEG and TIFF, for migration to professional-quality applications.

Price still limits image resolution, but increasingly sophisticated processing makes relatively low-resolution data more realistic (see "Imaging Without Film" on page 130). Though they still don't deliver

the vibrancy and sharpness of film-based cameras, the new Kodak-based cameras provide significantly better quality than less expensive digital cameras.

Kodak's DC40

Like Logitech's FotoMan Pictura, Kodak's DC40 (Digital Camera 40) offers more storage capacity than Apple's QuickTake (4 MB versus 1 MB) and higher image



Three digital cameras from Apple (top), Kodak (right), and Logitech (left) are all based on a Kodak core product. The Apple has the lowest price (\$739) and works with both Macintosh and Windows PC platforms.

CHAIK ALMNESS © 1995

Casio's QV-10: Portable Presentations

While Kodak's DC40 and Logitech's Pictura produce the best printed picture and Apple's QuickTake 150 has the best monitor display, Casio's new QV-10 stakes out NTSC video as its forte. Due this summer, Casio's entry into the digital camera market provides numerous design innovations that could steer things toward smarter, friendlier image capturing.

The 1.8-inch-square active-matrix color LCD viewfinder on the camera's back says that the QV-10 is not the standard point-and-shoot film box it resembles. Its through-the-lens view frames an object without parallax and brings WYSIWYG to the under-\$1000 camera field. You can adjust contrast and framing before taking the picture. Also, you can tilt the lens up or down, switch it to a macro for close-ups, and adjust the LCD's optimal viewing angle. Thus, it's easy to shoot with the camera placed in any convenient location.

The same LCD lets you review all 96 pictures, which you can store in the QV-10's 2-MB flash EPROM. To make comparison easier, the LCD can display four or nine pictures at once (and the images remain recogniz-

able). You can also zoom in on a portion of an image for detail. You can delete any picture in memory, and the remaining shots renumber to make room for more. (In contrast, the Kodak family lets you delete only the latest image, and enabling the delete-last-picture option can reduce storage capacity by 30 percent.)

The camera's weak point is that it captures images at a resolution of only 480 by 240 pixels. All output from the camera is converted to 320 by 240 pixels (or interpolated up to 640 by 480 pixels) so print and VGA output will likely be acceptable only in small sizes. But on a TV or videotape, the image works well.

What will sell the QV-10 is its in-camera presentation abilities. Images are stored digitally but can be retrieved as either digital or NTSC video signals. In "autoplay" mode, the QV-10 displays stored images sequentially at a selected rate. Even better, you can download images from your PC. You can upload images from the camera to a PC, add graphics and lettering, reorder everything, and then download a presentation back to the camera. Hook the QV-10 to a TV, turn on autoplay, and watch the show. It can loop endlessly, including four- and nine-image screen displays, making catchy advertising for store windows or sales booths.



Imaging Without Film

The CCD (charge-coupled device) that converts light to electric charge in today's digital cameras traces its ancestry back to the first black-and-white camcorders. A camera CCD is a single silicon chip that combines a rectangular array of light-sensitive cells with circuitry to process and digitize the image the cells record.

As the camera's shutter exposes the CCD's imaging substrate, each cell builds a charge proportional to the amount of light it receives. The resulting image is read cell-by-cell using a bucket-brigade process that takes 4 to 5 seconds with these cameras. The cells in the bottom row pass their charges to a serial shift register below the array. Cells in the rows above pass their charges down one row.

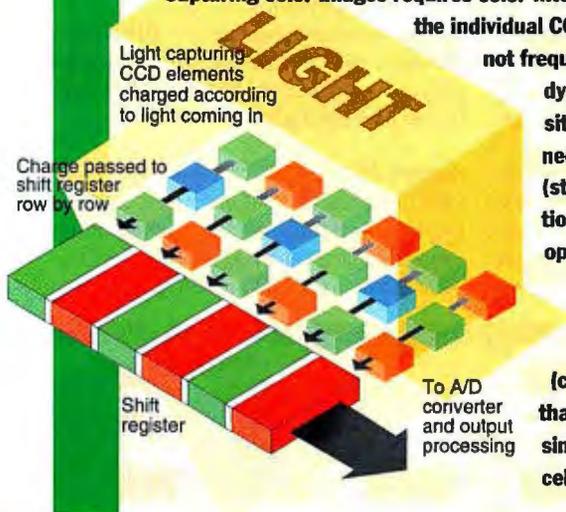
Cell by cell, the CCD chip reads the contents of the shift register, converting the number of electrons to an amplified analog signal. Row by row, the analog signal is processed into a digital image that is stored in the camera's memory. During this transfer, information from the cells may be discarded or combined to reduce image file size and resolution. Even today's low-end digital cameras compare each pixel to its neighbors and optimize for contrast, hue, and saturation.

Capturing color images requires color filters (red, green, and blue) because

the individual CCD cells measure light intensity, not frequency. The simplest technique

dyes the surface of each cell to sensitize it to one of the three colors needed. After early missteps (striped arrays that reduced resolution by two-thirds), Kodak developed a checkerboard mosaic of colored pixels based on experience gained with film chemistry.

The resulting Bayer Pattern CFA (color filter array) has more greens than reds and blues (see figure), since human visual systems perceive that ratio as "sharper."



resolution (768 by 512 pixels versus 640 by 480). After analyzing captured data with a "nearest neighbor" algorithm, all three cameras compress it with Kodak's proprietary RADC algorithm. RADC creates some edge artifacts but otherwise packs information into less memory with less quality loss than Kodak's older 80PCM algorithm (used in Apple's QuickTake 100).

Easy to set up, the DC40 combines plug

and play with point and shoot. The controls are easy to use. The camera's four AA lithium batteries are good for about 500 pictures (depending on flash use and how many images you download to a PC) and support a 5-second cycle time between shots when fresh.

Storage capacity and resolution options are the primary differences between the three cameras. The Kodak camera takes 48 or 99 pictures, depending on compres-



sion, but you must make the choice from your PC when the camera is empty. Choose the higher compression rate only when you'll display the pictures very small or in gray scale.

The PC connection is quick—simply run the cable from your serial port to the camera. With the bundled PhotoEnhancer software, you can view stored images as slides and download them to your computer. The software lets you perform any of a simple menu of image manipulations with ease. A helpful preview feature displays nine variations of the image at once. Kodak released Mac software in July.

The Kodak and Logitech cameras offer you more control than the Apple, as you can alter exposure $\pm 2EV$ on the fly. Telephoto and wide-angle lenses are available from such manufacturers as Tiffen to augment the built-in 42mm-equivalent lens.

Apple's QuickTake 150

Not surprising, Apple's QuickTake 150 works with both Windows-based PCs and Apple Macintosh computers. Both versions (\$739) come with appropriate cables and bundled software; the Macintosh software provides more features.

Although the Kodak-manufactured QuickTake 150 looks similar to the DC40, Apple cut the price 25 percent partly by not using unnecessary CCD (charge-coupled device) pixels. Using only a 640- by 480-pixel matrix, the QuickTake matches the most common monitor resolution. Having 86,016 fewer pixels to process speeds up operations from capture through transfer to display, and saves disk space, too. Additional cost savings come from reduced storage memory, simpler controls, fewer batteries, and elimination of the lens mount. The resulting lighter camera feels less substantial than the DC40 or the Pixtura, but delivers comparable images.

The QuickTake's 1 MB of memory holds only 16 to 32 images, but you can mix different quality shots in the same session. For lower-quality shots, both Apple and Kodak decided that compressing pixel data causes less "quality loss" than

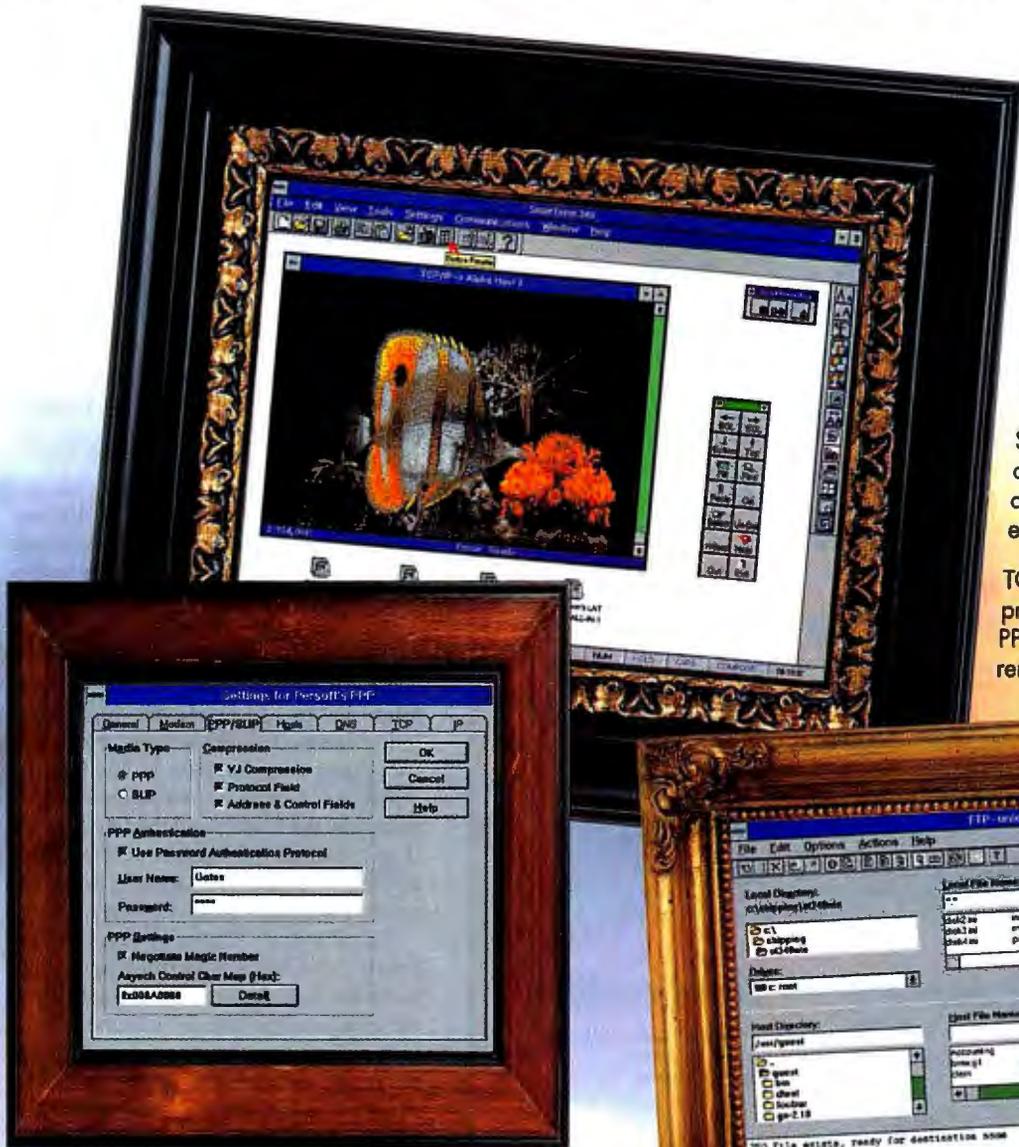
Digital Camera 40 . . . \$995
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Rochester, NY 14650
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(716) 724-4000
<http://www.kodak.com>
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FotoMan Pixtura \$995
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(510) 795-8500
fax: (510) 792-8901
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QuickTake 150 \$739
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Cupertino, CA 95014
(800) 538-9696
(408) 996-1010
fax: (800) 462-4396
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QV-10 \$995
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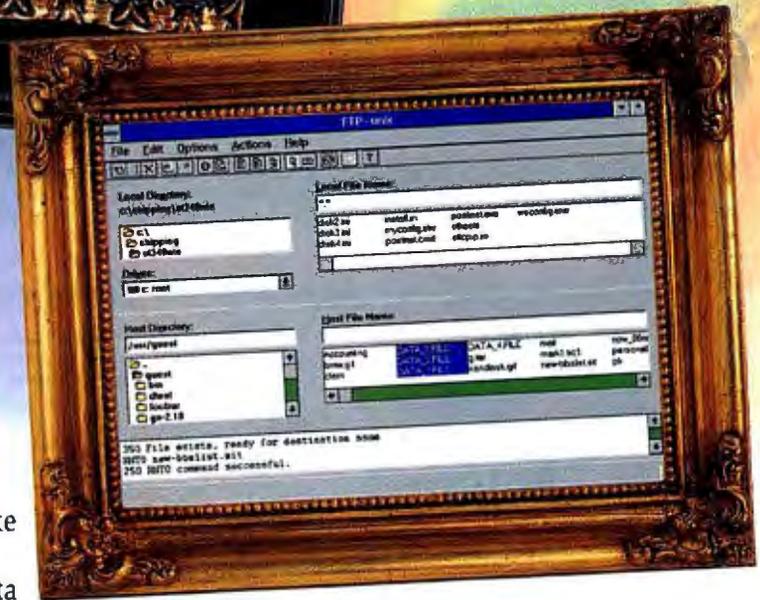
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REVIEWS

sampling fewer pixels—the approach taken by most cameras, including the Pixtura.

Of the three, the QuickTake is the simplest to operate, with fewer display-panel options and controls that are easier to figure out. The cycle time of 4 seconds between shots is faster than that of the DC40. Three AA batteries support only 200 pictures, but an optional external battery pack with eight AA cells can take thousands.

The fixed 50mm-equivalent lens focuses from four feet to infinity, and a snap-on close-up adapter with flash diffuser allows pictures in the 10- to 14-inch range. A parallax-correction lens is included for the view finder, which, like the other cameras, is not WYSIWYG.

Logitech's FotoMan Pixtura

The FotoMan Pixtura and the DC40 cameras are identical in appearance and nearly identical in features. At its default resolution, however, the Pixtura holds 144 pictures in its 4-MB memory, more images than any of the tested cameras. Logitech achieves this by making "standard" resolution 384 by 256 pixels and "high" resolution 768 by 512 pixels, rather than using increased compression as Kodak and Apple do. A memory management quirk shared by the Pixtura and the DC40 is that if you enable the "delete last picture" option, it reduces the capacity for high-resolution images from 48 to 31.

The Pixtura's Digital Eyes software (from Day One) supports a function not included with the others. You can adjust the compression rate for exported JPEG format files on a continuous scale from minimum to maximum, which lets you reduce file size greatly if your application can stand the data loss.

Parting Shot

With improved resolution and image processing, these midrange digital cameras will increase use of digital photography in business and professional applications. We preferred the QuickTake's controls and price; at \$739, it's \$250 under the others. However, the DC40 and Pixtura have a hand strap, higher capacity, and the ability to take additional lenses. Overall, Apple's QuickTake 150 is still the best buy. ■

Alan Morgan, a programmer for 15 years, is a freelance writer and photographer who no longer looks down his nose at digital cameras. You can reach him at amorgan@equinox.ShaysNet.com. Scott Wallace is a former BYTE technical editor who can be reached at editors@bix.com.

Let's Get Small

Super-small and super-smart, new microcontroller development systems are changing the shape of embedded design

RICK GREHAN

Miniaturization has created a new twist in the world of embedded design: The development system is also the target system—you design on the system that you deploy. Your PC becomes the development host and is tethered to the target via a serial cable or a specialized parallel cable.

Four development boards from Blue Earth Research, Micromint, Parallax, and Z-World are indicative of this trend. Such systems can include as few as two chips plus a few glue components for power-supply regulation and communications.

The Stamp

Parallax's Basic Stamp is currently king of the miniature hill. Two chips—one serving as the processor, the other acting as the serial EEPROM—do it all (not counting the support circuitry). It all fits on a 16-pin single in-line package (SIP), which you plug into a carrier board during development. The board is not much bigger than the 9-V transistor battery that powers the whole thing. A special cable connects the Stamp to your computer's printer port.

You program the Stamp in an admittedly anemic dialect of BASIC. But this becomes understandable when you recognize that you're working with just 256 bytes of program space and 14 bytes of variable space.

Parallax has offset the language's limitations, however, with specialized commands. For example, a single Stamp BASIC command can emit a pulse train out of an I/O-port pin (the Stamp has eight of them) with a specified duty cycle.

The Domino Effect

Micromint's Domino-52 comes in a solid epoxy package that looks like an oversize IC (it measures 1.1 by 1.75 inches). Inside is an 80C52 processor with ROM BASIC as well as 32 KB of static RAM (SRAM) and 32 KB of EEPROM (for program storage). A row of 20 pins along the underside provides an 8-bit bidirectional I/O port, a pair of interrupt lines, a serial port, and access to an optional 12-bit, two-channel A/D converter.

As with the Stamp, you program the



The Micro Genius (left) and Xplor-32. Inset: the Domino-52 (left) and Basic Stamp.

Domino-52 by plugging it into a carrier board that provides power regulation and communications hardware. Micromint also offers an optional multiwindowed host-based integrated development environment (IDE), called Host52, that serves as an editor/terminal program.

The BASIC dialect understood by the Domino is BASIC52, a reasonably orderly version that's far more robust than the Stamp's BASIC. It supports floating-point, one-dimensional arrays and a kind of rudimentary string handling.

TECHNOLOGY FOCUS

Serial Chips

Two things consume board space: parts and traces. The two-chip Basic Stamp reduces the parts count about as far as you could—or would want to—go. Minimizing traces is another matter; you have to be able to get data back and forth between the chips.

That's where serial chips help. For example, the 93LC56 serial EEPROM holds 256 bytes, which for most EPROMs would mean eight data lines and eight address lines to the host CPU. On the 93LC56, that's all handled by four wires: one for chip selection, another for the clock signal, and two more for data in and out. A clever designer can multiplex data in and out, bringing the number of wires down to three.

To read a byte, the CPU sends a



command packet to the EEPROM. This command consists of a read op code, followed by the address bits. The EEPROM decodes the command and responds with the 8-bit contents of the requested address. A similar protocol controls write operations. Bits flowing along the data line are synchronized by the clock signal.

Transfers between the CPU and EEPROM can be as fast as 2 Mbps. This is a lot slower than a conventional bus, but plenty fast considering the board-space savings.

Micro Genius

Compared to the other devices in this review, Z-World's Micro Genius is a Hulk Hogan of capabilities. It uses a Zilog Z180 that runs at 6.144 MHz. The Z180 is a descendant of the venerable Z80 processor with mutated abilities that include, among other things, addressing for up to 1 MB of memory.

The Micro Genius can support a variety of memory configurations. Its base version comes with 32 KB of SRAM and 32 KB of EPROM. The EPROM is socketed, allowing the system to support up to 512 KB of EPROM or 256 KB of EEPROM.

The base-model Micro Genius also includes an RS-232 port (used for communications with the host) and a 555 timer IC configured as an analog input channel for measuring external resistance. Without consuming any additional board space, an upgraded version also has a real-time

Product Information

Basic Stamp
With carrier board...\$54
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(916) 624-8333; fax (916) 624-8003
info@parallaxinc.com
Circle 1026 on Inquiry Card.

Domino-52
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Micromint.
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Micro Genius...\$79
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clock and an RS-485 circuit (for building "networks" of Micro Geniuses).

You program the Micro Genius with Z-World's Dynamic C, which includes a full-blown IDE that includes an editor, a C compiler, and a debugger. The IDE lets you open watch windows, evaluate expressions, single-step through the executing program, and even examine CPU registers.

Dynamic C is an extended version of C. For example, it supports *costatements*, types of constructs that allow cooperative multi-threading. The number of routines and libraries provided is stunning; the package even includes two real-time kernels.

Exploration

Blue Earth Research's Xplor connects to your PC via the serial port. Programming the Xplor is simply a matter of firing up a communications program and entering BASIC code. Once you've entered and debugged your program, that's all there is to it; the code is automatically saved in the Xplor's on-board 4-KB EEPROM. Turn off the Xplor, install it wherever it needs to be, and the next time power is applied,

the Xplor executes your program.

I tested the lowest member of the Xplor family tree: the Xplor-32. Its rudimentary I/O hardware consists of 12 digital I/O lines.

The capabilities of the Xplor's version of BASIC fall somewhere between the Stamp's and the Domino-52's. The Xplor's BASIC understands integers only and has no concept of strings or arrays. It provides a set of commands for controlling program flow, as well as special functions for reading the system's built-in A/D converter (functions that are not available on the Xplor-32) and returning the frequency of a wave form at one of the input pins.

Little Is Big

If you do embedded design, these little systems mean big savings. You don't have to spend money on in-circuit emulators, ROM emulators, EPROM burners, and so forth. All you need is a relatively modest PC and some extra space on your desk. ■

Rick Grehan is a senior technical editor for BYTE reviews. He can be contacted on the Internet or BIX at rick_g@bix.com.

URGENT—YOUR INPUT NEEDED

On: Data Communications and Voice Networking

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like your feedback about what topics, areas, and products we should be considering. Early next year, we plan to take a look at where data and voice communications are heading. How much further can we go with analog phone lines and modems before we switch to digital? How about wireless and cellular modems, cable modems, and set-top boxes? What's happening with simultaneous/alternating voice and data. ISDN is starting to arrive, but getting and using it isn't easy, and we're still waiting for asynchronous transfer mode (ATM). What are the real costs of all these new services? These are complex questions. To do them justice, we'd like to know what you're interested in. We want to hear your ideas and find out about concerns that we may not fully appreciate or be aware of. Also, we'd like your help in knowing who are the people we should be talking to.

To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the <FIELDNAMES> with their angle brackets, followed by your information and comments. And thanks very much for your help.

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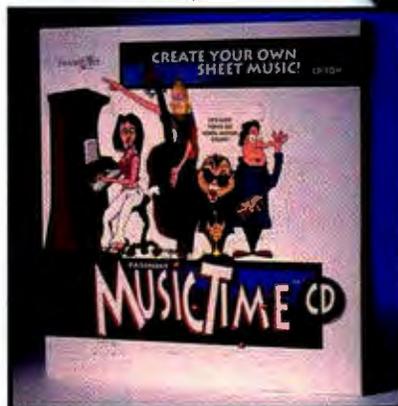
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Jennifer Lane is a 17 year old high school student from southern California. She has placed fourth in the prestigious nationwide Composer's Guild Composition Contest, as well as winning three separate awards from the Disneyland Creativity Challenge™ Contests.

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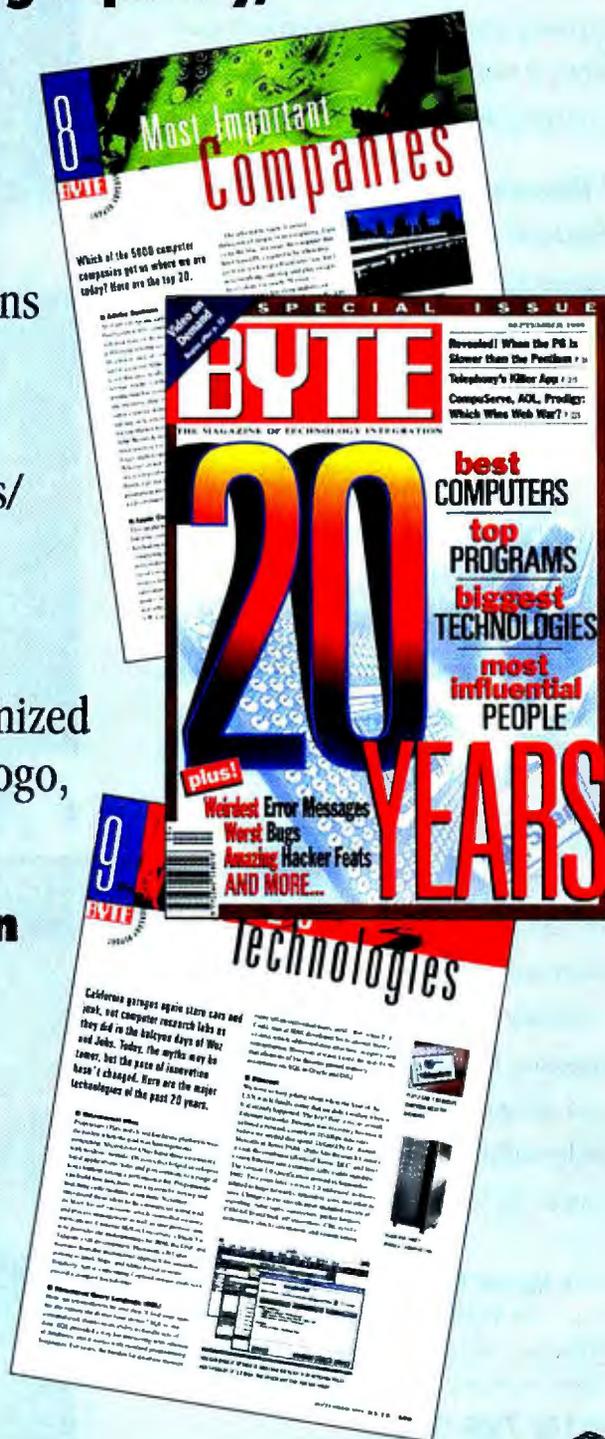
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Industrial-Strength Fax Servers

Six high-end network programs offer company-wide faxing and enough throughput for an entire fax-based business

**REX BALDAZO, DAVID ESSEX,
AND STAN MIASTKOWSKI**

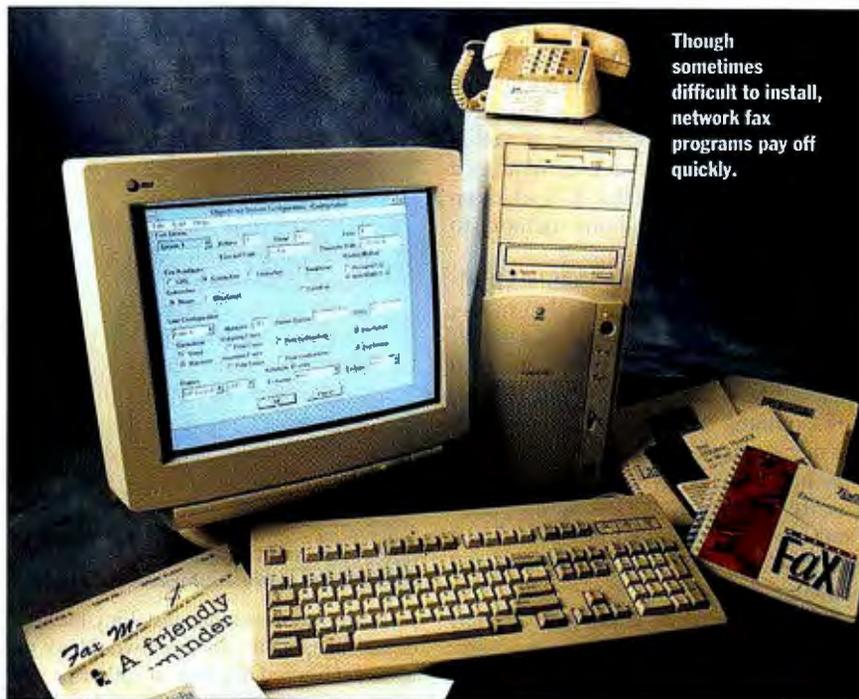
High-powered, server-based fax software can bring faxing to every network user. By placing the fax boards and telecommunications software in a central location, companies can provide the same functions that would otherwise require more costly individual setups.

Networked DOS/Windows fax programs divide broadly into two categories: low-end/client-based and high-end/server-based applications. In this review we evaluate solutions based on dedicated servers that can use several multiline fax boards to handle hundreds of faxes per hour. We're talking about units that can serve, say, 1000 employees during business hours, then broadcast 2000 revised price lists to customers overnight.

To judge overall quality, we considered ease of installation, ease of use, upward scalability, robustness of administrative features, and compatibility with the widest possible range of fax boards and network OSes. Ignoring reports about the difficulty of installing these complex programs, we set out to do six in one month, learning our lessons the hard way. War stories follow...

FACSys

Optus Software's FACSys 3.40a, a DOS-based fax server for NetWare, packs a surprising number of features and excellent



Though sometimes difficult to install, network fax programs pay off quickly.

performance into a \$995 package.

Installation was remarkably easy. In less than 20 minutes (not including the time it took to set up the fax board), we had FACSys performing its basic functions. After you've logged in to NetWare as a supervisor, FACSys' installation takes care of pesky chores. There's no need to fuss with NetWare's SYSCON or PCONSOLE because FACSys creates its own print queue and grants rights to the group EVERY-

ONE for basic FACSys operation.

One of the most impressive and unique things about FACSys is its wide support of fax devices. Besides the high-performance Brooktrout and GammaLink boards, FACSys supports Intel and PureData units, and all Class 1 and Class 2 fax/modems. Out of the box, it supports up to eight telephone lines and an unlimited number of clients. FACSys also has built-in OCR and built-in E-mail support, including cc:Mail, Novell Groupwise and MHS, and MS-Mail (via MHS only).

Both the DOS and Windows clients include personal and shared phone books and detailed in and out logs (the other five programs offer similar client setups). There's a utility for sending a quick fax, or you can choose the FACSys print queue in Windows Print Manager from your application's print-setup menu.

For its power, FACSys is an excellent value for a small- to medium-size business, especially in view of its wide hardware support and standard features. And it's scalable to larger installations—\$2995 buys a multiple-server version that offers fault tolerance and load balancing to handle huge amounts of fax traffic.

continued

The Many Ways to Send a Fax

Network faxing comes in four different flavors:

Low-end to mid-range software. Adds fax functions to existing networks. Some are little more than fax modem-sharing utilities. Includes NetWare NLMs that are somewhat scalable for high-end use. Major players: Delrina's WinFax Pro for Networks and Cheyenne's FaxServe.

Mid-range to high-end software. The focus of this review. Often used for mission-critical applications such as broadcasted price updates. Major players: FACSys, LanFax, RightFax.

Hardware/software bundles. Nice for avoiding the pain of software configuration, turnkey systems are available in all the major capacity ranges. Major player: OAZ Communications' Netfax.

Black box solutions. No monitor, hardly any software-installation issues. A neat little box is the server. Major players: Castelle's FaxPress (pictured), U.S. Robotics' Shared Access.



Fax Resource

Resource Partners' Fax Resource runs its server software on Windows instead of in DOS. The server machine can then launch other applications, even faxing from an application running on the same machine as the fax server. Unfortunately, the reality falls short of the potential.

The main hurdle is DOS's 640-KB memory barrier. Naturally, we had to load the various NetWare drivers to put the server on the network. Then we wanted to load the CD-ROM device driver, as well as MSCDEX. The fax server itself requires a large number of file handles. It all added up to insufficient conventional memory to run Windows.

Eventually, by putting DOS's MEMMAKER utility into aggressive mode, foregoing the CD-ROM driver, and tweaking the Fax Resource INI file manually to disable EMS, we were able to get Windows running. But all that did was push our memory problem into Windows, which now had insufficient resources to run the Fax Resource server. Getting desperate (and mad), we installed PC-DOS 7 and ran RAMBOOST, which finally freed enough memory.

The Fax Resource client software lets you print from any Windows program. Address books are in Microsoft Access MDB format, and you are free to create as many as you want. Installing the client

Only Power Servers Need Apply

We tested the six fax server programs that are best able to grow into high-volume, mission-critical applications. Thus, we didn't test some well-known products, such as Delrina's WinFax Pro for Networks and LANSource's Faxport, that are designed more to add client-level fax features than to undergird a high-volume, fax-based business.

To narrow the field further, we looked for software that runs on NetWare networks (though most also work with Microsoft LAN Manager, IBM LAN Server, and others). Our criteria also specified that all of the programs must run on GammaLink's GammaFax boards, the de facto standard for high-end fax systems, though many also support coprocessor-equipped boards from Brooktrout and PureData.

We didn't test an important subcategory of fax server software, NetWare

NLMs, such as Cheyenne's FaxServe. Detractors say some network administrators are leery of hanging extra hardware onto their main servers. Both Cheyenne and competitor Tobit Software have taken steps to address these concerns. Supporters say NLMs are cheaper and more NetWare-saavy.

We installed the programs on a pre-release AT&T Globalyst, a 133-MHz Pentium tower with 16 MB of RAM and an 853-MB hard drive. The server machine was connected to our corporate Novell network via thin Ethernet. We used V Communications' System Commander to choose MS-DOS 6.22, PC-DOS 7, or OS/2 Warp at bootup.

The fax board we used for our testing was a high-end GammaLink GammaFax CP4/LSI, stocked with four analog ports, each configurable for either inbound or outbound traffic.

software was easier than installing the server package, but the software would not run until we figured out how to authorize user access. (Similar hurdles cropped up when we installed LanFax and Net Satisfaction.)

Fax Resource needs some work. We like the Windows server idea, but the drivers need to be smarter about memory. Given time and revision, this could be a good product. *continued*

TECHNOLOGY FOCUS

Inside CSID

Most fax machines transmit a Call Subscriber ID (CSID) calling string with the faxes they send. The CSID value can be programmed into the fax machine or entered into a field from the fax software. This subscriber ID is intended to label the specific fax machine, but you can use the string to support different methods of automatic routing.

For CSID routing, the fax software builds a table that associates CSID strings to network nodes or E-mail addresses. The software captures the string, then routes the fax to the associated network station or sends the fax via E-mail. The table can also associate a group of recipients to a single CSID.

With CSID, you can set up two basic types of automatic routing:

- If you are the only one in your organization who receives faxes from a specific fax machine (perhaps a sup-

plier or a client who works only with you), your administrator could associate the client's CSID to your network or E-mail address. The fax software would then automatically route any faxes from this machine to you.

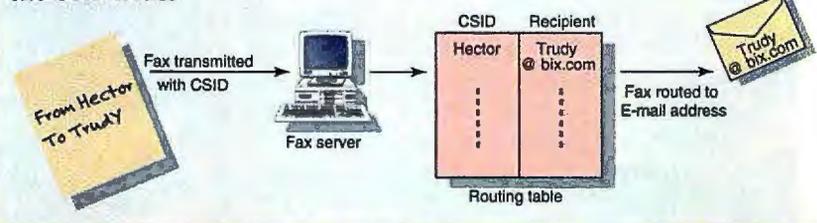
- You could also employ a more creative CSID routing method. The administrator could assign CSID strings to specific network addresses or to a group of addresses. When someone wants to send you a fax, you would tell them the CSID code to input. The sender then

would change the CSID field (if sending via software) or reconfigure the hardware to transmit the proper CSID. The routing table would capture the designated string and send the fax directly to you or your workgroup. In effect, you would have your own routing code.

This will work well as long as the sender knows how to change the CSID at his or her end.

Call Subscriber ID (CSID) routing associates the sender with a fixed E-mail address. Most fax machines transmit a CSID calling string.

The CSID Route





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RightFax is the only product we tested that runs OS/2 on the server. The operating system's preemptive multitasking allows more flexibility in placing file and fax server components on different servers.

LanFax

In a roundup plagued by installation problems, Alcom's LanFax was the worst offender. Once you get past its sore spot, though, LanFax reveals a power and versatility that show why it remains a popular choice for industrial-strength applications.

LanFax requires 550K of conventional RAM, an unrealistic requirement in an environment where loading network drivers high can create other problems. We modified EMM386 parameters to include some memory areas recommended by the manual and ended up with 520K. We were then able to run the LanFax server program—that is, after hours of flipping through manuals; editing DOS configuration files; searching for, modifying, and creating special configuration files; sec-

ceiving faxes. Notification of incoming faxes is clear and intuitive, with point-and-click access to a fax viewer.

LanFax comes with an array of traffic-management, fax, and other communication features. It can work alongside other packages, such as Delrina's WinFax Pro and Cardiff's Teleform. Programmers will appreciate the API access to DOS/Windows libraries and Windows DLLs.

With a capacity of 8000 users and 32 lines per server, LanFax is built for large installations. It's a technically impressive product with a multitasking design that allows parallel task processing,

and-guessing instructions; and so on.

To set up the client software, we had to load a runtime version of Borland's Paradox and use it to call .DB files that the installation program had not placed where the manual said they would be. We then were told

to run a network communication TSR. Ultimately, we brought up LanFax's Windows client and were now quickly

sending and receiving

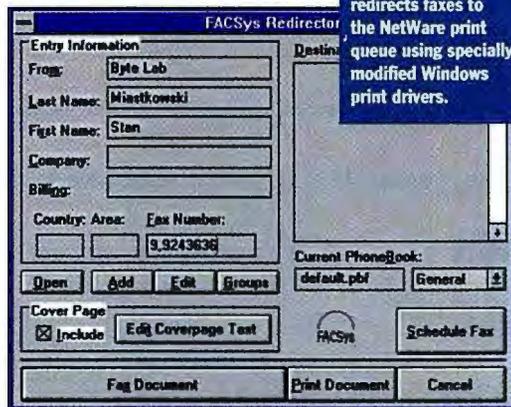
and it has transport-layer support for network operating systems. But its size and complexity could scare off customers with somewhat less ambitious plans.

Net Satisfaction

Version 3.0 of Delrina's Net Satisfaction adds support for GammaLink GammaFax boards, though the program's 1000-user, eight-line capacity exposes its background as a midrange product. Delrina, which acquired the software from Intel after our testing was completed, plans to add its WinFax front end to the next major upgrade of Net Satisfaction.

Delrina's installation software and supporting documentation are the best of this group. The program guides you in the prop-

Optus's FACSys Redirector dialog box pops up over third-party applications. The program redirects faxes to the NetWare print queue using specially modified Windows print drivers.



Fax Routing: You Can't Get There from Here

Fax routing is a huge problem for fax vendors and for enterprises implementing network-based faxing. All fax server software offers at least the first three options listed below.

Manual in-bound routing is reliable but inconvenient. A person views incoming cover sheets and redirects the fax files using

software. The drawback: labor intensive. **DTMF-based routing** employs the beeps of Touch-Tone phones to transmit numbers that identify recipients. The software sets up dual-tone multifrequency (DTMF) aliases for client workstations. DTMF requires that senders know the recipient's code and can enter it from the fax machine touchpad.

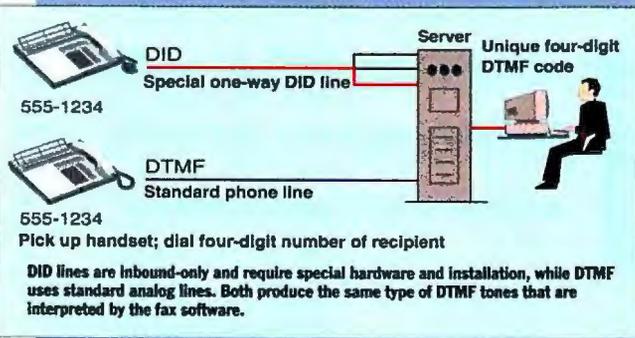
Direct inward dialing (DID) requires a special trunk line that sends faxes directly to the correct recipient using the final four digits of a unique fax number. It is one of the most reliable methods but is expensive because of the extra lines and equipment. **Call Subscriber ID** (CSID) uses a string transmit-

ted to the receiving station. A routing table associates the CSID with the proper network or E-mail address.

Line routing (or channel routing) is the simplest, most reliable, and usually most expensive approach. Requires a separate phone line for each recipient or workgroup. **OCR** reads the recipient's name from the cover sheet and exports it to the server's user database. Matching the OCR engine's guesses against the database of network users can improve the odds.

T.30 subaddressing uses coding contained in the T.30 protocol for fax transmission. Potentially the best combination of affordability and reliability, T.30 has not been adopted widely yet.

These are the most popular routing methods. Vendors add their own. Delrina's Net Satisfaction, for example, lets you add the recipient's network user name.



Network Faxing... The Next Generation

Marc Blanaire & Andrea Quesnelle

With the recent release of Windows95 and of WindowsNT, network faxing is evolving, and with it emerges the next generation. So how to define the "next generation" of network fax products? Two main factors emerge: usability (including re-usability) and tighter integration, with both the network and the desktop.

User needs... user costs...

Training costs and usability are major considerations when selecting a network fax solution. How much time will it take to bring users up to speed? Will they use all of the available features? Start by selecting the right user interface - one that is well laid out and simple to follow, such as FAXport from LANSource Technologies. When seeing FAXport for the first time, most users are already "familiar" with how it works, as the user interface seems to neatly mesh the best of most every single-user fax software.

One Button Faxing. Since many users often forget to change the printer driver or simply don't know how to, faxing should be as easy as pressing ONE button. FAXport does this admirably, by including a FAXmenu button on screen that automatically selects the fax-printer driver without changing the default. This saves time and frustration.

Integration... Integration...

Next generation network faxing must be able to integrate and customize fax functionality into various desktop applications. Next generation network faxing products require OLE Automation, DDE, and a DLL API to provide all fax functions from send, to receive, to status updating. FAXport provides all three

APIs. With over 140 OLE Automation functions available and using, say, Visual Basic as your scripting language, you can tightly integrate network faxing into various applications.

WinFaxTM Compatibility. Like it or not, WinFax has a large market share, and many users have it installed on their PCs. Any network fax solution should also include the best features of this software, but more importantly, be able to read WinFax phonebooks, view WinFax images and even use WinFax DDE links. FAXport does exactly that only better; it's a true network FAX Server solution. With FAXport, a corporate solution has no holdouts, making it easier to administer.

UNC Support. With WindowsNT and Windows95 comes the need to support UNC (Universal Naming Convention), i.e.: the means by which to replace drive mappings with the actual location of the files. Think "\\Server\volume\filename" instead of "H:\Filename". This becomes very useful when you know where a file is but not on what drive.

ODBC Compliant Phonebooks. Next generation network faxing should allow use of almost any data source as a fax phonebook. That means ODBC! FAXport's ODBC Mapping program, allows you to MAP any ODBC database (datatable to the purest) to a FAXport phonebook. The three table design displays the FAXport phonebook format, a link column, and the ODBC table format. This ingenious design lets you drag & drop the data field into the link column to match the FAXport phonebook format.

More & more & more faxing

Bulk faxing is an increasingly necessary, albeit painful, marketing tool in many companies. A next generation fax product has to make this task accessible to all as easily as sending a single fax. The fax server should do all the work - generating

individual cover pages, adding network attachments, sending at the optimum time, all with meaningful reporting. In this way, it increases sales potential and customer satisfaction. FAXport does exactly that. Users can send bulk faxes the same way they'd send a single fax; the only difference is that you select one or many phonebooks, instead of a single address, as the destination.

The next generation fax product must include an advanced Cover Page/Form Designer, that is OLE 2.0 enabled and capable of customizing faxes by inserting fax phonebook fields that the fax server can then read and fill. It must also allow you to add custom entry fields, related to a database of your choosing, in order to create the right form for faxing. FAXport's Cover/Form Page Designer provides all of these capabilities.

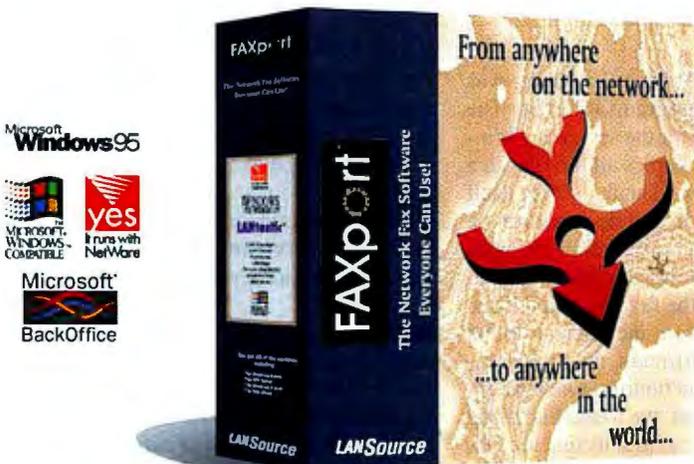
The 32 bit world

For the corporate network, reality has evolved into a 32 bit world, with WindowsNT and Windows95 at its centre. Ironically, not all fax softwares have a 32 bit version, let alone a 32 bit fax server that runs as a service on NT. FAXport, however, provides these, as well as a 32 bit client software for both Windows95 and WindowsNT, and even a great Windows version for those who choose to live in a 16 bit world a little longer.

Overall, next generation network fax software needs to integrate more with the changing reality both on the network and on the desktop. LANSource Technologies Inc.'s FAXport is an excellent example of a next generation product that addresses these factors effectively, at a very competitive price. A 5 user, 4 modem version starts at only US\$399. ■

Andrea can be reached at andrea@lansource.com

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FAX SERVER FEATURES COMPARED

	FACSYS	LANFAX	NET SATISFACTION	OBJECTFAX	FAX RESOURCE	RIGHTFAX
ADMINISTRATION						
Event log is exportable	●	●	●	●	●	●
Fax board is software configurable	●	●	●	●	●	●
Supports passwords for inbound faxes	●	●	●	●	●	●
Has integrated billing module	●	●	●	○	○	●
FAX						
Major boards supported (B=Brooktrout, G=GammaFax, I=Intel, P=PureData)	B, G, I, P	G, I, P	G, I, P	B, G	G, I, P	B, G
Maximum number of users/lines	Unlimited/8	8000/32	1000/8	4096/32	Unlimited/160	Unlimited/24
Supports binary file transfer	●	●	●	○	○	●
NETWORK						
Networks supported	NetWare	NetWare, LAN Manager, LAN Server, LANtastic, Vines, etc.	NetWare	NetWare, LANtastic, Vines, Pathworks, etc.	NetWare, LAN Manager, LAN Server, LANtastic, NT, etc.	NetWare, LAN Server
Handles image conversion on server	●	●	●	○	●	●
Allows remote installation of client software	●	●	●	○	●	●
Client OSes	DOS, Windows	DOS, Windows	DOS, Windows	DOS, Windows	DOS, Windows	DOS, Windows, OS/2
ROUTING						
CSID	●	●	●	●	●	○
DID	●	●	●	●	●	●
DTMF	●	●	●	●	●	●
Line (channel)	●	●	○	●	●	●
OCR	●	○	●	●	○	●
T.30 subaddressing	●	●	○	●	○	○
SERVER						
Operating system	DOS	DOS	DOS	DOS	DOS/Windows	OS/2
Minimum CPU	286	386	386	286	20-MHz 486SX	386
Minimum RAM	2 MB	8 MB	3 MB	640 KB	4 MB	12 MB
Minimum hard disk capacity	— ¹	100 MB	40 MB	30 MB	80 MB	200MB
WORKGROUP						
Builds phone book from NetWare Bindery	●	●	○	○	○	●
Number of E-mail protocols supported	2	4	— ²	3	4	4
Supports MAPI	○	●	○	●	●	●
Supports MHS	●	●	○	○	○	○
Supports VIM	●	●	○	●	●	●

Yes = ● No = ○

¹ Faxes are stored on NetWare file server.

² Available via third-party CAS gateways.

er order through all the required steps. The administrative module is straightforward and lets you establish user privileges by choosing names in a list imported from the NetWare Bindery.

While far less feature-rich than LanFax or RightFax, Net Satisfaction nonetheless has numerous features that mark it as a contender for mission-critical operations. It supports direct inward dialing (DID) (see the text box "Fax Routing: You Can't Get There from Here" on page 140), and it comes with billing options that are useful for setting up a fax-based line of business. Its unique drawback: minimal support for E-mail.

ObjectFax

ObjectFax, from Traffic Software, was one of the easiest programs to set up. The installation module for the server is a Windows program that copies all the files to a NetWare file server. (The fax server itself is a DOS application and does not run on the file server.) The installation program also sets up a Windows administrator program to configure the fax board and lines.

The client software includes an inbox toolbar; for administrators, the toolbar includes configuration buttons. Once we installed it on the client, we found that using ObjectFax is as simple as selecting the ObjectFax printer and printing. From a float-

ing toolbar, you can call a simple text editor to fax a short note. You can even create standard attachments that are then available from the program's toolbar.

While ObjectFax directly supports only DOS and Windows clients, an API option allows the enterprising programmer to access the fax server from any platform connected to the file server.

RightFax

A full-fledged multitasking, multithreading native OS/2 application, RightFax is designed for serious high-volume faxing in medium-to-large organizations. That target market is most evident from its pricing:

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\$995 buys you a very basic one-telephone-line license. Each additional line costs \$795. It can add up quickly. For example, a four-line RightFax installation with OCR and E-mail support costs \$5970, and that's not counting hardware.

Because of OS/2's true preemptive multitasking, you can install RightFax along with an OS/2 NetWare server, E-mail or voicemail server, or put all of them on the same system. You can also install RightFax in a file server configuration (whether on the same or different hardware as your NetWare). A file server installation supports fax annotation, which isn't available with a dedicated fax server. However, resource and performance issues make a dedicated fax server the best bet for all but the smallest installations.

RightFax posed another difficult installation. You need the latest version of the NetWare Requester for OS/2. Even if you already have it, you'll probably need to reinstall it to make sure it's set for Global NetWare Shell Support and both client and server support. But that's just the beginning. You also must have NetWare Administrator privileges. And you need to fiddle with both SYSCON and PCONSOLE before installing the RightFax software, setting up a RightFax user account and establishing a print queue. Unlike FACSys and Net Satisfaction, RightFax doesn't do a quick basic installation that you can dink with later.

Installing the client is simple. In Windows, RightFax has the handy PowerBar (see the screen on page 140). This is a floating and customizable icon bar that

gives you quick access to a phone book, in/out box, and a utility for almost-instant faxing. The PowerBar has icons to instantly switch between your default printer and the RightFax queue. You can also drag and drop document icons onto the fax icon in the PowerBar.

RightFax has extensive support for use of billing codes. You can even prevent people from sending faxes unless billing codes are entered.

Playing Favorites

When we judge all six programs by our general criteria of user friendliness and upward scalability, Optus' FACSys pulls ahead of the pack. Its rich hardware compatibility, ease of use, and tight integration make it a comfortable fit for most applications. FACSys appears to do the best job of accommodating both mid-range network faxing and high-end, mission-critical applications. Adding cards and servers lets FACSys scale up as demand grows. FACSys works only with NetWare, but a Windows NT version provides wider network compatibility.

Following a close second is Traffic Software's ObjectFax. It sports the best-looking client interface, a fairly advanced object orientation to faxing, and an API that we may use someday to provide interoperability with our Macintosh clients. ■

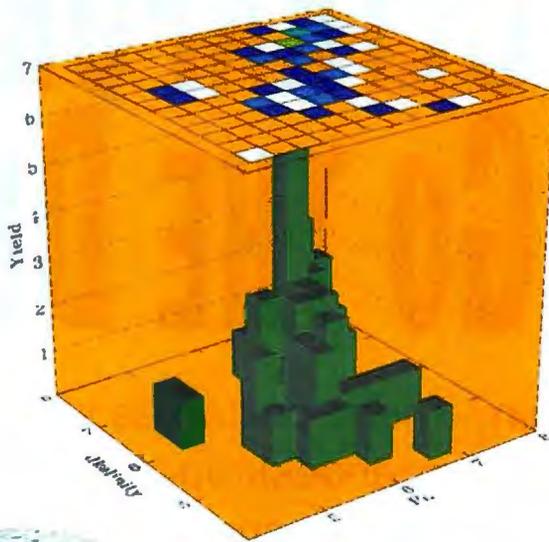
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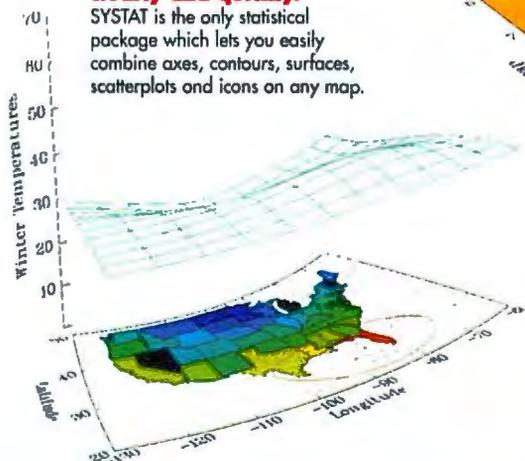
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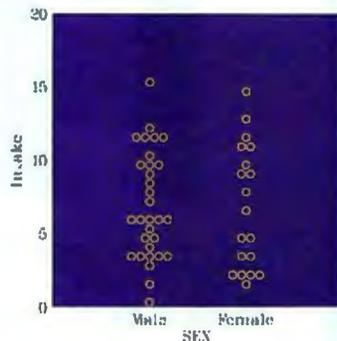
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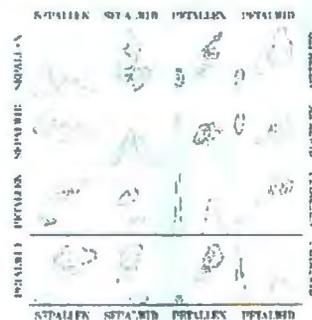
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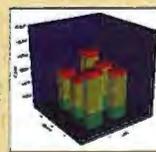
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HANDS-ON TESTING

11 ULTRAPORTABLES GO THE DISTANCE

On the road again? These portables weigh in at about 6 pounds and offer near-desktop-level performance, great displays, large hard drives, and loads of useful features.

ANTHONY J. LENNON AND JOHN MCDONOUGH

They say the universe is expanding, but hardened road warriors know better: Time and space seem to converge when you're working in cramped quarters while in transit. With this in mind, we tested 11 ultraportables that provide near-desktop performance while you're in the back seat of a cab or flying above the clouds. These ultraportables may be petite machines, but they don't suffer from the features-deprivation complex that afflicted their subnotebook predecessors. Some of the systems we tested are resplendent with color active-matrix displays, zippy Pentium CPUs, and hard drives with over 500 MB.

Ultraportables have their drawbacks (e.g., most require external floppy drives), but they are catching up to heavier notebooks in terms of functionality. Battery life is getting longer (3½ hours on average; Hewlett-Packard's OmniBook 600CT lasted an incredible 5 hours and 46 minutes in the Thumper II tests), as many vendors migrate from nicad batteries to nickel-metal-hydride (NiMH) and lithium-ion batteries.

The majority of these ultraportables house Intel's SL-enhanced 486DX4 processor (either 75 or 100 MHz), and four of them have active-matrix displays. As a rule of thumb, expect to spend at least \$700 more for a system that has an active-matrix

How to use this guide

We selected the best ultraportables by evaluating their price, speed, screen quality, battery life, features, and ease of use.

See the Roll Call on pages 164-165 for features included at this price.

A combination of the weighted scores for performance, screen quality, features, battery life, and usability.



Digital HiNote Ultra CT475

At 5.6 pounds with all its accessories, the HiNote Ultra CT475's 9½-inch active-matrix LCD gets the highest screen rating with deep yellows and dark blacks in our color-bar tests. Testers liked its unique trackball design (see "Honorable Mentions" on page 163) and the upright status LCD located to the right of the screen instead of below it. The HiNote's lithium-ion battery pack (4 hours and 40 minutes—second best overall) conveniently clips on the rear of the system, and Digital's optional Mobile Media Module (\$599) turns the HiNote into a multimedia notebook. Its only drawback is a \$4999 price tag.

	PRICE AS TESTED	CPU/SPEED	OVERALL		EASE OF USE	SCREEN QUALITY	BATTERY LIFE (HR:MIN:SEC)
			SCORE	FEATURES			
DEC HiNote Ultra CT475	\$4999	486DX475	▲▲▲	▲▲▲	▲▲▲	▲▲▲	4:30:55
Gateway 2000 Liberty DX4-100 DL	\$4499	486DX4100	▲▲▲	▲▲▲	▲▲▲	▲	4:15:12
HP OmniBook 600CT	\$3999	486DX475	▲▲▲	▲▲	▲▲▲	▲▲▲	5:46:10
Zeca Meridian 400A	\$3495	486DX4100	▲▲▲	▲▲▲	▲▲▲	▲▲▲	2:29:49
IBM ThinkPad 701C	\$4599	486DX475	▲▲	▲▲▲	▲▲	▲▲▲	2:08:32

Key: Ratings from 1 to 4; ▲ is the lowest; ▲▲▲▲ is the highest.

A subjective assessment of the keyboard layout and feel, pointing device, status lights, and other considerations.

Based on BYTE's Thumper II battery run-down test.

This rates the display's crispness, intensity and color range, and range of viewing angles.

Lightweights with a Punch

LCD

The days of monochrome displays are gone—color rules, and active-matrix LCDs produce the most striking tints and hues. Systems with passive-matrix and dual-scan displays are much cheaper, but you lose some pizzazz.

ADJUSTABLE FEET
Many ultraportables have adjustable feet that let you angle the keyboard to a comfortable typing position.

BATTERY
Ultraportables with lithium-ion batteries generally outlast those with nicad and nickel-metal-hydrate (NiMH) batteries, but the latter are less expensive.

REMOVABLE HARD DRIVE

Some ultraportables have a modular design that makes it easy to swap hard drives and upgrade when necessary.

EXTERNAL FLOPPY DRIVE

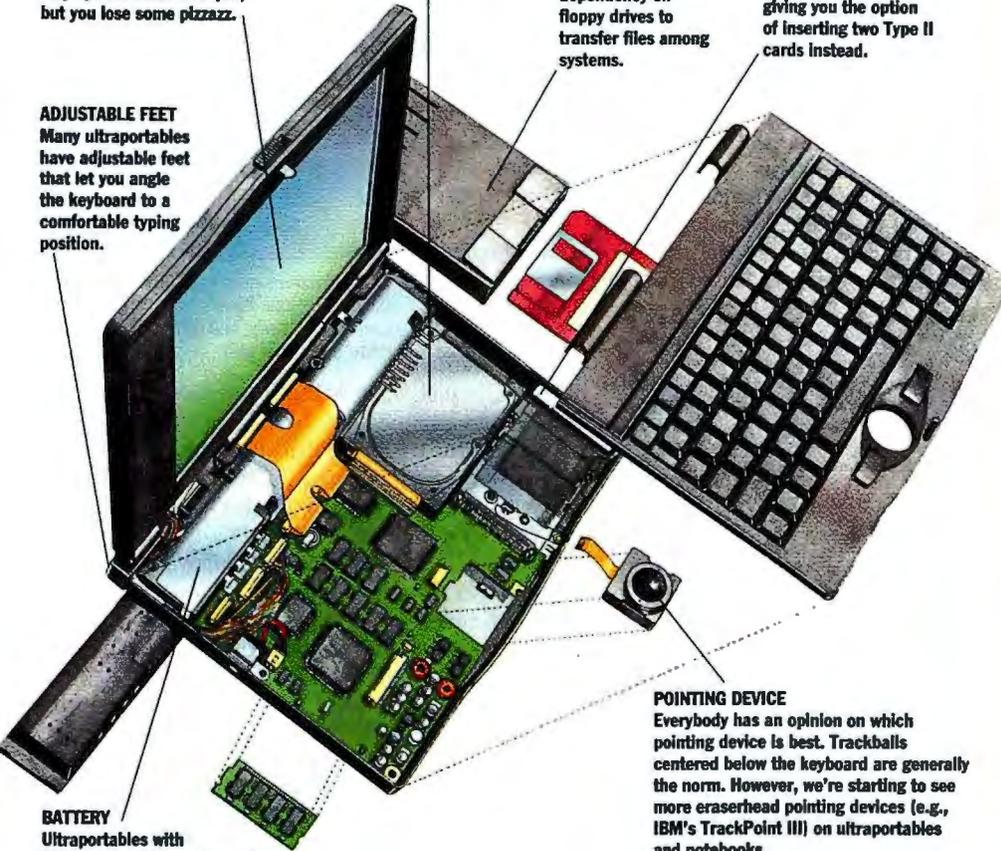
A necessary evil with most ultraportables. The Internet and networks, however, are decreasing our dependency on floppy drives to transfer files among systems.

PC CARD SLOTS

All but four of these ultraportables support one Type III card, giving you the option of inserting two Type II cards instead.

POINTING DEVICE

Everybody has an opinion on which pointing device is best. Trackballs centered below the keyboard are generally the norm. However, we're starting to see more eraserhead pointing devices (e.g., IBM's TrackPoint III) on ultraportables and notebooks.



OCTOBER 1995
BYTE
BEST
ULTRAPORTABLES

BEST

BEST HIGH-END ULTRAPORTABLE

Digital Equipment HiNote Ultra CT475

If you've got the money (\$4999), Digital's HiNote Ultra CT475 is the perfect travel companion. Its 9½-inch active-matrix display produces vibrant, fully saturated colors—the best in our screen-quality tests. This ultraportable with a 75-MHz 486DX4 has a lithium-ion battery pack that powers it for over 4½ hours in our Thumper II battery run-down test. The system has 16-bit sound and supports an optional multimedia module for business presentations.

PAGE 148

BEST LOWER-COST ULTRAPORTABLE

AT&T Globalyst 130

This ultraportable looks more like a notebook system with its integrated floppy drive and 10.4-inch, passive-matrix LCD. It didn't do well in our performance benchmarks, but it lasted about 4 hours in the Thumper II test. The Globalyst has easy-to-read status indicators, a wide viewing angle, a large trackball, and an expansive wrist rest. Its \$2223 price won't give you sticker shock.

PAGE 150

display than one with a dual-scan display. Active-matrix displays usually give you a wider viewing angle and fill the screen with brighter colors.

Constrained by such a small form factor, vendors have come up with some unique designs. The keyboard of IBM's ThinkPad 701C literally jumps out at you, the mouse on HP's OmniBook pops out the side, and several systems have infrared ports that let you transfer files with your desktop system, sans serial cables.

These innovations don't come cheap, however. The average price of an active-matrix ultraportable in this report is \$4273. The Compaq Contura Aero 4/33C Model 250 and the Sceptre Technologies TS37 Sub-notebook dip below \$2000, but they don't have as many features as the higher-end systems.

Because vendors had difficulty squeezing their sys-

tems through our tight testing criteria, we reviewed fewer machines than normal. To be included, an ultraportable had to weigh 5 pounds or less without accessories or about 6 pounds with accessories (e.g., an AC adapter, a floppy drive, a battery, and so on). It had to have at least a 25-MHz 486SX CPU, 8 MB of RAM, a 200-MB hard drive, a color display, a 3½-inch floppy drive, and an integrated pointing device.

We divided the systems into two categories: high-end ultraportables priced above \$3000 and the lower-cost alternatives. Our performance tests use Windows and DOS applications, such as Word, Excel, WordPerfect, and FoxPro, that measure how fast these featherweights are in real-world situations. The low-level InterMark suite tests stress system components, such as graphics and storage subsystem components under Windows.

High-End Ultraportables

We tested five high-end ultraportables that should reduce a road warrior's fears about taking to the streets. These systems cost you dearly at \$3495 or higher, but they all feature 486DX4 processors, and all but the Gateway 2000 Liberty DX4-100 Deluxe have active-matrix displays.

What Gateway's Liberty lacks in screen quality, however, it makes up for in performance by surpassing all the others in our high-level InterMark benchmarks. The Liberty is truly built for speed, with 24 MB of RAM and a 100-MHz 486DX4 processor. It is also the only one with 256 KB of secondary cache memory. The Zeos Meridian 400A also has a 100-MHz 486DX4 and draws bit-mapped Windows images faster than the Liberty does.

The Liberty has an expansive, 10.4-inch dual-scan LCD that

surprisingly scored lower than many passive-matrix displays in our screen-quality tests. Testers believed that its colors were somewhat washed out in our color-bar test. The remaining high-end ultraportables did much better in the screen-quality tests, thanks to their active-matrix LCDs.

We were also impressed with the unique designs of



Clockwise from lower right: IBM's ThinkPad, Digital's HiNote, Zeos's Meridian 400A, Gateway's Liberty, and HP's OmniBook display NSTL's color-bar test.

the ultraportables. IBM's

ThinkPad

701C, which was held back by its short battery life (2 hours and 9 minutes), has a TrackWrite keyboard (known as Butterfly) that slides out and extends over the edges of the chassis. The 85-key keyboard is surprisingly firm to the touch. Our winner in this category, the slick-looking Digital Equipment HiNote Ultra CT475, features a Floppy Dock, which houses a 3½-inch floppy drive and connects underneath the HiNote; it angles the keyboard, increasing typing comfort. Also, the HiNote, the ThinkPad 701C, and the Hewlett-Packard OmniBook 600CT have built-in sound with high-quality speakers, and the latter two have built-in microphones.



Digital HiNote Ultra CT475

At 5.6 pounds with all its accessories, the HiNote Ultra CT475's 9½-inch active-matrix LCD gets the highest screen rating with deep yellows and dark blacks in our color-bar tests.

Testers liked its unique trackball design (see "Honorable Mentions" on page 161) and the upright status LCD located to the right of the screen instead of below it. The HiNote's lithium-ion battery pack (4 hours and 40 minutes—second best overall) conveniently clips on the rear of the system, and Digital's optional Mobile Media Module (\$899) turns the HiNote into a multimedia notebook. Its only drawback is a \$4999 price tag.

	PRICE AS TESTED	CPU/SPEED	OVERALL SCORE	FEATURES	EASE OF USE	SCREEN QUALITY	BATTERY LIFE (HR:MIN:SEC)
DEC HiNote Ultra CT475	\$4999	486DX4/75	▲▲▲	▲▲▲	▲▲▲	▲▲▲▲	4:39:55
Gateway 2000 Liberty DX4-100 DL	\$4499	486DX4/100	▲▲▲	▲▲▲	▲▲▲	▲	4:15:12
HP OmniBook 600CT	\$3999	486DX4/75	▲▲▲	▲▲	▲▲▲	▲▲▲	5:46:10
Zeos Meridian 400A	\$3495	486DX4/100	▲▲▲	▲▲▲	▲▲▲	▲▲▲▲	2:29:49
IBM ThinkPad 701C	\$4599	486DX4/75	▲▲	▲▲▲	▲▲▲	▲▲▲	2:08:32

Key: Ratings from 1 to 4; ▲ is the lowest; ▲▲▲▲ is the highest.

THE INCREDIBLE SHRINKING PENTIUM

A laptop can never be too fast nor weigh too little. Toshiba America Information Systems (Irvine, CA, (714) 583-3000) has applied both these lessons well in designing the Portégé 610CT.

Like the Dell Latitude XPI P90T (see "Impressive Battery Life in a Laptop Pentium PC," September BYTE, page 286), the Portégé 610CT uses Intel's low-power Pentium clocked at 90 MHz. The 610CT uses extended data out (EDO) RAM, which, in certain circumstances, can improve performance. However, on our BYTEmark native-mode tests (see the chart), the scores were just about on par for a normally

aspirated 90-MHz Pentium. That's not to say the extra expense of EDO RAM is wasted, but our low-level tests did not show a noticeable speedup.

The benefit of a low-power microprocessor was readily apparent in our Thumper II word processing battery-life test. The smaller 610CT bested its big

brother, the T4900CT (4 hours and 25 minutes), running 5 hours unplugged.

Many of the pieces in the 610CT seem familiar—almost ordinary: built-in 16-bit sound and a 9½-inch color thin-film transistor (TFT) display. But this computer is more than the sum of its parts. Somehow, Toshiba has managed to put the equivalent of a full-featured desktop Pentium into an elegant package that weighs under 5 pounds.

This achievement is not without some sacrifices. The floppy drive is an external unit, as is the AC power brick. But the biggest drawback is the tiny keyboard. IBM's magnificent Butterfly keyboard (see "Incredible Expanding Keyboard," May BYTE) has simply set the bar higher, and the Portégé 610CT does not rise to the challenge. A cramped keyboard used to be a trade-off we would accept to gain better portability. Now that someone has shown the world a better way, anything else seems like a step back.

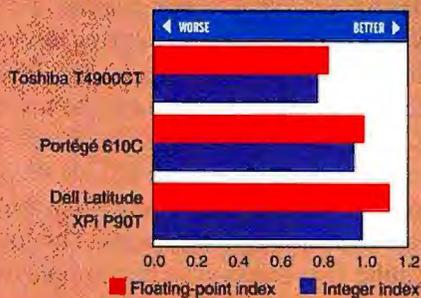
Toshiba has once again delivered an amazing amount of power in a small form factor. Now if the company can just convince IBM to license the Butterfly keyboard, this could be the perfect traveling companion for the mobile professional.

—Rex Baldoza



Toshiba's Portégé 610CT.

Pentium Performance



A Dell 90-MHz Pentium-1.

Product Information

Portégé 610CT
8 MB of RAM, 686-MB hard drive \$464
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Lower-Cost Alternatives

The lower-cost ultraportables we tested averaged \$2100 less than the high-end ultraportables. Four of the systems carry passive-matrix displays, and the other two use dual-scan LCDs. Passive-matrix displays cost less and consume less power than active-matrix displays, but the trade-off is inferior color, lower contrast, and slower video response. Some of the lower-cost ultraportables, however, surprised us when we ran our screen-quality tests.



AT&T Globalyst 130.

The AT&T Globalyst 130 offers the widest viewing angle and plenty of real estate on its 10.4-inch passive-matrix display as measured by NSTL's Heads-Up Range Device (HURD), which determines an ultraportable's maximum viewing angle from left to right and by tilting the screen backward. Both Austin Direct 486 StepLite Notebook models feature 9½-inch passive-matrix LCDs with wide viewing angles, which produced strong color scores. The least expensive models, Compaq's Contura Aero 4/33C Model 250 (\$1199) and Sceptre Technologies' TS37 Subnotebook (\$1695), however, did poorly on the color tests. Also, the Contura Aero's 7.8-inch passive-matrix LCD maxes out at 16 colors.

At \$2795, the Zeos Meridian 400C costs more than the other ultraportables in this category, but its 100-MHz 486DX4 processor powers it to the third-best performance scores of all the products. You pay a price for the speed, however; life gets sucked out of the Merid-

ian 400C's nickel-metal-hydride (NiMH) battery (2 hours and 30 minutes) much faster than the other lower-cost ultraportables (which averaged 3 hours and 36 minutes). At the other end of the performance spectrum are the Sceptre TS37 Subnotebook and the Contura Aero, which use 33-MHz 486SX processors. They dragged through our performance benchmarks but had longer battery lives than that of the Meridian 400C.

The AT&T Globalyst 130, TS37 Subnotebook, Contura Aero, and the two Austin models have trackballs of assorted sizes and placement, while the Meridian 400C has an eraserhead to the right of the handrest with left- and right-click buttons on the front of the chassis. This makes it easy to click with your thumb while keeping a finger on the eraserhead. When it comes to trackballs, we find the bigger, the better.



AT&T Globalyst 130

The AT&T Globalyst 130 looks more like a traditional notebook than an ultraportable with its integrated floppy drive and wide, 10.4-inch passive-matrix display. Nevertheless, the \$2223 ultraportable weighs only 6.1 pounds with all its accessories. AT&T picked its components carefully to make sure its system was affordable, with enough features to satisfy any traveling businessperson. Its long-lasting NiMH battery (3 hours and 52 minutes), 340-MB hard drive, and 75-MHz 486DX4 processor give it respectable performance for road work.

	PRICE AS TESTED	CPU/SPEED	OVERALL SCORE	EASE OF USE	SCREEN QUALITY	BATTERY LIFE (HR:MIN:SEC)
AT&T Globalyst 130	\$2223	486DX4/75	▲▲	▲▲▲	▲▲▲	3:52:28
Zeos Meridian 400C	\$2795	486DX4/100	▲▲	▲▲▲	▲▲	2:20:39
Austin Direct 486 StepLite	\$2407	486DX4/75	▲▲	▲▲▲	▲▲	3:18:33
Austin Direct 486 StepLite	\$2065	486DX4/50	▲▲	▲▲▲	▲▲▲	2:52:15
Sceptre TS37 Subnotebook	\$1695	486DX/33	▲▲	▲▲	▲▲	3:31:48

Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

TOUCHPADS TO NAVIGATE BY

An individual's taste in pointing devices, like music and art, is highly subjective. Some of us love IBM's TrackPoint device, while some can't quite get the hang of it. Touchpads, too, claim devotees and naysayers, but the technology has made some notable advances over the last few years.

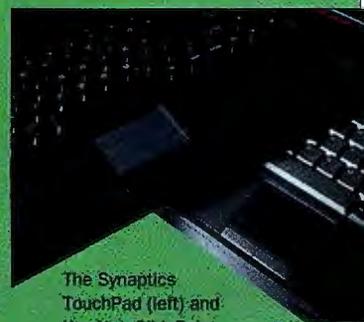
The first widely available touchpad for portables is Alps Electric's (San Jose, CA, (800) 825-2577) GlidePoint (see "Do the Electric Glide," April BYTE, page 203), which uses field-distortion sensing, a capacitance-sensing technology licensed from Cirque (Salt Lake City, UT). The two layers of electrical conductors, arranged in a grid, generate an electrical field over the GlidePoint's surface. Your fingertip distorts the field, and the GlidePoint determines the exact location of your fingertip by sensing the strength of the distortion at each conductor.

For comparison purposes, we tried the Cirque technology on a Sharp PC-8900 that comes standard with a GlidePoint. It takes some getting used to, especially the tapping motions required to trigger mouse-clicks, double-clicks, and click and drag. But once you get a feel for it, the GlidePoint is a natural way to navigate a cursor around the screen. You run into trouble, however, when you're dragging an item and your finger runs into the edge of the pad. With the GlidePoint driver, you can configure the right mouse button to act as a drag-lock key, but that's not the best solution.

An even better answer is the Synaptics (San Jose, CA, (408) 434-0110) TouchPad. The TouchPad also takes advantage of capacitance-

sensing technology, but the company has extended the pad's capabilities with proprietary algorithms for pattern recognition and adaptive analog VLSI technology. Not only does the TouchPad sense motion of any kind, it also senses pressure or even the distance of your fingertip from the pad's surface. Although not yet enabled through the current driver, this technology will support pressure-based functions such as handwriting, painting, and other applications that usually require a pressure-sensitive graphics tablet.

To deal with the limitations of dragging, the TouchPad supports Edge Motion. When your finger reaches the edge of the pad's surface, the cursor continues to move in the indicated direction as you apply pressure to the edge of the pad. We used the Synaptics TouchPad on an Epson ActionNote (Torrance, CA, (800) 374-7300), and everything worked as advertised. Edge Motion removed one of the last major complaints about using touchpad technology and made the TouchPad a better choice than the GlidePoint. Your choice of pointing devices is still a personal decision, but touchpad technology just keeps getting better.



The Synaptics TouchPad (left) and the Alps GlidePoint.

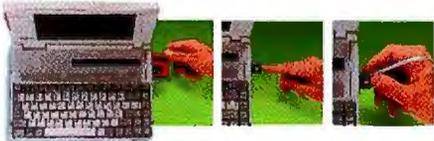
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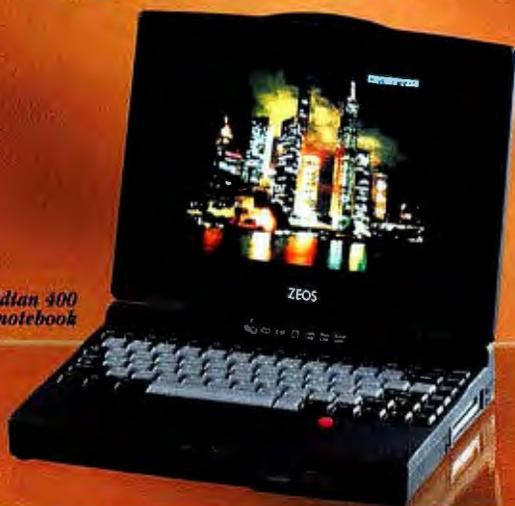
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Circle 128 on Inquiry Card.

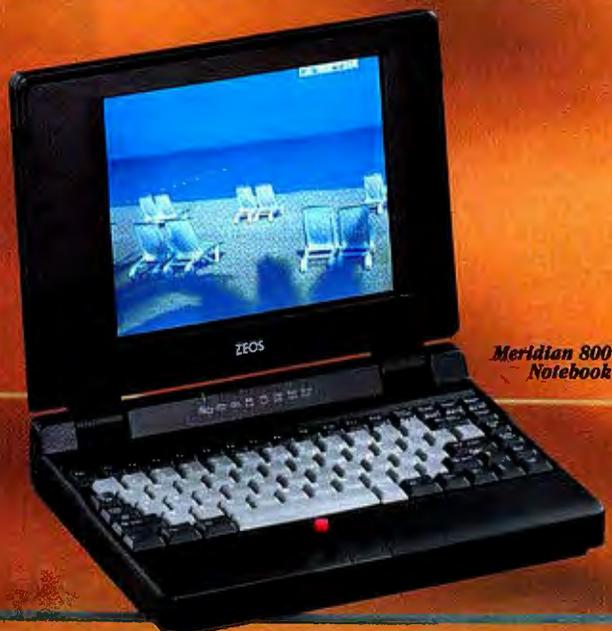
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Meridian 400 Subnotebook



"ZEOS is out to prove that good things do come in small packages with its Meridian 400C subnotebook," reported *Windows Magazine*.

At 3.9 pounds, the Meridian 400 is molded with a special carbon-fiber material that cuts weight and improves durability. And with a DX4-100MHz processor *standard*, it may well be the highest performance subnotebook available; "faster than a speeding desktop" is how *Computer Shopper* described it.

In addition to great performance, you also get hard drives to 350MB, RAM that's user-upgradable to 20MB, two Type II PCMCIA slots, an external ultra-light 3.5" 1.44MB floppy drive (included in Packages 2 and 3) and your choice of active matrix or dual scan color screens. Amazing!

Meridian 800 Notebook



"The 800C notebook offers sleek styling, solid construction and hot performance... one of the fastest notebooks we've ever tested," said *Windows Magazine*.

At 6.3 pounds, the Meridian 800 full-size notebook is light enough to travel anywhere yet, with its whopping 10.3" dual scan or 9.5" active matrix color display, is large enough to use for presentations and everyday computing.

To complete the package, you also get a DX4-100MHz CPU, up to 20MB of user-upgradable RAM, a removable hard drive to 528MB, a built-in 3.5" 1.44MB floppy drive and PCMCIA slots supporting two Type II or one Type III devices. Full desktop features that fit in your briefcase!

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"On our Graphics Winmark 95 tests... ZEOS's Meridian 850C grabbed the top position. The ZEOS 850C again finished first on our Disk Winmark 95 tests," reported *PC Magazine*. Grade A+ for performance!

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II or one Type III devices and a built-in 3.5" 1.44MB floppy drive, this is the notebook computer that rivals today's most advanced desktops!

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<ul style="list-style-type: none"> ➤ 4MB RAM ➤ 260MB IDE hard drive ➤ 800: Internal 3.5" 1.44MB floppy drive ➤ MS Windows® 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Works 95 or MS Works 			<ul style="list-style-type: none"> ➤ 8MB RAM ➤ 350MB IDE hard drive ➤ 3.5" 1.44MB floppy drive. 400: External, 800: Internal ➤ Custom nylon carrying case ➤ MS Windows 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Works 95 or MS Works 			<ul style="list-style-type: none"> ➤ 8MB RAM ➤ IDE hard drive. 400: 350MB, 800: 528MB ➤ 3.5" 1.44MB floppy drive. 400: External, 800: Internal ➤ 14.4 PCMCIA fax/modem ➤ Custom carrying case. 400: Leather, 800: Nylon ➤ Extra battery ➤ MS Windows 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Works 95 or MS Works 		
Pentium® Processor 850C			Pentium® Processor 850C			Pentium® Processor 850C		
75MHz		\$3295	75MHz		CNI \$3795	75MHz		CNI \$4195
90MHz		\$3495	90MHz		\$3995	90MHz		\$4395
<ul style="list-style-type: none"> ➤ 8MB RAM, 256K synchronous SRAM cache ➤ 528MB DE hard drive ➤ Internal 3.5" 1.44MB floppy drive ➤ Integrated 16-bit stereo sound ➤ MS Windows 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Works 95 or MS Works 			<ul style="list-style-type: none"> ➤ 16MB RAM, 256K synchronous SRAM cache ➤ 810MB IDE hard drive ➤ Internal 3.5" 1.44MB floppy drive ➤ Integrated 16-bit stereo sound ➤ Custom nylon carrying case ➤ Extra battery ➤ MS Windows 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Office Pro 95 or MS Office Pro 			<ul style="list-style-type: none"> ➤ 16MB RAM, 256K synchronous SRAM cache ➤ 1.3GB IDE hard drive ➤ Internal 3.5" 1.44MB floppy drive ➤ Integrated 16-bit stereo sound ➤ External amplified speakers ➤ 14.4 PCMCIA fax/modem ➤ Custom nylon carrying case ➤ Extra battery ➤ MS Windows 95 or MS-DOS 6.2 & Windows for Workgroups 3.11 ➤ MS Office Pro 95 or MS Office Pro 		

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Printers to Go

We reviewed three portable printers that you can hook up to an ultraportable for a short print job if you're stuck in a hotel or an airport. These packable printers—the Mannesmann Tally (Kent, WA, (206) 251-5524) MobileJet (\$350), the Pentax Technologies (Broomfield, CO, (303) 460-1600) PocketJet (\$529), and the Citizen America (Santa Monica, CA, (310) 453-0614) PN60 (\$399)—aren't built for speed or large-volume tasks, but they can get you out of a pinch if you need a hard copy of an invoice or a one-page document for an upcoming meeting.

Mannesmann Tally's MobileJet (4.6 pounds) is an ink-jet printer, and the smaller PocketJet (2.2 pounds) and PN60 (2.6 pounds) use variations of thermal-transfer technology to place ink on paper. The PocketJet is the most interesting because its direct thermal technology doesn't require ink cartridges, ribbons, or toner. The printer heats dye on special thermal paper supplied by Pentax. There is no toner to spill or ink ribbons to change, but the 8-cents-per-page cost of the paper can add up. The PN60 is the only one with color capabilities; its optional color print cartridge (\$14.99 for a two-pack) replaces the printer's standard black-ink cartridge.

All three printers operate on both AC and battery power, and you can plug the MobileJet and the PN60 into a car's cigarette lighter with an optional adapter. The MobileJet is the most versatile printer because it doesn't require special paper and prints on envelopes, transparency film, and adhesive-backed labels. It is also the only one with a multiple-page feeder, so you don't have to feed the pages manually. The PocketJet pays a price for its unique printer technology: It doesn't print envelopes or adhesive-backed labels.

The PocketJet is the fastest printer on all but one of our printer performance tests. It prints at speeds of three text pages per minute with a maximum resolution of 300 dots per inch. The slim, rectangular PocketJet produces letter- and legal-size output and hooks up to your computer via a serial or parallel port. It has full Printer Control Language 4 (PCL4) LaserJet IIP compatibility and

dark or light you want the print job to be. The PocketJet produces quality text output and line drawings, but its output on our black-and-white photograph test was washy and unrepresentable. However, its combination of speed and quality on text output makes it a good choice for those



Hook up to an ultraportable with the Mannesmann Tally MobileJet (upper left), the Citizen PN60 (middle), and the Pentax PocketJet.

who need to print forms or invoices in a hurry.

The Mannesmann Tally MobileJet is the heaviest portable in the test-bed, but it offers more features than the other printers. The bubble ink-jet printer supports resolutions of up to 300 dpi, and its cut-sheet feeder can hold up to 15 pages. You can purchase optional nicad and nickel-metal-hydride (NiMH) battery packs, or you can load in 10 AA batteries to power the printer when a power conduit is not nearby. Ink cartridges are easy to install.

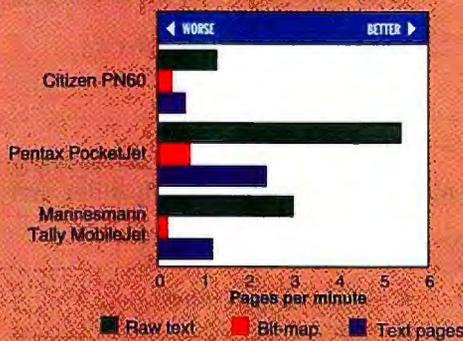
The MobileJet, which looks more like a desktop printer than the others do, is faster than the PN60 in our text performance tests, but it is the slowest printer in our font and graphics tests.

Despite its slow performance, it prints a much crisper photographic image (although still kind of blotchy) than do the other two printers. It also prints better-quality output in our more graphically complex print-quality tests. The easy-to-use printer has a print speed of 2 pages per minute and a bidirectional parallel interface, and it is HP DeskJet Plus (PCL3+)-compatible.

The PN60 has a rectangular chassis similar to that of the PocketJet, and the thermal-transfer PN60 offers the highest-resolution setting at 360 dpi. It is the only printer available with an optional RS-422 serial interface for a Mac (it also has a standard parallel interface and an optional RS-232 serial interface). The printer has five built-in fonts and supports industry-standard IBM and Epson emulations.

The PN60 was the slowest printer we tested, taking about four times as long as the PocketJet to print the text and raw-text tests, but it was slightly faster than the MobileJet on the font and graphics tests. The PN60 received only a fair printer-quality rating, because it had trouble printing reverse type (black on white), and its output in the photograph test was an imperceptible blur of pixels. Testers also had some bones to pick with the PN60. They encountered frequent paper jams and found that you must manually guide the paper into the single-sheet feeder perfectly straight for it to catch. They also discovered that its tiny buttons are hard to push. Despite these criticisms, the PN60 is the only choice if you need to highlight documents with a splash of color.

Printer Performance



PRINTERS AT A GLANCE

	PRICE	WEIGHT (LBS.)	MAX. RESOLUTION (DPI)
Mannesmann Tally MobileJet	\$350	4.6	300
Pentax PocketJet	\$529	2.2	300
Citizen PN60	\$399	2.6	360

includes seven Hewlett-Packard internal fonts. Although the PocketJet is a single-sheet-feed printer, testers liked the way it goes back on-line when it's time to feed through the next sheet of paper.

The PocketJet's rechargeable nicad battery supports 30 to 35 pages per charge and installs easily inside the printer's 11-inch-long chassis. The printer has three status indicators (power, data, and battery), and a density dial on the left side lets you set how

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Circle 125 on Inquiry Card (RESELLERS: 126).

How We Tested

To pick the best ultraportables, we first ran a suite of tests using applications-based tests and NSTL's InterMark performance benchmarks to determine the fastest systems. We also measured their endurance with our Thumper II battery run-down tests, examined their screen quality, and decided which ones were easiest to use and had the most important features. The performance scores are weighted most heavily, followed by the screen-quality, battery-life, features, and usability scores.

PERFORMANCE

We assessed the performance of each ultraportable with a suite of applications-based and low-level InterMark tests. Prior to testing, we installed MS-DOS 6.2 and Microsoft Windows for Workgroups 3.11 onto formatted hard disks.

NSTL's Windows-based, low-level InterMark tests exercise the Windows Graphical Device Interface (GDI), as well as low-level graphics, CPU, FPU, memory, graphics, and the hard drive systems. The GDI component determines how well a

system executes basic graphics calls within Windows. We ran all the Windows-based tests in 640- by 480-pixel resolution at 256 colors (except the Compaq Contura Aero 4/33C Model 250, which supports only 16 colors) using vendor-supplied graphics drivers. These applications benchmarks employ widely used programs, such as WordPerfect, FoxPro, and Excel, and thus gauge real-world performance.

FEATURES

We asked each vendor to complete a questionnaire to give us a detailed description of each system's features and support options. We then weighted each feature and calculated an overall features score (see the Roll Call on page 164).

We focused on three aspects of screen quality: crispness, intensity/color range, and viewing range. The screen-quality tests measure horizontal and vertical line placement, the color and gray-scale depths, and the frequency of LCD streaking. We used Sonera Technology's DisplayMate Professional 1.0 to analyze a wide range of display capabilities. To determine color

quality, we displayed a color bar on each screen and assigned a score ranging from 1 (worst) to 5 (best). After plotting the viewing range using NSTL's Heads-Up Range Device (HURD), we computed the group's viewing-angle scores.

We measured battery performance with BYTE's Thumper II system. Thumper emulates a typical word processing session; robotic arms and optical sensors detect and control each system's power management scheme. Prior to testing, we completely drained and recharged each system's battery according to the manufacturer's instructions. We then configured each notebook's power management features to spin down the hard disk after 2 minutes of inactivity and shut off the backlighting after 1 minute. We let each system enter standby mode during the test cycle. At intervals, Thumper's robotic arms would wake up each system so that it would run until the battery died.

You must interpret the results of any battery-life test, including our own, with some caution. People use their ultraportables differently, which uniquely affects a system's battery life.

USABILITY

We also assessed the quality of each keyboard, concentrating specifically on key placement. We worked extensively with the ultraportables to see how comfortable they became after extended use, and we rated the response and feel of the keys. We also evaluated pointing devices for both right- and left-handed people and considered the usefulness of the LCD status indicators.

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HOT CPU CHIPS KEEP THEIR COOL

There has always been a great compromise for users of portable systems: A faster (and hotter) CPU always meant shorter battery life. To end this trade-off, Intel has introduced 75- and 90-MHz Pentium processors specifically designed so that mobile systems perform better without compromising battery life.

The key to this paradox is Intel's Voltage Reduction Technology (VRT). It lets the Pentium processor operate at 3.3 V using off-the-shelf components, while its inner core operates at a cooler 2.9 V. This means that VRT-based Pentiums will consume as much as 30 percent less power than their desktop counterparts. The chips have a typical power dissipation of 2.5 to 3.5 W and idle power consumption of less than 1 W, according to Intel.

One of the first systems to debut with the Mobile 90 Pentium is Toshiba America Information Systems' Portégé 610CT (see the text box "The Incredible Shrinking Pentium" on page 148).

By the time you read this, portable systems featuring the two new 2.9-V chips will be shipping from such leading vendors as AST Research, Compaq, Dell, Hewlett-Packard, and NEC.

While Intel boasts that it will convert the entire notebook market to Pentiums by the end of this year, Cyrix has plans of its own. Cyrix showcased its mobile-slanted 5x86 CPU family last summer. According to Cyrix, it rivals 75-MHz Pentium performance. Power management features, which include System Management Mode (SMM), conserve power within the processor, as well as power flowing to peripherals.

One advantage of Cyrix's chip design that makes it attractive to vendors is that you can easily insert it into current 486 footprints. The chip will be in production in the fall, and many Taiwanese vendors (e.g., ASE, Chicony, Dataexpert, and Veridata) have shown preproduction 5x86-based notebooks. Epson plans to use the chip in upcoming portable and desktop systems.



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- 2 Type II/1 Type III PCMCIA Slots
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- Optional Dell Latitude DeskDock™ Available
- 3 Year Extended Warranty¹
- * Upgrade to 16MB RAM for \$499 more.

\$4499

Business Lease*: \$162/Mo.
Order Code #800030

DELL LATITUDE XPi P90D 90MHz PENTIUM PROCESSOR

- 10.4" Dual Scan Color Display
- 8MB RAM (40MB Max RAM)
- 256KB L2 Cache
- 420MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
- Optional Dell Latitude DeskDock Available
- 3 Year Extended Warranty
- * Upgrade to an 810MB Hard Drive for \$406 more.

\$3599

Business Lease: \$130/Mo.
Order Code #800027

DELL LATITUDE XPi P75D 75MHz PENTIUM PROCESSOR

- 10.4" Dual Scan Color Display
- 8MB RAM (40MB Max RAM)
- 256KB L2 Cache
- 420MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
- Optional Dell Latitude DeskDock Available
- 3 Year Extended Warranty
- * Add a 2B.8 Modem for just \$299 more.

\$2999

Business Lease: \$111/Mo.
Order Code #800025

DELL LATITUDE LX 4100D 100MHz INTEL® DX4™ PROCESSOR

- 10.4" Dual Scan Color Display
- 4MB RAM (20MB Max RAM)
- 128KB L2 Cache
- 420MB Upgradeable Hard Drive (810MB Max)
- \$99 More for 2nd NiMH Battery (Slides into floppy drive to achieve extended battery life)
- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
- 1 Year Warranty¹
- * Double your RAM for only \$200 more.

System Not Pictured

\$1999

Business Lease: \$74/Mo.
Order Code #800020

Unlike most Pentium processor notebooks, Dell's Latitude XPi gives you battery life that's actually "big."

That's not just an idle boast, either. In the independent VeriTest "Cross Country"™ test,² the Dell Latitude XPi P75D notebook lasted an average of four hours and forty minutes.

So pick up the Dell Latitude XPi notebook. And get big battery life without the obligatory big battery.



DELL®

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Keycode #01051

**The VeriTest Cross-Country v2.0 test simulates typical executive use of Microsoft Office® applications in Microsoft Windows® 3.11 during an airplane flight. Power management was enabled and 8MB RAM was installed. VeriTest, inc. is located in Santa Monica, CA. Promotional pricing featured is not discountable. ¹For a complete copy of our Guarantees or Limited Warranties, please write Dell USA L.P., 2214 W. Braker Lane, Building 3, Austin, TX 78758. ⁰Business leasing arranged by Leasing Group, Inc. *Prices and specifications valid in the U.S. only and subject to change without notice. Microsoft, Windows and the Windows logo are registered trademarks of Microsoft Corporation. The Intel Inside logo and Pentium are registered trademarks and IntelDX4 is a trademark of Intel Corporation. ©1995 Dell Computer Corporation. All rights reserved.



Designed for



Microsoft
Windows 95

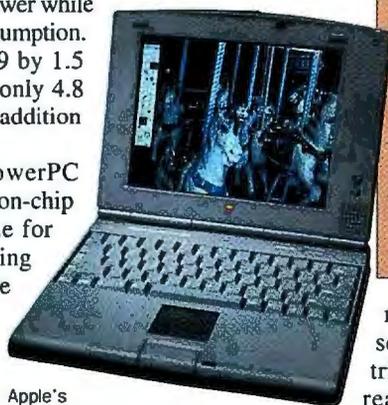
Apple's Dynamic Duo

In August, Apple migrated its ultraportable computer line (called the PowerBook Duo) to the PowerPC processor. Recast as the PowerBook Duo 2300, it provides RISC power while holding the line on power consumption. It measures only 8.5 by 10.9 by 1.5 inches and tips the scales at only 4.8 pounds, making it a welcome addition to anyone's briefcase.

The Duo 2300 uses a PowerPC 603e, which has two 16-KB on-chip caches (one for data and one for code) and several power-saving modes. The processor can idle certain subsystems (e.g., the FPU or perhaps the data cache) when they're not in use. A single Type III nickel-metal-hydride (NiMH) battery provides an estimated 2 to 4 hours of battery life. Base system RAM is 8 MB, which is expandable to a maximum of 64 MB. Internal hard drives start at 750

MB and can be as large as 1.1 GB.

The Duo has a 9½-inch backlit active-

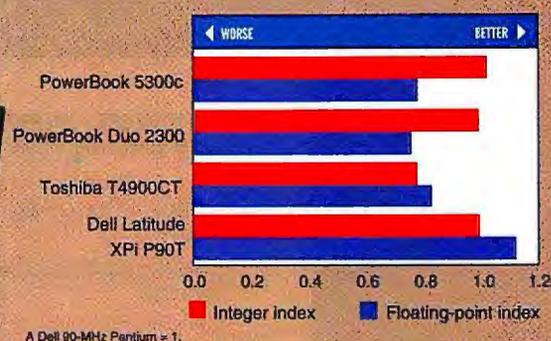


Apple's PowerBook Duo 2300c.

matrix LCD screen that's a trifle small but readable. The engineering com-

promises made to achieve the Duo's slim form factor are a minimal set of I/O ports. It has a slot and an RJ-11 connector for an internal modem and a mini-DIN-8 serial connector that can function as a LocalTalk network port, printer port, or modem port, if required. Behind a hinged door lies a connector for plugging the computer into Apple's docking station, the Duo Dock. An optional small floppy docking unit can plug into this connector to provide ports for Apple Desktop Bus (ADB) and a floppy drive. This makes the com-

PowerBook Performance

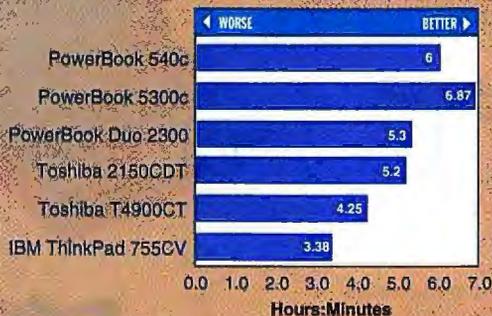


puter more capable for stand-alone work but requires that you remember to pack the docking unit and the floppy drive.

The 603e's low power consumption, combined with Apple's power-conservation software, delivers long battery life. The BYTE battery-life tests showed that the Duo 2300 operated for 5½ hours. In terms of performance, the Duo 2300 weighs in with an integer BYTEmark of 0.986029 and a floating-point BYTEmark of 0.752184. Prices start at \$3500 for a Duo 2300c with 8 MB of RAM, a 750-MB hard drive, and a 9½-inch active-matrix LCD screen.

—Tom Thompson

Battery Duration



COLOR FOR THE ROAD

If you happen to be on the road with your trusty color PowerBook and you need to knock out a full-color document for a client, whom are you going to call? Now you can have your color files and print them, too, with Apple's Color StyleWriter 2200 (priced at \$419). This portable color ink-jet printer prints at resolutions of 360 dots per inch and can accept plain paper, medium-weight labels, #6 and #10 envelopes, and transparency film. It measures in at just 2.2 by 11.8 by 6.2 inches and weighs in at just over 3 pounds (4.2 pounds with the battery attachment).

The printer takes only a few minutes to set up and consists mainly of clipping either a black- or color-ink cartridge into the print-head assembly. A storage case holds the ink cartridge when you travel with the printer. The printer connects to a PowerBook via a serial cable. Several floppy disks contain the printer-driver software and 19 ad-

ditional TrueType fonts.

Printing speeds are determined by two factors. First, the more gutsy the PowerBook's processor is, the faster the driver generates the page image. For best appearances, you'll want to have your application generate page images at 144 dpi or better, which means more data must be shipped to the printer. This, in turn, slows the printing process. But the wait is worth it: Color output is gorgeous and rivals the output quality of the Hewlett-Packard 1200C ink-jet printer.



For quality color in a portable package: the Apple Color StyleWriter 2200.

—TT

Product Information

Apple PowerBook Duo 2300\$3500 and up
Apple Computer, Inc.
Cupertino, CA
(800) 776-2333
(408) 996-1010
Circle 1228 on Inquiry Card.

HONORABLE MENTIONS

Tired of fumbling around behind your desktop system for a serial port every time you have to transfer files to and from your desktop system and ultraportable?



The Gateway 2000 Liberty DX4-100 Deluxe, the IBM ThinkPad 701C, and the Hewlett-Packard OmniBook 600CT have infrared ports and accompanying software for wireless data transfer. You point the Irda-compliant ports on

these advanced ultraportables to an infrared module connected to the desktop to exchange files, or to an infrared-capable printer to print documents.

The ThinkPad 701C comes with an expansion unit (it attaches to the back of the system) called the MultiPort II, which has eight ports for a serial device, a parallel device, audio input and output devices, a keyboard, a mouse/numeric keypad, a power port, and an external display. The module weighs less than one-half pound, and you can leave it home if you don't anticipate attaching external devices during your jaunt.

PRIMAX'S COLORMOBILE OFFICE

So you've picked your ultraportable and portable printer. What's left? How about a color scanner for the road that can handle almost any scan job. Primax Electronics' (Campbell, CA, (800) 338-3693 or (408) 364-2800) ColorMobile Office (\$289) features a modular design so that you can snap on attachments for hand-held, sheet-fed, and self-motorized scanning of images and documents.

The ColorMobile Office weighs only 2 pounds and supports any image mode from black-and-white up to 24-bit true color at resolutions ranging from 100 to 400 dots per inch. The ColorMobile Office working alone as a hand-held scanner can scan pages from a book or manual. If you have shaky hands, the Motor Module attachment rolls the scanner along a flat trackpad for up to A4-size documents. The Office Feeder sheet-fed module sucks in 4-inch-wide business cards or photographs.

The scanner is bundled with the TWAIN-compatible ImagePals Go file management and image-editing software. It also includes ReadIris Intelligent Text Recognition OCR software to edit scanned-in text files. ColorMobile Office works on AC power and hooks up to a system via the parallel port.



Primax's ColorMobile Office lets you scan documents while in transit.

Digital Equipment put a lot of thought into the trackball on its HiNote Ultra CT475. The left-click mouse button wraps almost entirely around the trackball, while the seldom-used right-click button is just a sliver above the trackball.



Dubious Achievements

On the two Austin ultraportables, the Sceptre TS37 Subnotebook, and Gateway's Liberty, you have to pull the external floppy drive off the parallel port if you want to connect a parallel-attached network adapter, printer, or external CD-ROM drive. The Compaq Contura Aero 4/33C Model 250 uses its PC Card (formerly PCMCIA) slot for its external floppy drive, which occupies a valuable expansion slot. The other ultraportables have ports dedicated for their external floppy drives.

Hewlett-Packard's OmniBook 600CT gets one of the best usability ratings, but its mouse that pops out the side of the system is really annoying. The mouse attaches to the ultraportable via a plastic leash that not only proved restrictive when moving the cursor but also felt like it would break off with a quick jerk.



Zinc-Air Batteries Last All Day

In portable computing, no technology seems to be changing more rapidly than that of batteries. Today, nicad batteries are being eclipsed by nickel-metal-hydride (NiMH) and lithium-ion cells. On the horizon, however, are zinc-air batteries that can power a laptop for between 10 and 15 hours.

AER Energy Resources ((404) 433-2127) has developed zinc-air batteries (priced at \$399) for portable systems from Toshiba, Hewlett-Packard, and Zenith that can last an entire workday. Zinc-air cells, which store 150 watt-hours of energy, have two to three times more gravimetric energy than nicad and NiMH batteries, but the batteries are boxy and bulky at about 4 pounds. These batteries use oxygen from the air to support reactions that generate electricity, and they need more airflow than other batteries.

Besides the benefit of longer running time, zinc-air batteries lack the memory effect found in nicad batteries, so you can recharge them anytime rather than waiting until the battery is totally drained. The batteries, however, endure only 25 to 50 recharge cycles, but according to AER representatives, you get 200 to 400 hours of total run time from a zinc-air battery, which is about the same as with nicad and NiMH batteries that have 200 to 300 recharge cycles.

Introducing The Gateway 2000 Solo Portable Multimedia PC!



GATEWAY2000
S O L O™

Life is an adventure. Packed with twists and turns because you never take the beaten path. You need a computer that's up for the ride, but won't weigh you down. It's time to go solo.

The Gateway 2000 Solo™ PC is your ultimate Microsoft® Windows® 95 portable. Priced from \$3499, this Pentium® processor-based multimedia portable melds our famous values with cutting-edge technology. The Gateway 2000 Solo PC is outfitted to be your primary computer, and starting at only 5.6-pounds,* ready to roll through even the most rugged computer terrain.

It's full-featured and will be your companion on every junket, from the rugged outback to the urban jungle. Choose your model with a 75MHz or 90MHz Pentium processor. All Gateway Solo models have a removable hard drive, minimum 8MB RAM, 256K L2 cache, modular bay for 3.5-inch floppy or CD-ROM drive, full-sized keyboard with Windows 95 keys, and either MS Office 95, Professional Edition or MS Works 95.

And because the most scenic panoramas don't include outlets, you'll get a high-capacity lithium battery for hours of computing power. It'll just be you and your Gateway Solo portable PC traversing the globe. Everything you need, right at your fingertips. And when you're called back to home base, its optional docking bar allows easy connection to a host of external gear including a monitor, keyboard and printer.

What's keeping you tied to the office? Multimedia is no longer relegated to desktop computers. With this portable's large active matrix color display, modular CD-ROM drive, integrated stereo speakers and microphone you get multimedia wherever your travels take you.

All portables from Gateway 2000® are built rock-solid with quality in mind. We know that occasionally a pothole appears on life's highway, so every Gateway portable comes with 24-hours, seven-day a-week technical support.

So the next time you hear the call of the wild, go solo! *Call Gateway 2000 today for more information!*

*Configuration includes: 540MB Hard Drive, SVGA Active Matrix Color Display and Option Bay Cover.



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Microsoft Word

Mr. R. Mooka
It has come to a

Microsoft Excel - Regional Sales Numbers

1995 Regional Guitar Sales

	A	B	C	D	E	F	G	H
1								
2								
3								
4								
5								
6								

Legend:

- N. West
- East
- Midwest

Taskbar: Start | Slide Show | Microsoft Word | Microsoft Excel - R | Goodtime | 3:45 PM

GATEWAY2000
SOLO



ROLL CALL OF ULTRAPORTABLES TESTED

	AT&T GLOBAL INFORMATION SOLUTIONS GLOBALYST 130	AUSTIN DIRECT 486 STEPLITE NOTEBOOK	AUSTIN DIRECT 486 STEPLITE NOTEBOOK	COMPAQ COMPUTER CORP. CONTURA AERO 4/33C MODEL 250
Price as tested	\$2223	\$2065	\$2407	\$1199
Performance rating	5.6	4.6	6.1	3.4
Features/ease of use	7.9/7.7	7.1/7.8	7.2/7.8	6.2/6.6
Screen quality	7.3	7.0	6.2	2.7
Battery life (hr:min:sec) as tested	3:52:28	2:52:15	3:18:33	4:22:47
Traveling weight (lbs.) ²	6.1	6.4	6.6	5.7
MICROPROCESSOR				
CPU/MHz	486DX4/75	486DX2/50	486DX4/75	486SX/33
Voltage	3.3	5.0	3.3	5.0
SYSTEM RAM				
RAM as tested/max. RAM (MB)	8/20	8/20	12/20	8/20
Memory speed (ns)	70	70	70	70
Memory architecture	Noninterleaved	Fast-paged	Fast-paged	Paged
SYSTEM BIOS				
BIOS vendor	SystemSoft	Phoenix	Phoenix	Compaq
Flash ROM upgradable	●	●	●	●
System ROM BIOS shadowing	●	●	●	●
Video ROM BIOS shadowing	●	●	●	●
VIDEO				
Screen manufacturer	Sharp	Sharp	Sharp	N/A
Graphics accelerator manufacturer/model	Chips & Technologies 65535	ACC 2066NT	ACC 2066NT	N/A
Diagonal screen size (inches)	10.4	9.5	9.5	7.8
Display technology	Passive-matrix	Passive-matrix	Passive-matrix	Passive-matrix
Max. display resolution (pixels)/total colors	640x480/256	640x480/256	640x480/256	640x480/16
Graphics memory as tested/bus width (bits)	512-KB DRAM/32	512-KB DRAM/32	512-KB DRAM/32	512-KB DRAM/16
External VGA display support	●	●	●	●
Max. ext. display resolution (pixels)/total colors	1024x768/16 million	1024x768/256	1024x768/256	640x480/16
Simultaneous int. and ext. display/key-activated toggle for display selection	●●	●/●	●/●	○/●
BATTERY				
Battery type	NIMH	NIMH	NIMH	NIMH
Supports multiple battery packs/hot swapping	○/●	○/○	○/○	○/○
MASS STORAGE AND FLOPPY DRIVES				
Hard drive manufacturer and model	Toshiba MK1824FCV	Toshiba MK1824FCV	Toshiba MK1824FCV	Compaq 250
Hard drive interface type/average access time (ms)	IDE/13	IDE/13	IDE/13	IDE/17
Hard drive controller cache (KB)	128	128	128	None
Hard drive formatted capacity/largest available (MB)	340/540	335/810	517/810	250/250
Removable hard drive	●	●	●	○
Standard 3½-inch floppy drive	Internal	External	External	External
I/O PORTS (BUILT IN)				
Number of nine-pin serial ports	1	1	1	1
Number of 25-pin serial ports	N/A	1	1	N/A
UART type	16550	16550	16550	16550
Centronics parallel port	Bidirectional	EPP	EPP	EPP
Pointing device	Trackball	Trackball	Trackball	Trackball
External keyboard port	●	●	●	○
Type II/Type III	N/A/1	N/A/1	N/A/1	1/N/A
Other I/O ports	N/A	N/A	N/A	N/A
SOUND				
Integrated sound	○	○	○	○
Built-in microphone	N/A	N/A	N/A	N/A
Ext. microphone port	N/A	N/A	N/A	N/A
Ext. speaker port	N/A	N/A	N/A	N/A
Volume control	N/A	N/A	N/A	N/A
ADDITIONAL FEATURES				
Embedded/overlaid numeric keypad	●	●	●	●
Wattage	24.0	30.4	30.4	10.0
Switchable voltage	●	●	●	○
SOFTWARE				
DOS disks included	●	●	●	○
Microsoft Windows 3.1 disks included	●	○	○	○
Microsoft Windows for Workgroups disks included	○	●	●	○
Other	AT&T Mail Access Plus, OAG FlightDisk, AT&T Vistum, Share, CompuServe, GENIE, Prodigy, WinComm Lite	Microsoft Office Standard 4.2	Microsoft Office Standard 4.2	TabWorks, WinLink Transfer Utility and Lotus Organizer
MISCELLANEOUS				
14.4-Kbps fax modem	N/A	N/A	N/A	N/A
External battery charger (for secondary battery)	Included	Optional	Optional	Optional
Additional battery	Optional	Optional	Optional	Optional
Standard warranty length (years)/coverage	1/P, L, R	1/P, L	1/P, L	3/P, L, F, R
VENDOR INFORMATION				
Toll-free phone	(800) 447-1124	(800) 752-1577	(800) 752-1577	(800) 345-1518
Phone	(513) 445-5000	(512) 339-3500	(512) 339-3500	Call local Compaq dealer.
On-line address	pcc.info@daytonoh.attgts.com	http://www.lpcotechinc.com	http://www.lpcotechinc.com	http://www.compaq.com
Inquiry number	1229	1230	1231	1232

● = BYTE Best.

● = yes; ○ = no; N/A = not applicable.

¹ Not SL-enhanced.² The traveling weight includes the system and its components, such as a floppy drive, adapters, and a battery pack.³ One optional extra Type III in expansion dock.



DIGITAL EQUIPMENT CORP. MINOTE ULTRA CT475	GATEWAY 2000 LIBERTY DX4-100 DELUXE	HEWLETT-PACKARD CO. OMNIBOOK 600CT	IBM PC CO. THINKPAD 701C 1	SCEPTRE TECHNOLOGIES, INC. TS37 SUBNOTEBOOK	ZEOS INTERNATIONAL MERIDIAN 400A	ZEOS INTERNATIONAL MERIDIAN 400C
\$4999 7.1 7.8/7.9 10.0 4:39:55 5.6	\$4499 9.9 8.4/7.8 3.6 4:15:12 6.1	\$3999 6.4 6.3/8.3 8.1 5:46:10 5.8	\$4599 6.4 8.0/8.1 8.2 2:08:32 6.4	\$1695 3.8 7.0/7.7 3.0 3:31:48 6.4	\$3495 7.7 7.1/8.0 9.9 2:29:49 6.0	\$2795 7.6 7.1/8.0 6.4 2:20:39 6.0
486DX4/75 3.3	486DX4/100 3.3	486DX4/75 3.3	486DX4/75 3.3	486SX/33 5.0	486DX4/100 3.3	486DX4/100 3.3
8/24 70 Interleaved	24/24 70 Paged	8/32 70 Paged	8/24 70 Paged	8/12 70 Interleaved	8/20 70 Fast-paged	8/20 70 Fast-paged
SystemSoft ● ● ●	SystemSoft ● ● ●	Phoenix ● ● ●	IBM PC Co. ● ● ●	SystemSoft ● ● ○	Phoenix ● ● ●	Phoenix ● ● ●
Toshiba Chips & Technologies 65545 9.5 Active-matrix 640x480/256 1-MB VRAM/32 ● 1024x768/16 million ●/●	Sharp Chips & Technologies 65545 10.4 Dual-scan 640x480/256 1-MB DRAM/32 ● 1024x768/256 ●/●	Toshiba Chips & Technologies 65545 9.5 Active-matrix 640x480/65,536 1-MB DRAM/32 ● 1024x768/65,536 ●/○	Sharp Chips & Technologies 65545 10.4 Active-matrix 640x480/256 1-MB DRAM/32 ● 1024x768/16 million ●/●	Sharp Chips & Technologies 65540 9.5 Dual-scan 640x480/256 512-KB DRAM/16 ● 1024x768/256 ●/●	Toshiba Cirrus 6440 7.9 Active-matrix 640x480/256 1-MB DRAM/32 ● 1024x768/256 ●/●	Toshiba Cirrus 6440 7.9 Dual-scan 640x480/256 1-MB DRAM/32 ● 1024x768/256 ●/●
Lithium-ion ○/○	Lithium-ion ○/●	Lithium-ion ○/○	Nicad (optional NiMH) ○/●	NiMH ○/●	NiMH ○/○	NiMH ○/○
Toshiba MK1824FCV IDE/12 256 528/528 ○ External	IBM DBOA-2720 IDE/13 N/A 720/720 ● External	Integral Viper 260 PC Card ATA/16 32 260/260 ● External	IBM DBOA-2360 IDE/13 64 540/720 ○ External	Hitachi DK221A34 IDE/12 64 250/820 ● External	Areal A340 IDE/12.3 32 350/350 ○ External	Areal A340 IDE/12.3 32 350/350 ○ External
1 1 16550 EPP Trackball ● N/A/1 ³ N/A	1 1 16550 EPP EZ Point Integrated Pointer ● None/1 N/A	1 N/A 16550 Bidirectional Pop-out mouse ○ N/A/1 Infrared	1 N/A 16550 EPP TrackPoint III ● N/A/1 Irda, audio I/O, headphone, speaker, and microphone	1 N/A 8250 Unidirectional Trackball ● 1/None N/A	1 N/A 16550 Bidirectional TruePoint ● 2/None N/A	1 N/A 16550 Bidirectional TruePoint ● 2/None N/A
● ○ ● ● ●	○ N/A N/A N/A N/A	● ● ● ● ●	● ● ● ● ●	○ N/A N/A N/A N/A	○ ○ ○ ○ ●	○ ○ ○ ○ ●
● 30.0 ●	● 35.0 ●	● 40.0 ●	● 30.0 ●	● 25.7 ●	● 37.0 ●	● 37.0 ●
○ ○ ○	● ○ ○ ○	○ ○ ○ ○	● ○ ● ●	● ● ○ N/A	● ○ ● ●	● ○ ● ●
OAG FlightDisk, Lotus Organizer, TranXit, CompuServe, InterNav for Delphi	OAG FlightDisk, Ascend, and Microsoft Office	LapLink Remote, AOL, CompuServe, and Day-Time Organizer	N/A	N/A	Microsoft Works	Microsoft Works
N/A Optional Optional 3/P, L, R	Included Optional Included 1/P, L, R	N/A Optional Optional 3/P, L, F	Included N/A Optional 3/P, L, F, R	N/A Optional Optional 1/P, L, R	Included N/A Included 1/P, L, F, R	Included N/A Included 1/P, L, F, R
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Warranty:

P = parts
L = labor
F = freight to repair center
R = return to customer

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BYTE has compiled every major article written on networking from the January 1993 issue through the October 1994 issue on a multiple disk set. With easy-to-use search and retrieve capabilities, this fully indexed text database allows you to access valuable technology and product information from networking product reviews, features, news analysis, and technical columns from the pages of BYTE. All articles are

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Is There a GLINT in Your Future?

**A close look at a coprocessor
that accelerates 3-D graphics**

**TREVOR MARSHALL
AND JOHN DAVEY**

Both the Pentium and the PowerPC deliver sufficient horsepower to display 3-D images on desktop computers. But as powerful as these processors are, to offer real-time support of 3-D imagery, they require an assist from dedicated hardware.

The GLINT chip from 3DLabs is the most mature of all the chips, from several manufacturers, that will bring true 3-D graphics display capabilities to the desktop over the next few years. These chips won't produce images like you see in Hollywood films because they use a technique called Gouraud shading instead of the more photo-realistic ray-tracing mechanism. But they do produce images that can move fast enough to fool the eye into the illusion of three dimensions.

In this article, we will explain how the GLINT 300SX chip connects to external hardware and how a GLINT board produces fast real-time 3-D displays. We will also look at a few features that 3DLabs added to the chip to make 3-D displays really sizzle.

3-D Display Basics

A lot of hardware and software technology goes into producing a 3-D graphics display system. Chips such as the GLINT 300SX can produce 300,000 Gouraud-shaded triangles per second, but very few software packages are currently capable of driving them to this capacity. Even a 120-MHz Pentium processor with a fast PCI bus connected to the GLINT is capable of generating only about 200,000 triangles per second.

Several factors limit the speed of 3-D operations. A lot of information has to be passed over the bus. It takes 29 32-bit parameters to describe each of the two shaded triangles that make up a polygon. This translates into a sustained data rate of 10 MBps, which is impractical over an ISA bus and even difficult for the PCI bus (see "Fast Transit," October 1992 BYTE). The applications software itself also has to keep track of an extra dimension of parameters, which places a further load on the CPU. So a ton of thought has been put into ways in which the graphics processor can reduce the computing load on the host CPU.

The GLINT not only handles multiple display windows (so only part of a screen needs

updating between frames), it also keeps track of Z-buffer data (used to plot only those objects in the "front" of the image). In addition, the chip manages the alpha blending (transparency); fogging (which enhances the illusion of depth); copying (which moves a cube of 3-D data, not just a 2-D image plane); and dithering (a technique for interpolating colors to make surfaces look smoother).

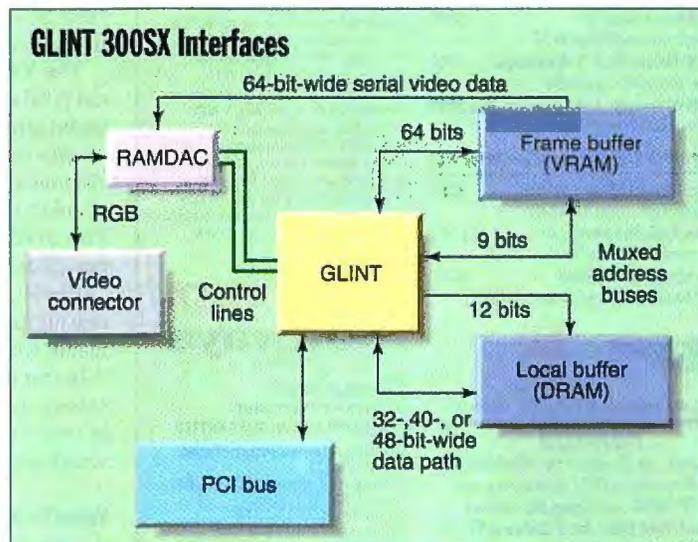
To do all this, GLINT uses two memory systems: a VRAM frame buffer that contains the actual pixel information, and a DRAM-based local buffer that contains the Z-buffer, alpha blending, and other 3-D housekeeping bits associated with each pixel in the display buffer.

Why So Many Pins?

The GLINT chip comes in a 304-pin package. It's a gate array made for 3DLabs by IBM Microelectronics, and it looks similar to IBM's PowerPC 601 CPU. The size of the silicon die, however, is larger than that of the 601, and it has more transistors. One of the reasons there aren't too many good 3-D graphics display chips available is that, as the die size indicates, they tend to be pretty complex beasts. Luckily, despite its internal complexity, the GLINT hardware interface makes it really quite simple to integrate into a display system design.

As the figure "GLINT 300SX Interfaces" shows, in a typical GLINT display system, the chip can simultaneously access data from the PCI bus, a 64-bit-wide VRAM frame buffer memory, and a 48-bit-wide DRAM local buffer. Pins are also required to handle the VRAM and DRAM address buses.

The GLINT connects directly to the PCI bus, which



The GLINT as a video controller in a PCI-bus display board. Little glue logic is required to connect the chip to the PCI and RAM buses.

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The GLINT displaying a 3-D object with fogging, which enhances the illusion of depth.

eliminates the glue logic normally required to communicate to the bus. This also reduces a graphics board's component count and cost. The GLINT has an internally set PCI manufacturer's ID of 0x3d3d (clever—3Dlabs) and supports all the signals and registers defined in the PCI 2.0 standard. It has internal DMA, which allows either command or data blocks to be burst over the bus at around 20 MBps. This capability is important—without burst mode, you can get a data rate of only 3 to 8 MBps on a PCI bus.

Connecting VRAM and DRAM to the GLINT is very easy indeed. The address bus is internally multiplexed, so you can just connect the GLINT address pin through a damping resistor to the address lines on the memory. The control and data lines connect in the same way. Again, no glue logic is necessary.

When the GLINT powers up, it senses the state of some of the data lines (which are pulled either up or down by resistors) and configures its internal logic to address the amount of RAM present. It also automatically sizes the data bus widths (bus widths of 32, 48, or 64 bits are supported, depending on whether you're addressing DRAM or VRAM). This lets you customize the display system for the exact features you need. Once you've considered a few control lines and redundant power and ground lines, all 304 pins have been accounted for.

The VRAM has another 64-bit data bus, which passes the serial pixel data to a RAMDAC. The latter component assembles the 64-bit stream into pixels of different sizes. These 64-bit chunks of data can be modified to produce eight 8-bit (256 colors) pixels, four 16-bit (thousands of colors) pixels, or two 24-bit (millions of colors) pixels, as determined by the RAMDAC's display mode. This pixel bus operates at a maximum speed of 150 megapixels per second.

Having all these separate buses gives the GLINT massive processing power and throughput. It can be receiving a PCI command, writing a new pixel to the VRAM, and reading mask and Z-buffer information from the local DRAM, all during the same system cycle. It would not be possible to do these operations all at once with a general-purpose CPU, like the PowerPC 601, which handles only one 64-bit data access at a time.

Video Features

As important as throughput is to a display's performance, for 3-D imagery, additional image-processing capabilities are crucial for fast screen drawing. The GLINT provides hardware support

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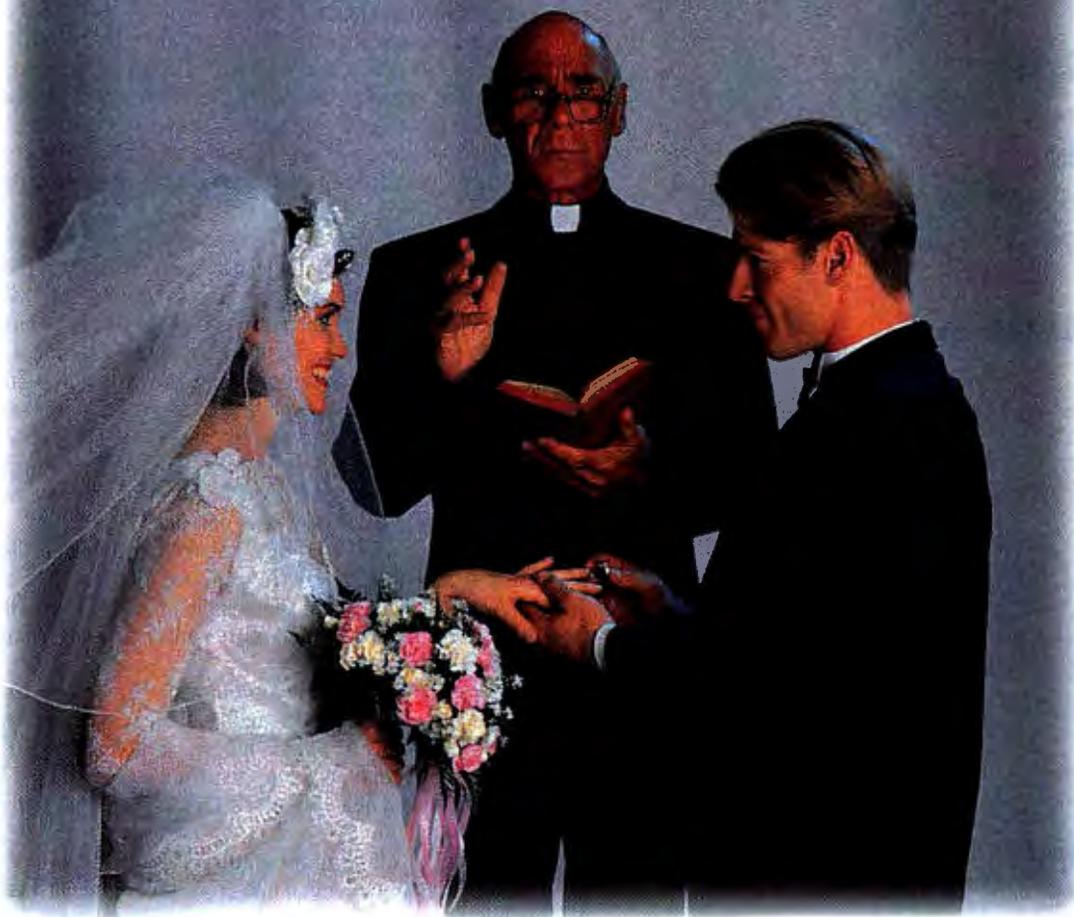
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in a number of areas. Three worth mentioning in detail are antialiasing, color dithering, and screen-buffer clearing.

Antialiasing: This important graphics operation helps convince the eye that an image appears "real" and not computer-generated. When the display system draws a diagonal line, it does so by illuminating a set of pixels on the screen. The pixels in this line appear as discrete steps, particularly at the transition (or boundaries) between screen pixels. Antialiasing adds extra pixels to the line, which smoothes out these sharp boundaries.

The GLINT chip does this automatically by calculating the correct color and position for each pixel so that such boundary effects are minimized. The host software tells the GLINT to draw a line in 3-D space, and the GLINT draws it with depth perception and automatic antialiasing characteristics. This allows the applications software to operate purely in a fast vector-drawing mode. The screen at left shows a typical 3-D vector program whose output has been enhanced using the built-in antialiasing and fogging effects.

Color dithering: When it is shading a surface, the GLINT calculates all the pixels with 32-bit accuracy. Only at the end of the pipeline does it convert them to the 24-, 16-, or 8-bit color display modes. A dithering unit at the end of the graphics pipeline takes the 32-bit color value and tries to display it so that, even if only 256 colors are available on-screen, the eye interpolates between the different colored pixels and perceives an intermediate color value. The GLINT does this interpolation inside a 4- by 4-pixel matrix (16 pixels) with no speed penalty at all. Surprisingly, it works very well, assisted by the additional pixel-averaging effect of the shadow mask apertures on your CRT.

Clearing the screen buffer: The frame buffer VRAM has a built-in "fast clear" hardware mode that allows it to be cleared very quickly indeed. But in a 3-D graphics display system, it is also important to clear all the Z-buffer and alpha information in the DRAM local buffer.

However, DRAM does not have a fast-clear hardware capability. To clear it, you typically have to write a new value to every memory cell. This is not practical to do at the typical 30 frames per second necessary to achieve smooth motion in a 3-D display environment. So the GLINT Z-buffer has a feature called "fast clear."

Instead of clearing the entire Z-buffer on every frame, the GLINT divides the screen into 16 or 256 segments that get cleared only on sequential frames. The GLINT keeps track of which segments have been cleared, and if you are drawing into a section that hasn't been cleared recently, it uses a cleared pixel value when calculating the new Z-buffer value. Tag bits, kept in the local buffer DRAM memory, indicate whether or not a segment has been cleared.

The Future Is 3-D, but Faster

The GLINT is the first of a series of 3-D graphics controllers to come to market. While other manufacturers are producing similar chips that are less expensive, 3Dlabs is concentrating on building display controllers that define the state of the art for desktop graphics systems. Future versions of the GLINT chip will be able to directly handle texture mapping, and no doubt they'll run faster. ■

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Weaving a Thread

Solaris and Windows NT both support powerful multithreading/multiprocessing to help get the job done faster

SHASHI PRASAD

Asymmetric multiprocessor (SMP), also called a shared-memory multiprocessor, has multiple CPUs sharing a common memory space. This memory sharing allows a single copy of the OS to be running on all the processors. SMP machines promise higher performance and better scalability, but the OS software must be designed to support multiprocessing and also be tuned for a scalable and efficient SMP. The OS, by means of some application programming interface (API), should allow the application developer to split his or her program into multiple pieces and run them simultaneously.

Loose Threads

A sequential process has a single flow of control, a sequence of instructions executed by the process. In a multithreaded process, there are multiple schedulable flows of control called threads. Threads are associated with a sequence of instructions and are often referred to as "threads of execution." Threads support the notion of concurrent programming and are used to exploit the inherent hardware parallelism of the SMP machine. By splitting a problem into smaller pieces, a thread can run each piece concurrently on an SMP machine.

Traditionally, applications were split into multiple processes, and some form of interprocess communications (IPC) was used to communicate between the processes. A multithreaded process has more than one thread of control sharing both address space and resources. Using threads eliminates the need for any IPC and reduces context-switching overhead. Threads are also referred to as lightweight processes (LWPs), since the context maintained for threads is much lighter than processes. Even though threads are schedulable entities, it does not necessarily mean that they run in parallel. Threads can be scheduled concurrently on multiple processors, while on uniprocessor machines, threads are time-sliced.

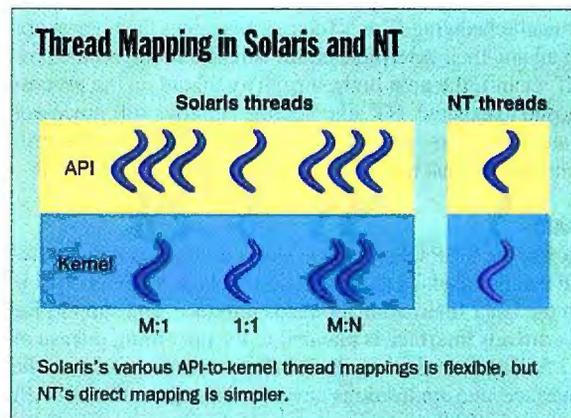
With Solaris 2.2, Sun introduced a threads library for applications developers to take advantage of the multiprocessing and multithreading features of the advanced kernel. Solaris uses a two-tier thread library model. At the top layer are the user threads, and at the bottom layer are LWPs.

LWPs are kernel threads—they use kernel resources and are the actual schedulable entities in Solaris. The kernel is aware only of LWPs and knows nothing about user threads. The user threads are managed by the threads library, which supports one-to-one, many-to-many, or many-to-one

mapping between the user threads and the LWPs (see the figure "Thread Mapping in Solaris and NT" below). The multiplexing of user threads to a pool of LWPs and the scheduling of user threads is handled by the threads library. Though the two-tier thread model adds some extra responsibility onto the user application, it allows for the cheap creation of user threads without using a lot of system resources.

Solaris has bound and unbound user threads. A bound thread is a one-to-one mapping between a user thread and an LWP. An unbound thread does not have a dedicated LWP; the threads library schedules the user thread on a pool of LWPs in a process. Applications that require global scheduling with respect to other LWPs in the system should use bound threads.

LWPs are scheduled by the kernel according to their scheduling class and priority. In Solaris, the process is created with an initial LWP, which inherits the scheduling



class and priority of the parent process. Bound threads inherit the scheduling class and priority of the underlying LWP, while unbound threads inherit the scheduling class and priority of the process.

The Solaris kernel employs a preemptive priority-based scheduling system. LWPs of higher priority run before LWPs of lower priority. The Solaris threads library schedules user threads using priority levels on a pool of LWPs and chooses an LWP to execute user threads that are ready to run. If the LWP is blocked on an indefinite wait, the library saves the context of the blocked thread and assigns another thread to the LWP to run. The threads library usually creates enough LWPs to ensure that the process can proceed without an indefinite wait.

A Different Approach

Microsoft Windows NT was designed from the ground up to support multiprocessing and multithreading. Borrowing

from the ideas of object-oriented design, Windows NT uses object classes to represent the system resources. In NT, both processes and threads are represented as objects. Threads are the schedulable entities in NT; every process in NT must have at least one thread before it can execute. Unlike the Solaris two-tier thread model, NT uses a straightforward one-to-one mapping between a user thread object and a kernel thread object.

Threads have 32 different priority levels and are broadly classified into two classes: real-time and variable. Real-time threads in NT are always scheduled ahead of other threads in the system, and the NT kernel does not alter the priority of real-time threads. The thread dispatcher uses a preemptive priority scheduler, with the highest priority thread always scheduled to run.

Threads in the variable class have a base and a dynamic priority. The base priority of a thread ranges two levels above and below

the process base priority. The kernel periodically adjusts a thread's dynamic priority. For example, when a thread waits on an I/O, the kernel raises the dynamic priority of that thread. Threads

that are CPU-bound tend to have lower dynamic priorities, while I/O-bound threads tend to have higher dynamic priority. A thread's dynamic priority can never fall below the thread's base priority.

Each process has a processor affinity, a set of processors on which the threads of that process can run. Processor affinity affects thread scheduling. The NT kernel first picks the highest priority thread and then determines if the thread can run on the processor. If it can't, the next highest priority thread on the processor is chosen to execute. NT, like Solaris, employs soft processor affinity such that it always tries to schedule a thread on the processor on which it last ran.

Threads API

In addition to the SMP OSes, both systems provide an API for creating and using threads in an application. Solaris's threads API is based on the Unix International threads interface, and support for the Posix threads interface is planned in the upcoming release of Solaris 2.5. The Solaris threads interface is very similar to the Posix interface, and applications developed using the threads API on Solaris can be easily ported to use the Posix interface. Windows NT does not support the Posix interface, and applications use the Win32 interface to develop multithreaded applications.

Any threads API can be broadly classified into such groups as thread management, thread synchronization, and thread-specific data. In both Solaris and NT, an initial thread is created when the process starts execution. Additional threads of control must be created by calling the thread-creation API. When a thread is created, it begins executing a start routine, and the new thread of control within the process is capable of independently being scheduled in both Solaris and Windows NT. Each newly created thread has its own stack, program counter, and a thread identifier. Thread identifiers in Windows NT are unique system-wide, while in Solaris they are guaranteed to be unique only within the context of the executing process.

Threads in a process exist in the same address space and share all the process resources, such as data variables, open file descriptors, and object handles. The sharing of data can be a blessing in disguise. Consider two threads in a multiprocessing

environment concurrently updating a linked list. The results of such operations are undefined and can lead to data corruption. In a multithreaded program, any data that multiple threads can update simultaneously must be synchronized. Both Solaris and NT provide several thread-synchronization primitives.

Solaris and NT provide mutual exclusion, or mutex locks, to manage critical sections of the code. These mutex locks allow only one thread to execute the critical section of the code.

In multithreaded applications, it is common to divide the work between multiple threads. In such cases, one thread might have to wait for another thread to reach a particular state before proceeding. This form of synchronization is often called event synchronization. Solaris provides condition variables, while NT provides event objects for interthread synchronization.

In addition to mutexes and condition variables, Solaris provides semaphores and reader/writer locks for thread synchronization. Some of the other synchronization primitives in NT are critical section objects, semaphores, and I/O completion ports. The synchronization APIs on NT offer better functionality than those on Solaris and, except for critical section objects, provide the same APIs for process and thread synchronization. Though both OSes provide the basic functions for thread programming, the Posix threads interface provides much more advanced features than does the Win32 interface.

Developing multithreaded applications also requires an environment that supports multithreading. Solaris provides re-entrant versions for most of the commonly used libraries. Currently, Solaris does not provide thread-safe versions for Motif and OpenLook libraries, which are rarely used by multiple threads in a program. Windows NT also provides re-entrant versions for most of its commonly used libraries.

Debugging multithreaded applications is a big challenge and could be frustrating without the support of a thread-aware debugger. Solaris supports a multithreaded debugger as a part of SPARCworks/iMPact, while Microsoft supports a multithreaded NT debugger as part of Visual C++. In addition to showing all threads of a process, both debuggers support suspending and resuming threads and inspecting variables on a per-thread basis.

The structured exception-handling (SEH) feature of Windows NT aids in the development of robust multithreaded applications. Terminating threads can always release held resources before exiting on exceptions, thus avoiding indefinite postponement. The exception-handling features of Windows NT are not language-specific.

Multithreaded Future

Solaris and Windows NT provide good environments for the development of multithreaded applications. They are by no means the only multithreaded OSes available at the desktop. NextStep, AIX (and other Unices), and OS/2 provide thread support, as does Windows 95. Future versions of the Macintosh OS will also go threaded. The increasing availability of multiprocessor hardware and the improved responsiveness realized even on uniprocessor machines means multithreaded applications are here to stay. ■

Shashi Prasad is vice president of ANSTEC Technologies, a systems integration and consulting firm in Somerset, New Jersey. He is the author of an upcoming book (spring 1996) from McGraw-Hill on multithreading programming techniques, covering multiple OSes. You can reach him on the Internet at shaship@anstec.com or on BIX at editors@bix.com.

Thread Comparison

	Solaris	NT
Thread model	Two-tier	Direct
Posix thread API support	No (planned for 2.5)	No
Re-entrant OS libraries (i.e., thread-safe)	Yes (except for Motif/OpenLook)	Yes

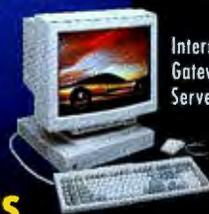


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The Standard Template Library

Part of the draft C++ standard, STL provides the framework for building generic, highly reusable algorithms and data structures

ALEXANDER STEPANOV

In every programming language, there's a need for various data structures, such as vectors, lists, and associative arrays. Programmers also need fundamental algorithms—for sorting, searching, and copying—defined for the data structures. It has long been lamented that C++ doesn't provide a good set of standard data structures.

But at last this problem has been remedied. The Standard Template Library is a framework of data structures (called *containers* in STL) and algorithms accepted as part of the draft C++ standard. A reference implementation of STL has been put into the public domain by Hewlett-Packard (it can be downloaded from butler.hpl.hp.com), and a growing number of commercial vendors are now shipping STL.

In the short time since its release, STL has generated many emotional—and conflicting—assessments. On one hand, for example, Bjarne Stroustrup of Bell Laboratories calls it a “large, systematic, clean, formally sound, comprehensible, elegant, and efficient framework.” On the other hand, Pamela Seymour of Leiden University writes that “STL looks like the machine language macro library of an anally retentive assembly language programmer.”

Goal: Generality + Efficiency

STL is not an attempt to impose yet another standard on a suffering humanity. And it was not designed by or for a committee. It is the result of over 15 years of research in generic programming that I've done in different places, with different collaborators, and in different programming languages. I did this research with a concrete goal in mind: to find a way to write algorithms in the most general way, but in such a way that their abstractness would not impose any performance penalty.

What do I mean by “in the most general way”? Simply that an algorithm works on all data types for which it makes sense. For example, a linear-search algorithm is written in the most general way if it can search any data structure for which the operations of looking at data, going to the next data element, and indicating the end of the search range are defined. So, it should work for an array, a singly linked list, a doubly linked list, a file, and even a binary tree.

An algorithm should also work for portions of such structures. For example, you might want to search half a list or sum the set of elements in an array that are n spaces

apart (i.e., a stride).

What do I mean when I say that an algorithm does not “impose any performance penalty”? In other words, how do you know that a generic algorithm is efficient? An algorithm is called *relatively efficient* if it's as efficient as a non-generic version written in the same language, and it's called *absolutely efficient* if it's as efficient as a nongeneric assembly language version.

For many years, I tried to achieve relative efficiency in more advanced languages (e.g., Ada and Scheme) but failed. My generic versions of even simple algorithms were not able to compete with built-in primitives. But in C++ I was finally able to not only accomplish relative efficiency but come very close to the more ambitious goal of absolute efficiency. To verify this, I spent countless hours looking at the assembly code generated by different compilers on different architectures.

I found that efficiency and generality were *not* mutually exclusive. In fact, quite the reverse is true. If a component is not efficient enough, it usually means that it's not abstract enough. This is because efficiency and abstractness both require a clean, orthogonal design. A similar phenomenon occurs in mathematics: Making a proof more abstract makes it more concise and elegant.

I found that efficiency and generality were *not* mutually exclusive. In fact, quite the reverse is true. If a component is not efficient enough, it usually means that it's not abstract enough. This is because efficiency and abstractness both require a clean, orthogonal design. A similar phenomenon occurs in mathematics: Making a proof more abstract makes it more concise and elegant.

Orthogonal Component Space

The past 25 years have seen attempts to revolutionize programming by reducing all programs to a single conceptual primitive. Functional programming, for example, made everything into a function; the notions of states, addresses, and side effects were taboo. Then, with the advent of object-oriented programming (OOP), functions became taboo; everything became an object (with a state).

STL is heavily influenced by both functional programming and OOP. But it's not a single-paradigm library; rather, it's a library for general-purpose programming of von Neumann computers.

STL is based on an orthogonal decomposition of component space. For example, an array and a binary search should not be reduced to a single, fundamental notion.

Printing Names of Productive Employees

```
vector<Employee> all;
bool is_manager(const Employee& x) {
    return x.title == "manager" }
...
remove_copy_if(
    all.begin(),
    all.end(),
    ostream_iterator<Employee>(cout),
    is_manager);
```

The two are quite different. An *array* is a data structure—a component that holds data. A *binary search* is an algorithm—a component that performs a computation on data stored in a data structure. As long as a data structure provides an adequate access method, you can use the binary-search algorithm on it. Only by respecting the fundamental differences of arrays and binary searches can efficiency and elegance be simultaneously achieved.

Iterators

The key to STL is the notion of *iterators*, which are generalized pointers that provide a glue for connecting algorithms and data structures. STL is indeed retrograde in its disregard of the current academic dogma suggesting that pointers are evil. Instead of hiding pointers behind value semantics, it makes them the cornerstone of the design. The decision to bring pointers back into the realm of respectability was based on a simple fact: Most things in programming resemble pointers in that they identify a location of

An STL Implementation of `remove_copy_if()`

```
template <class InputIterator, class OutputIterator, class Predicate>
OutputIterator remove_copy_if(InputIterator first, InputIterator last,
                             OutputIterator result, Predicate pred) {
    while (first != last) {
        if (!pred(*first)) *result++ = *first;
        ++ first;
    }
    return result;
}
```

data. For instance, Internet addresses, SCSI addresses, and file descriptors all function as pointers.

Consider the task of printing a list of productive employees (see the listing “Printing Names of Productive Employees” on page 177). The employees’ names are stored in a *vector*, an STL version of a one-dimensional dynamic array. To print the names of productive employees, you use the STL function `remove_copy_if()`, which scans the range of elements from its first argument up to, but not including, its second argument and copies those that do not satisfy a predicate (its fourth argument) into positions starting from its third argument. (For most people, the code is clearer than the explanation.) The functions `begin()` and `end()` return iterators pointing to the first element and past the last element in the vector, respectively. (STL requires that for every container, the number of valid iterators pointing to it is one greater than the number of elements in the container.) The STL component `ostream_iterator` provides an iterator-like interface to an output stream.

It’s important to note that if you later decide to put employees’ names in a list instead of in a vector, you do not have to change anything except the declaration of the variable `all`. The `remove_copy_if()` function works for vectors, lists, deques, and sets (which are all STL components), as well as for any user-defined container that provides STL-conforming iterators. It also works for regular C arrays.

Iterator Categories

STL classifies iterators into five categories: input, output, forward, bidirectional, and random-access. These iterator categories are sets of requirements for operations that are supported by concrete iterator types. An important experimental discovery I made was that hundreds of different practical algorithms can be written in terms of these abstract categories.

STL specifies a set of valid expressions for each category’s it-

erators, as well as precise semantics for each iterator’s usage. For example, given that `i` is a value of a type that belongs to a bidirectional iterator category, if `++i` is defined, then `--(++i) == i`. STL also prescribes certain complexity requirements for these expressions. Users are thereby guaranteed that algorithms written in terms of these abstract interfaces will work effectively.

Different algorithms require different kinds of iterators, and different algorithms are needed to perform different operations on different data structures. STL uses a novel language technique that selects the right algorithm at compile time, depending on the iterator category.

Generic Algorithms

The listing “An STL Implementation of `remove_copy_if()`” illustrates how STL deals with iterators. What’s most striking is the fact that it looks just like regular C code; only the signature is different. In fact, I’ve found that C programmers find it quite

easy to start programming in STL even when they don’t know C++, because the underlying idioms are already familiar to them. The fact that all the iterator categories are abstracted from pointers ensures that there is an efficient implementation for them.

In computer science it’s important to base abstractions on efficient models. In other words, I believe that `remove_copy_if()` is efficient because it generates good code when used with plain C arrays. In fact, if you use `remove_copy_if()` with STL function objects rather than with pointers to functions, as I did in the listing “Printing Names of Productive Employees,” you can obtain code that is often just as efficient as hand-written assembly code.

The Future

It is my hope that STL will prove to be the beginning of a long process of developing systematic catalogs of highly parameterized software components. The ANSI/ISO C++ standard committee saw the promise of STL and provided a conduit through which generic programming could reach working programmers.

I’d like to use this opportunity to advocate the creation of an industrywide consortium for developing new generic components. No single company can accumulate the algorithmic expertise that is needed for such an activity. And it is in everybody’s interest that all the fundamental algorithms and data structures be universally and inexpensively available. ■

ACKNOWLEDGMENTS

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Alexander Stepanov is a member of the technical staff at Silicon Graphics, Inc. (Mountain View, CA), where he works on C++ libraries and tools. Prior to joining SGI, he worked for HP Labs, AT&T Bell Labs, Polytechnic University (Brooklyn, NY), and GE R&D. He has worked in such areas as generic software libraries, storage systems, OSes, compilers, and path-planning algorithms for robots. He can be contacted on the Internet at stepanov@mti.sgi.com or on BIX c/o “editors.”

Internet Firewalls

The demand for good Internet firewalls is spurred by the growing number of intrusion incidents

STEPHEN COBB

With new connections to the Internet appearing at the rate of 1 million per month, internet-working may be the biggest revolution in computing since personal computers. But changes of this magnitude often create problems. It's no secret that the rate at which Internet connections are being hacked, cracked, or otherwise compromised is also growing at an alarming rate.

That has caused many companies to look to Internet firewall technology to protect their network resources. However, many companies, when searching for solutions, are finding that they are stymied by a lack of common definitions for key firewall functions. This makes it difficult to tell what functions you are paying for and makes comparisons of similar products impossible.

The National Computer Security Association (NCSA), an independent security association, is trying to bring some order to the confusion created by marketing hype. The NCSA has formed a group called the Firewall Product Developers' (FWPD) consortium. It brings together leading vendors of firewall products in an effort to address such common issues as customer education, standards, product testing, research, and certification.

The FWPD consortium is similar in structure to the Anti-Virus Product Developers' (AVPD) consortium, which was founded by the NCSA in 1991. That group, which included virtually all the major antivirus product vendors, helped clear up the confusion in the antivirus market. For example, the AVPD consortium agreed to use a common naming scheme for viruses. All vendors counted the number of viruses their products detected in the same way, letting customers easily compare products. The FWPD consortium seeks to do the same thing for firewalls.

Meeting a Need

The demand for good Internet firewalls is spurred by the growing number of intrusion incidents. The number of violations reported to the Computer Emergency Response Team (CERT) in 1990 was 130. That number increased to 2300 in 1994.

People involved in these incidents are not just kids getting their kicks with modems. Systematic and automated probing of new Internet connections is being carried out by a shady cast of characters that includes hackers-for-hire, information brokers, and foreign governments. Katherine

Hutchison, director of secure business for Harris Computer Systems, points out that computer crackers gained unauthorized access through the Internet in more than 80 percent of the computer crimes investigated by the FBI.

Fortunately, network administrators can avail themselves of some effective countermeasures, notably firewalls. A firewall can be defined as a collection of systems, routers, and

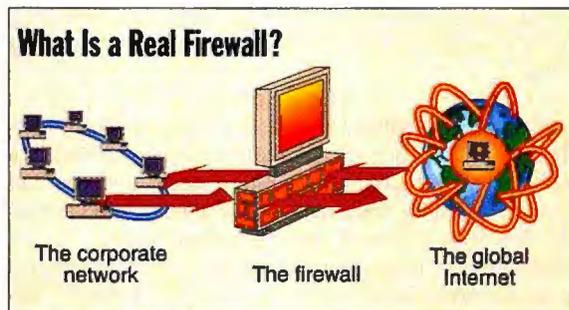
policy placed at a site's central connection to a network. This definition comes from the paper "Keeping Your Site Comfortably Secure," an excellent introduction to Internet firewalls from the National Institute of Standards and Technology (NIST Special Publication 800-10). It can be downloaded free of charge from the NIST World Wide Web site (<http://www.nist.gov>), as well as from sources such as the NCSA InfoSecurity Forum on CompuServe (type GO NCSA to get to the forum).

According to Rich Kosinski, president of Internet Security (Lexington, MA), a firewall is a form of access-control technology that prevents unauthorized access to information resources by placing a barrier between an organization's network and an unsecured network (see the figure "What Is a Real Firewall?"). You can also use a firewall to prevent the unauthorized export of proprietary information from a corporate network. In other words, a firewall functions as a gateway, controlling traffic in both directions.

The Firewall Dilemma

Firewalls have been called condoms for corporate networks. They provide digital protection for participants in the packet-level intercourse associated with the rapid growth of internetworking and commercialization of the Internet. As with condoms, many people have heard of firewalls, and some people use them. However, the number of security incidents arising from Internet connections strongly suggests that not enough people are using them properly.

continued



The Firewall Product Developers' consortium is working toward a common language that will let users better understand and compare firewall implementations.

You might think this is a no-brainer: If you can't make a safe connection to the Internet without a firewall, you get one or you don't connect. But both of these options are fraught with problems. The current level of information-superhighway hype is so intense that network managers who don't provide users with Internet services are likely to find users doing it for themselves.

"Users buy a \$100 modem with petty cash, plug it into a PC on the network, and, since our machines are already running TCP/IP, just turn on SLIP or PPP and dial out to a local service provider," says one network manager (who preferred to remain anonymous) at a major automobile plant. "What these users don't realize is, they have just made the company network part of the Internet."

If you decide to take the preferred approach, an officially sanctioned and properly managed Internet connection, you will find that installing a firewall is several orders of complexity beyond plugging in a modem or configuring NetWare directory access rights. For a start, you have to decide whether to build your own firewall (perhaps using a router and one of the available toolkits), buy an off-the-shelf product, or budget for a specialized firewall consultancy.

Next, you have to decide what type of firewall you want. Do you want a packet filtering router, a dual-homed gateway, a screened or bastion host, or a screened subnetwork? Do you want to integrate a modem pool while you're at it? Are you going to run the firewall software on Unix or under Windows NT? What sort

For more information about the Firewall Product Developers' consortium, contact:

National Computer Security Association
10 South Courthouse Ave.
Carlisle, PA 17013
(800) 488-4595
(717) 258-1816
firewall@ncsa.com

of access controls will you place on the host to prevent internal tampering with the firewall settings?

When you look at the current offerings in the marketplace, you see a wide range of prices, from tens of thousands of dollars down to a few hundred dollars. You may wonder what could possibly make the top-end product worth so much more than the bottom-end product. This is where customer education is critical. Most vendors will gladly supply you with white papers and briefings, point you to Web sites, and otherwise assist you in understanding their product.

However, you may well discover that one vendor's definitions are not consistent with another's. That can cause much confusion. In fact, the lack of a standard terminology with which to describe this rapidly evolving technology means that you will probably have difficulty reaching the decisions required to successfully implement a firewall, causing further delays.

Unfortunately, the lack of a common vocabulary, combined with the urgent need for protection, is being exploited by unscrupulous vendors. Some vendors have slapped the word *firewall* on products that do not measure up to the NIST definition given earlier. If a firewall is not installed properly, it could be worse than

MEMBERS OF THE FIREWALL PRODUCT DEVELOPERS' CONSORTIUM

(For information about each organization's efforts, send E-mail to the address listed.)

ANS CO+RE Systems, Inc.	interlock@ans.net
Atlantic Systems Group	sales@asg.com
CheckPoint Software Technologies	shlomo@CheckPoint.com
Digital Equipment Corp.	kalden@ljo.dec.com
Harris Computer Systems Corp.	Cyberguard@mail.hcsc.com
IBM	peter_crotty@vnet.ibm.com
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Telos	michael.lazar@telos.com
Trusted Information Systems	gauntlet-info@tis.com

not having one due to a false sense of security.

Some Relief in Sight

This is where the FWPD consortium comes in. It was formed in June by a group of vendors and several security agencies (see the table). The FWPD wants to foster codes of practice for the industry. "The FWPD will promote awareness and understanding of firewalls, explore product certification and testing, and serve as an

authoritative but independent contact point for inquiries about firewall technology," says Peter Tippett, president of the NCSA.

Tippett describes the public information role as countering the media hype and being the voice of calm. To provide the necessary depth of knowledge in firewall technology, the NCSA has formed a strategic partnership with Marcus Ranum. Head of Information Works, Ranum is well known for his seminal 1992 paper "Thinking About Firewalls." Ranum also designed the TIS Internet Firewall Toolkit, which forms the basis of more than a dozen commercial products.

Noting that many firewall product descriptions use similar jargon in dissimilar ways, Ranum proposed, and the inaugural meeting of the FWPD agreed, that the first order of business should be to develop a common language for talking about firewalls. As a starting point, Ranum presented a draft version of the Firewall Product Functional Summary, a standardized format in which vendors can describe the distinguishing features and advantages of their products. The Summary's second major purpose is to give users a way to compare and contrast the features and design principles of firewall products.

The goal of the Firewall Product Functional Summary is to provide plenty of scope for vendors to present the strengths and advantages of their particular offerings, but in a way that has some real meaning to users. The document can be accessed via the Web at <http://iwi.com> or by sending an E-mail message to firewall@ncsa.com.

Beyond Standards

The FWPD is not "yet another standards committee," says Bob Bales, executive director of the NCSA. Noting that the industry already has appropriate committees, such as ANSI, for setting standards in areas such as firewall-to-firewall encryption, Bales says that the goals of the FWPD are more in the direction of customer education and industry self-regulation.

"The bottom line is getting more people to use more firewalls more effectively," says Bales. The formation of the FWPD means that the people who need firewalls and the people who make them will be able to work together more effectively to better defend the network systems upon which we all increasingly rely. ■

The author of more than 20 books and hundreds of articles on computing, Stephen Cobb is director of special projects for the NCSA and cochair of the Computer Ethics and Responsibilities Campaign. His latest book, The NCSA Guide to PC and LAN Security, will be published by McGraw-Hill later this year. He can be contacted at scobb@ncsa.com.

JERRY POURNELLE

Death Swoops and Upgrades

I'm just back from watching the DC/X do a perfect death swoop, and maybe I'd better explain that. The DC/X is a one-third scale model of a single-stage-to-orbit (SSTO) spacecraft. Back in 1989, Max Hunter, General Daniel Graham, and I convinced the National Space Council to investigate the SSTO concept, and the DC/X was one result. If you see it fly, it's unforgettable: it goes straight up, hovers, and lands on a tail of fire.

One design for a full-size SSTO spacecraft reenters nose first, meaning that somewhere in the flight it must rotate to tail down. That's a dangerous maneuver that's become known as the death swoop, but yesterday's flight went so well it was almost dull.

There was one glitch. The radar altimeter gave a false reading, and the flight-control software, which thinks this is a very odd F-15 flying an even odder flight profile, believed the reading. Thus, the ship came down fast and landed harder than she was supposed to, crushing some nonresilient shock-absorbing material. That's what's supposed to happen in a hard landing, and the crushables are designed to be field-replaceable, so you can count this another successful test.

Meanwhile, we've been upgrading both hardware and software at Chaos Manor. As usual, things didn't go quite as planned, so we learned a lot.

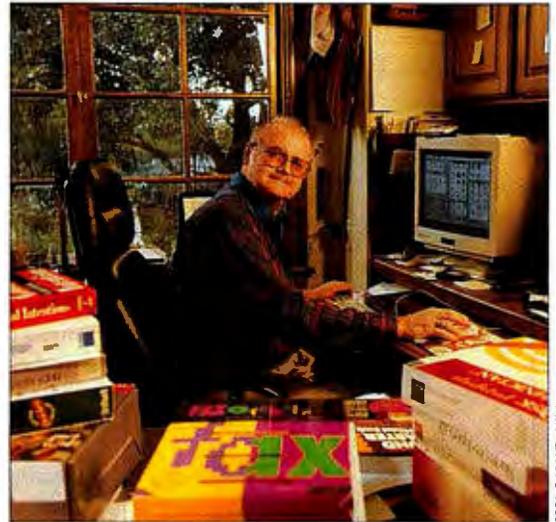
The first upgrade was installing OS/2 Warp Connect on Valiant, the ValuePoint Pentium. Installing OS/2 has been so difficult that I expected more trouble with Warp Connect than I had. Still, I had enough problems that I kept IBM technical experts Sam Detweiler and Charlie Brown on the phone for 3 hours.

IBM has been listening: OS/2 Warp Connect's installation program is a lot better than previous OS/2 installation programs. Installing it on Percy, the IBM PS/2 Model 77, went without a hitch. Percy had been running Blue Label Warp, meaning that it has Win-OS/2 built in. Alas, Valiant was running Red Label Warp—which requires your own DOS and Windows—and OS/2 Warp Connect is Blue Label. An additional problem was that I was using OS/2 LAN Server with the older Warp. You can't install

Warp Connect over that. Fortunately, it uninstalls itself easily.

Before it was over, I learned more about editing an OS/2 CONFIG.SYS file than I wanted. Although I was talking to system programmers, standard IBM technical support is quite good. If you're determined to get Warp Connect installed, they'll work with you until you manage it. One detail is significant: when you do get it installed, turn off your computer before you bring it up for the last time.

When you get OS/2 Warp Connect running, you'll like it. It retains one major design defect. Whereas Windows and Windows 95 (W95) trap Ctrl-Alt-Del and let you use that to shut down a nonresponding window, all flavors of OS/2 commit suicide when receiving Ctrl-Alt-Del. While it's rare to get an application so fouled up that Ctrl-Escape won't return to the OS/2 desktop, it can happen with both DOS and Windows programs running in an OS/2 environment. It's most



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likely when testing new software. It's extremely likely if you run a DOS game inside Windows inside OS/2. Also, I can reliably crash OS/2 by being careless with the reply editor in Norton Commander's MCI Mail Manager.

With that exception, I've found OS/2 Warp Connect as solid as a rock. It's fast. It networks to itself, Windows for Workgroups, and W95 with no problems. It does reliable multitasking. It prints so well that I've connected the Hewlett-Packard LaserJet III to Valiant and do all my printing across the network. The package includes an astonishing amount of useful and solid software, including communications software that makes Internet surfing almost trivially simple.

OS/2 is neat. Why not try it? A year ago, that would have been an insane suggestion: changing OSes was a big deal. Now it's fairly simple. First, storage space is no longer a major problem. You can buy enormous hard drives—a 1-GB IDE drive is under \$300, and we got a 3-GB SCSI drive for under \$800.

Second, and more important, Communications' System Commander lets you change OSes more easily than you used to be able to change CONFIG.SYS and AUTOEXEC.BAT.

System Commander is a blooming miracle. It's simple to install, and once installed, it's easy to add OSes. The instructions are complete, and the documents are a decent guide to configuring OSes.

You install System Commander under DOS. If you're putting it on an OS/2 machine, you dual-boot back to DOS and install it there, after which System Commander will operate exactly as OS/2 Boot Manager, whether you installed Boot Manager or not. Once you have System Commander installed, you can add OSes to your heart's content. I'm seriously thinking of setting up a machine with Blue and Red Label Warp; DOS 3.x, 5.x, and 6.x; Novell DOS 7; NT; W95; Linux; and SCO Unix. That may be going a bit far, but it's possible.

Some installations can be a bit tricky, and you'll want to read the documents carefully. For instance, if you already have W95 installed, you must save some files in a temporary place, boot up with a DOS disk, install System Commander, reboot W95, reboot from a DOS disk, SYS the hard disk with DOS, and reboot one more

time. At this point, you'll have your choice of booting with DOS or W95. You can then add other OSes.

Highly recommended for anyone who likes to experiment.

PowerQuest's PartitionMagic works with System Commander, and it's recommended in the System Commander manual. While System Commander lets you change OSes without reformatting and losing your data, PartitionMagic lets you decide how much of your hard drive you want to devote to each OS. You can change those allocations on the fly. If you want to experiment with OS/2's High Performance File System (HPFS), this is a painless way to try it.

The version I have says "For OS/2," but in fact it includes a version that runs just fine under DOS. You can use DOS

PartitionMagic to create a new logical drive for OS/2 and

other OSes.

You can then use System Commander to choose among those systems when you boot up and finally use PartitionMagic to reallocate space to them after you've done your experiments—all without losing data. Of course, you

should back up everything before trying this.

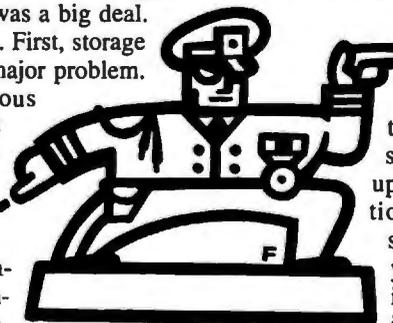
Installing and using PartitionMagic is easy, and the instructions are clear and complete. If you get System Commander, you'll almost certainly want this, too. Highly recommended.

Before you upgrade, you must back up your system. You should know about SnapBack, which may be the ultimate in backup programs.

My regular backup system remains Palindrome's Network Archivist with a digital audiotape (DAT) drive. I have used it for years both locally and over a network, and I have never lost a byte of data protected by it.

Network Archivist is great for recovering lost files, and its library management guards against operator errors. I wouldn't want to be without it; but using it to restore whole volumes can be complicated, and it doesn't do anything to restore the boot sectors of an OS.

For that you need SnapBack, which builds up a "below-the-OS" low-level image of any drive or drive partition. That image can contain as much of the original data as you like and can be stored on



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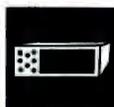
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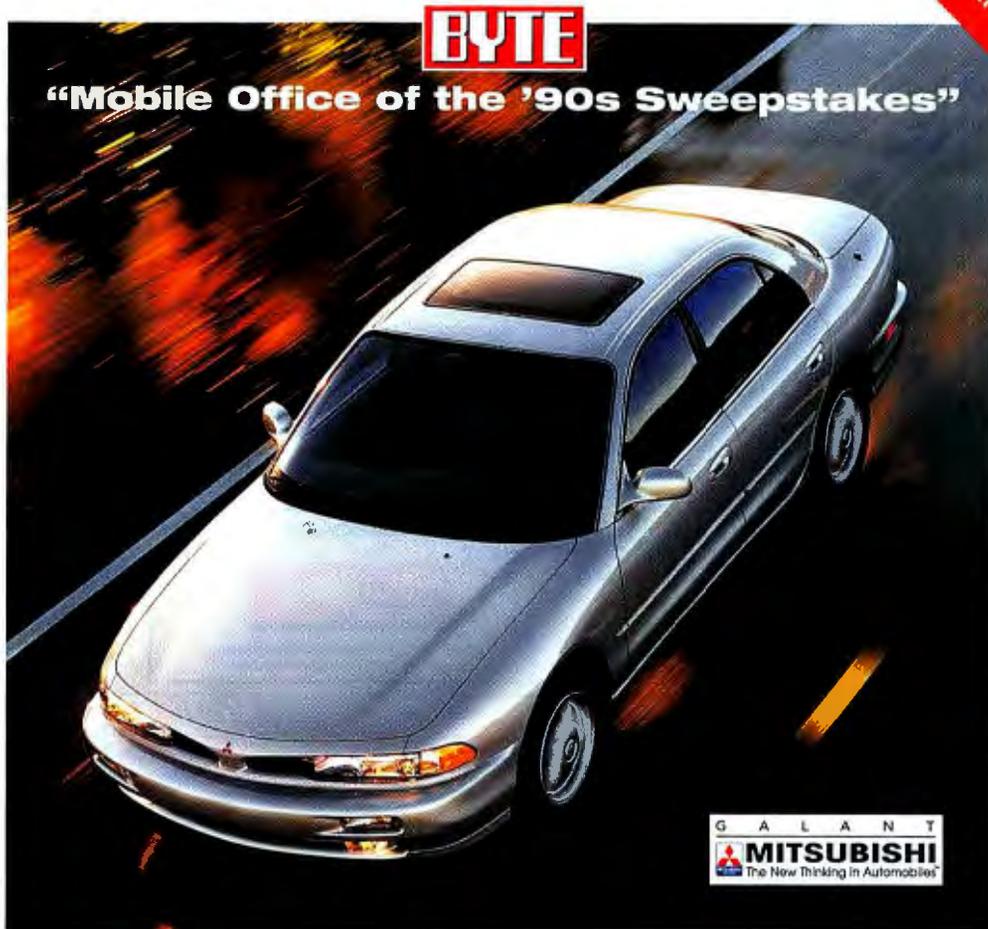
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nearly any SCSI device, including tape. SnapBack itself can be run from a hard drive or a floppy disk on any machine that will boot DOS. Once SnapBack is running, it doesn't care what OS it's installing on the target disk, nor does that target disk have to be formatted.

Novell system administrators will love the newest version of SnapBack, which lets you back up a hard drive and transfer everything to a new and larger drive with a larger Novell partition.

If you need this, you need it bad.

Our next upgrade was to replace the Pentium chip in Pentafluge. Intel makes it very easy to replace your math-defective Pentium chip. It took me longer than it will take you, because I happen to know a senior Intel vice president, and I called him. My friend handed the job to another executive, who passed it along to a third;

**Intel really wants that
old math-defective
Pentium chip back, and
if you don't send it in,
they'll charge you
about \$500.**

eventually I got connected to the people who do this routinely, which is where I should have started. They asked a number of intelligent questions to establish the speed of my current Pentium chip and the kind of socket it sits in. Then they got my address and a credit-card number.

The credit-card number is required so that you'll have an incentive to return your old chip: Intel really wants that chip back, and if you don't send it in, they'll charge you about \$500. However, they send self-addressed prepaid packaging, so returning your old chip is both simple and free.

The new chip comes with complete instructions. It took me less than 5 minutes to power down Pentafluge, open him up, replace his Pentium chip with the new one, connect the chip fan to the power supply, button up the machine, and restart it. It took another 5 minutes to box up the old chip and get it out.

I hoped my next hardware upgrade would be as easy as upgrading the Pentium, but it

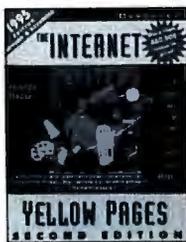
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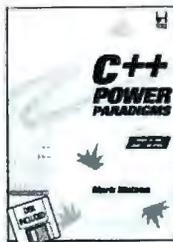




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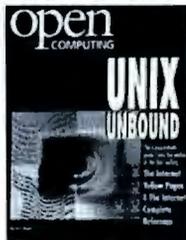
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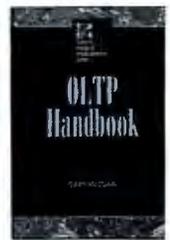
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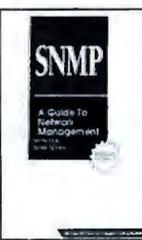
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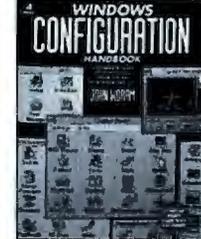
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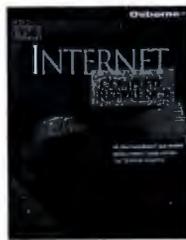
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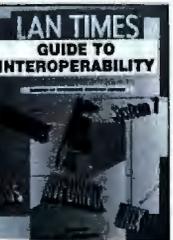
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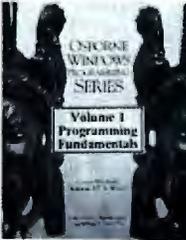
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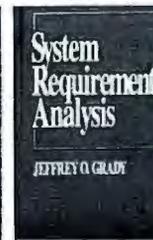
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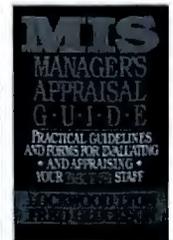
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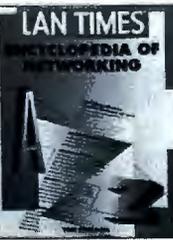
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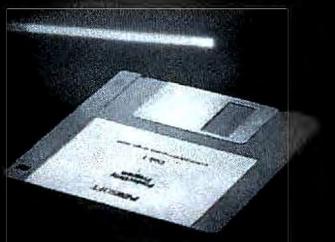
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POURNELLE

didn't work out that way.

It started with a Western Digital Caviar AC31000 1.1-GB hard drive, which I used to upgrade SuperCow, the Gateway 2000 486DX2/66. I was in a hurry, so I figured that rather than transferring all the files from the 500-MB hard drive SuperCow came with, I'd install the Caviar as a second physical drive. Western Digital's instructions are clear and complete.

Alas, when I tried to partition the new drive, SuperCow could see only about 25 MB of the 1.1 GB. The instructions warned that might happen; the remedy is to get a new BIOS. That costs \$80, and you get it from Micro Firmware (Norman, OK, (405) 573-5501; <http://www.firmware.com>). Ordering the BIOS took less than 5 minutes, including rebooting SuperCow to get the current BIOS version number.

SuperCow uses flash ROM, so the new BIOS came on a floppy disk. The documentation is excellent. About 10 minutes later, I had installed the BIOS and used FDISK to partition the Caviar AC31000. Formatting took another 10 minutes or so.

For most of you, that will be the end of the story, but apparently nothing is simple at Chaos Manor. My hard drive worked just fine, Windows for Workgroups came up, and I could share the new drive across the network—but for reasons we still don't understand, the Future Domain 8-bit SCSI card that runs Network Archivist and its DAT drive simply would not work.

I have two versions of that SCSI card, an ancient one that has no ROM and is thus ideal for using a DAT since it takes up no memory unless the tape is actually operating, and a later version with ROM that will run an 8-bit SCSI device string, including the Maximum Storage Duette read/write optical drive. Both worked fine before I upgraded the BIOS; neither works now. On boot-up, they report "Internal Self Check Failure."

I reported this to Micro Firmware and shortly after got E-mail from Robert Braver, president of the company. He made several suggestions, all sensible. None worked. Finally he asked me to send him the SCSI cards, which I did. Of course, they worked perfectly when he tried them on some of his Gateway 2000 486DX2/66 systems.

The next step will be to swap mother-

boards. Micro Firmware has offered to send me one; they're far more curious about what has caused this than I am.

The bottom line here is that the Western Digital Caviar AC31000 is easy to install and works splendidly. If you need to install a new BIOS—and you probably will if you have a machine more than a few years old—that won't be difficult. If you have problems, Micro Firmware has excellent technical support.

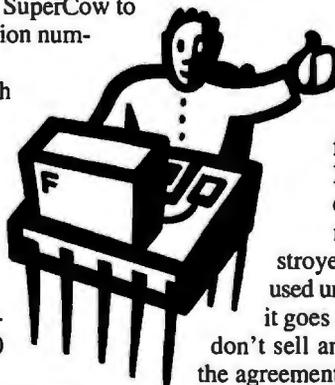
About a month ago, I got a strange offer, which I presume was made to a lot of journalists: Fujitsu would be pleased to send me one of its DynaMO 230 magneto-optical (MO) drives if I'd sign a pledge not to sell it for a year. Clearly, they're trying to break the lock SyQuest and Iomega established in much the same way.

This was no problem for me. I never sell anything I get for review. Some equipment goes back to the manufacturer, some gets destroyed, and quite a lot just gets used until it's obsolete, after which it goes to a local school; but I sure don't sell any of it. Anyway, I signed the agreement and specified the external model.

It's neat. The external drive is 5 by 8 by 1.5 inches thick, considerably smaller than the DAT unit. It comes with a little stand that will hold its slot vertical, but I laid it on its back. Unfortunately, I wasn't paying attention. I put it on the tower case of the Cheetah 386 and put the DAT unit on top of it. Over a week later, I discovered that I'd laid it upside down, completely covering the ventilation holes. I don't recommend that as standard practice, but it doesn't seem to have done any harm.

The DynaMO 230 came with an Adaptec 16-bit EZ-SCSI card. Installation was simple. Adaptec's documents are complete, and their installation software took care of it all. I had the DynaMO 230 running in 10 minutes. Then, just for luck, I put Network Archivist and the DAT drive on the same SCSI string. This is the drive that normally runs off the Future Domain card I'd sent to Micro Firmware for testing. When I booted up, the Adaptec card announced that it had found both the optical and tape drives, and when I brought up Network Archivist, that ran fine. Both the DAT drive and the DynaMO 230 are now sharable network resources.

The DynaMO 230 came with an order form for more optical disks: a five-pack



of 230-MB MO disks costs \$185. A 230-MB optical disk actually formats to 217 MB, so your medium cost is about 17 cents a megabyte. The optical disks are smaller (about the size of a 3½-inch floppy disk), and the drive is light and easy to carry around. The medium cost with DAT is about 1 cent a megabyte, but tape is a lot slower and less convenient.

The Fujitsu DynaMO 230 seems reliable. I've beat the living daylight out of it by setting up a batch file that writes and overwrites it for hours at a time. I did get a write-protect error when it was upside down, but standing it up to get some ventilation fixed the problem. It's fast. Though not as fast as the current generation of hard drives, it's faster than those we had five years ago. It takes a lot less time to write a backup copy to an optical drive than to a tape drive. Speed is important to backup systems: unless they're fast, you won't use them often. Every hour or so, I write a copy of my current work to a different machine; it would be as easy to write to an optical disk.

Everyone needs more disk space. If you are thinking of expanding, optical drives like Fujitsu's DynaMO 230 are well worth considering.

Continuing with upgrades, there's W95; I've had five builds in the last month. Each one cures another bug or two.

We went through builds 464, 480, 495, 501, and suddenly jumped to 950, which is probably a symbolic number. Build 950 installed easily—all the upgrades have—or so I thought until I tried to access the network.

There wasn't any network. Pentafluge couldn't see any other machines out there. I nearly panicked. Then I remembered I'd had a similar problem with OS/2 Warp Connect, so I tried the same remedy: I turned the machine off, counted to 10, and turned it back on.

That did it. When W95 came up, I looked into the Network Neighborhood folder, and voilà!, there were all my network resources.

There are still some problems. For example, while I use Microsoft Word for complex editing, I prefer to create text with a character-based editor. For years, I used the stand-alone version of Q&A Write, but my experience with Word has got me accustomed—*addicted* might be a better word—to using a mouse for moving and deleting blocks of text. Stand-alone Q&A Write doesn't have mouse support, but the Write built into Q&A 4.0 does, and I decided to write this column using that.

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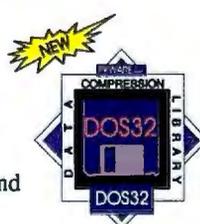
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Anyway, all went well until I needed to transfer an address from a previous column. What I usually do is open a DOS window running Microlytics' GOfer, send it out to search my old columns until it finds the company name, and use the Windows editing facility to mark and copy the text from the GOfer window and then paste it into the Q&A Write window. This works fine with stand-alone Q&A Write; but when I tried it with Write inside Q&A itself, I got an error message inviting me to recover with "escape." That "recovered" in the sense that I was back at the command level of Q&A, but all my text was gone.

Fortunately, I save early and often, particularly before doing anything odd; I don't leave an editing window without saving my text first. Still, it's annoying, because text transfer through copy and paste is a convenient Windows feature. By mucking around, I find that I can paste into stand-alone Q&A Write, save the file, and read that saved file into Q&A. That's not a very convenient kludge.

I suppose I'll just have to bite the bullet and start using Word for text creation. On the other hand, finding bugs is fun...

W95 has multimedia support and a ton of features, so it's a natural for a multimedia tutorial program on CD-ROM. Alas, EasyTutor from CRT Multimedia isn't the right one for me. It has some slick multimedia, but while the introductory level is surely that, the detailed level doesn't go anywhere near far enough.

For instance, at the Microsoft W95 dog and pony show, they showed a lot of tricks using the registry and registry editor. W95

help on using the registry is skimpy to nonexistent, so I'd hoped this tutorial would tell me more. Alas, the Power User topic is no more useful on the subject than Microsoft's Help file.

It's worse than that. If you leave EasyTutor open and go do something else, it not only puts itself on top of your toolbar, where it prominently displaces the Programs item, but it somehow bollixes up the Alt-Tab task-switching feature. Closing EasyTutor fixes both problems.

I sure wish I had a good tutorial to explain the W95 registry, though.

I continue to work on Roberta's reading-instruction program. The Mac version has produced some astonishing results in beta tests. I'm upgrading the QuickBasic DOS version preparatory to putting it on Windows with Visual Basic.

In both cases, I'm using Crescent Tools from Progress Software. Visual Basic plus Crescent Tools gives you some truly awesome programming capabilities. The programs may not be as fast and compact as programs written in C++, but I really don't care. With Visual Basic, I can get things running in days, not months.

I'm also looking at 3D Choreographer from AniCom. It produces stand-alone animated sequences you can call with programs like PowerPoint—and, of course, Visual Basic. I've only just started with it, but it seems easy to use and solid.

The book of the month is *Independent Birth Of Organisms* by Periannan Senapathy (Genome International, 1994). Fair warning: this book is heavy reading, being nothing less than a new theory of



evolution; or, rather, a critique of why current theories

based on Darwin can't be correct. If nothing else, this is a readable (with difficulty) introduction to modern molecular biology. I found it fascinating, but then I like complicated scientific detective stories.

There are two computer books of the month from The Waite Group: *Visual Basic 4 How-to for Windows* and *QB Primer Plus*. These are excellent as both introductions and reference works.

There are about a zillion Internet books. One that's sort of fun is by Rawn Shah and James Romine, *Playing MUDs on the Internet* (Wiley, 1995). A MUD is a Multiuser Dungeon, and this will tell you what they are, how they work, and which ones to look into. That's worth knowing, because I suspect MUD technology will become important for business and education in the future.

The game of the month is *Terror from the Deep*, MicroProse Software's follow-on to *XCOM: UFO Defense*. The aliens are back, and they're really angry. Warning: as with many MicroProse games, this was released with bugs. Log on to GENie or another on-line service and download the upgrade patch. Also available on GENie is a great little "cryogenics" program that will let you transfer your XCOM troopers into this game.

One final note: they fly the DC/X with a mouse. When the Air Force turned the DC/X over to NASA after the flight, the presentation plaque sported a model of the ship and a Macintosh mouse. ■

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 the Internet or BIX at jerry@bix.com.

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Installing and using **PartitionMagic (for OS/2 and DOS, \$69; for DOS and Windows, \$49)** is easy. Contact PowerQuest Corp., Orem, UT, (800) 379-2566 or (801) 226-8977; <http://www.powerquest.com>.
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Novell system administrators will love **SnapBack 3.06 (per server, \$995)**,

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System Commander (\$99.95) lets you change OSes more easily than you used to be able to change CONFIG.SYS and AUTOEXEC.BAT. Contact V Communications, Inc., San Jose, CA, (800) 648-8266 or (408) 296-4224.
Circle 1244.

The game of the month is **Terror from the Deep (about \$49.95)**. Contact MicroProse Software, Hunt Valley, MD, (800) 879-7529 or (410) 771-1151; <http://www.microprose.com>.
Circle 1245.

3D Choreographer (\$149) seems easy to use and solid. Contact AniCom, Inc., Chapel Hill, NC, (800) 949-4559 or (919) 967-2890; <http://www.spadlon.com/anicom>.
Circle 1246.

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WHAT'S NEW Hardware

PREVIEW MAC POWERBOOKS

Portable Mac: Power, Long Battery Life

With a 100- or 117-MHz PowerPC 603e at its heart, Apple Computer's latest line of PowerBooks combines RISC-processing power with insanely great battery life. Apple went with the 117-MHz specification for two reasons: 603e yields at 120 MHz were problematic, and Apple doesn't want to repeat the supply shortages that plagued the PowerBook 500 series.

BYTE looked at a preliminary PowerBook 5300c with a 100-MHz 603e and a 10.4-inch active-matrix color LCD screen. The PowerBook 5300c's long battery life is achieved through the power-saving features of the 603e, which saves its internal state while turned off, and the power management software in the Mac OS, which literally switches off the processor between keystrokes. A single lithium-ion battery provides an estimated 3 to 5 hours of battery life.

We used BYTE's Thumper 2 on the PowerBook 5300c and obtained an impressive battery life of nearly 7 hours (see the table above). Although Thumper 2 imitates some keyboard activity, the



PowerBook 5300c

With a 100-MHz processor, 8 MB of RAM (expandable to 64 MB), a 500-MB hard drive, and a 9½-inch dual-scan gray-scale LCD screen, \$2200; with a 10.4-inch active-matrix color LCD screen, \$3800.

Apple Computer
Cupertino, CA
(800) 776-2333
(408) 996-1010

Circle 976 on Inquiry Card.

Battery-Life Performance

System	Hours
PowerBook 5300c (100-MHz PowerPC 603e)	6.87
PowerBook 540c (33-MHz 68LC040, two Type II NiMH batteries)	6.00
Toshiba 2150CDT (75-MHz 486DX4)	5.20
Toshiba T4900 CT (75-MHz Pentium)	4.25

603e processor switches off between keystrokes, so BYTE's battery-life benchmark number is optimistic. But it does indicate that Apple's 3- to 5-hour estimate for heavy usage appears accurate. Your mileage will vary, depending on your work patterns and the PC Card (formerly PCMCIA) peripherals you use.

Other notable features include a 32-bit I/O bus; a PC Card slot, which holds one Type III or two Type II cards; an infrared communications port; and a storage bay that holds a removable floppy drive or other storage media.

In sum, the PowerBook 5300c racks up Pentium-caliber performance and impressive battery life far beyond what we've seen with 486- or Pentium-equipped notebooks, all in a package weighing in at 6.2 pounds.

—Tom Thompson

133-MHZ SUPERSYSTEM

Specifically designed for CAD and engineering applications, the Tri-CAD 133/SS is built around Intel's 133-MHz Pentium processor and a PCI-bus mother-

board. The 133/SS (\$7399) comes with 32 MB of EDO RAM; a 1.6-GB hard drive; 256 KB of TriStar's proprietary CADcache; a dual-channel 32-bit EIDE controller; an Elsa Winner 2000

Pro/X graphics accelerator with 8 MB of video memory, 1600-by 1200-pixel resolution, and an 85-Hz refresh rate; a 21-inch ViewSonic digital monitor; a hex-speed CD-ROM drive; and a 28.8-Kbps internal fax modem.

Contact: Tri-Star Computer, Tempe, AZ, (800) 800-7668 or (602) 731-4926.

Circle 980 on Inquiry Card.

REMOVABLE HARD DISK SYSTEMS

Available in capacities of 1, 1.7, 2.1, 4.2, and 9 GB, the Stampede line of

storage systems offer access times as fast as 8 ms and data transfer rates as fast as 20 MBps and allow you to combine 3½- and 5¼-inch drives within a single docking station. Each drive module can accommodate a fast SCSI-2 or fast-and-wide SCSI-2 hard drive. Each SCSI address can accommodate more than 63 GB of data, and you can daisy-chain Stampede docking stations to achieve more than 400 GB of storage capacity per SCSI bus. Stampede systems (\$1750 each) are available in two-, four-, and eight-bay desktop docking stations, in an eight-bay desk-side pedestal, and in an eight-bay rack-mount configuration.

Contact: MountainGate Data Systems, Reno, NV, (800) 556-0222 or (702) 851-9393;

sales@mntgte.lockheed.com.

Circle 982 on Inquiry Card.

CENTRAL-SITE CONCENTRATOR

XpressStack, a series of three modular, stackable central-site concentrators (from US\$9450), employ multi-RISC processor technology for the best possible throughput, whether you use one or multiple modules. For basic-rate ISDN connections, XpressStack BRI provides 16 64-Kbps channels, support for a single 10Base-T LAN interface, and

an asynchronous console port. XpressStack PRI provides the same concentration via one ISDN PRI interface, which provides 23 North American (or 30 European) 64-Kbps channels. A 24-port intelligent Ethernet switch, XpressStack VLS creates an independent 10-Mbps Ethernet segment.

Contact: Gandalf Technologies, Nepean, Ontario, Canada, (800) 426-3253 or (613) 723-6500; <http://www.gandalf.ca>.

Circle 986 on Inquiry Card.



MULTIFUNCTION WORKCENTER ▲

The Document WorkCenter Pro 610 (\$2495) delivers plain-paper laser-faxing and digital-copying features together with optional printing and scanning. You can program up to 100 auto-dial numbers and up to 10 one-touch group dials for fax broadcasting. Up to 10 individual mailboxes let you receive and retrieve faxes from remote locations. The 40-page memory is upgradable to 200 pages (\$199), and the 250-sheet paper tray is upgradable to 500 sheets (\$99). The optional Windows and DOS printing capability (\$495) supports PCL 5e with 600-dpi resolution. The scanning option (\$99) offers a resolution of 300 by 300 dpi, which you can use with TWAIN-compatible software packages, and OCR capability via TextBridge 3.0.

Contact: Xerox, Palo Alto, CA, (800) 275-9376 or (415) 813-6800; <http://www.xerox.com>.

Circle 985 on Inquiry Card.



VIRTUAL-REALITY HEADGEAR ▲

An integrated headset, the VFX1 Headgear Virtual Reality System (\$995) features high-contrast 789- by 230-pixel LCDs, a three-axis VOS Head Tracker, high-fidelity stereo headphones, a ComSet microphone, a Smart Visor, and custom lenses. The system includes the CyberPuck controller, a device that provides additional virtual-reality input, and a CD-ROM with playable versions of PC-based games such as Electronic Arts' Magic Carpet and Interplay's Descent. The VFX1 Headgear Virtual Reality System also incorporates Access.bus technology, which lets you simultaneously connect up to 125 devices to your PC.

Contact: Forte Technologies, Rochester, NY, (716) 427-8595; sales@fortech.com.

Circle 981 on Inquiry Card.

INTERNAL OR EXTERNAL TAPE BACKUP DRIVES

The Ditto 420 (internal, \$99.95; external, \$199.95) can back up 420 MB of information on a single QIC-wide tape. Using Travan technology, which enables you to back up and restore more than 3 GB of information in a single, unattended session, the Ditto 800 (internal, \$199.95; external, \$299.95) has the ability to back up 800 MB of data, and the Ditto 3200 (internal, \$299.95; external, \$399.95), 3.2 GB of data. The Ditto 800 and Ditto 3200 drives are all compatible with QIC, QIC-wide, Travan, and Irwin tape formats.

Contact: Iomega, Roy, UT, (800) 697-8833 or (801) 778-1000; http://www.iomega.com.

Circle 979 on Inquiry Card.

MULTIMEDIA X TERMINALS

The TekXpress XP400 series X terminals (\$2695 to \$4795) are designed to provide a single desktop solution for graphical access to network information and distributed multimedia applications. The systems all come with an LSI 33120 RISC processor; 8 MB of RAM, expandable to 136 MB; 2 MB of video memory; a twisted-pair Ethernet interface; two RS-232 ports; and a monitor. Options include an MPEG digital-video coprocessor, an audio coprocessor, thinnet and thicknet interfaces, flash memory, a dual-slot PC Card (formerly PCMCIA) interface, a parallel port, a keyboard, and a Sony 20-inch monitor. With the Tek XpressWare software, the XP400 series systems can access network-mainframe, legacy, and Unix applications. With the WinDD software, you can display Windows and other PC applications on your XP400.

Contact: Tektronix, Wilsonville, OR, (800) 547-8949 or (503) 682-7300; http://www.tek.com.

Circle 983 on Inquiry Card.

COLOR-THERMAL PRINTERS

The latest models in the Spectra*Star line of plain-paper color-thermal printers are the Model 240 (\$2995) and the top-of-the-

line Model 280 (\$3995). Both models support PostScript Level 2 and Pantone-certified color matching and offer serial, parallel, and AppleTalk ports. A Color Copy Cartridge (about \$200) plugs into the Pockette slot and provides a connection to popular color scanners, so you can also use the printers as full-color copiers.

The Spectra*Star Model 240 uses a 25-MHz Intel 80960CA



RISC processor and comes with 6 MB of RAM (expandable to 24 MB) and 52 professional fonts. It can print at resolutions of up to 600 by 300 dpi with additional RAM. The Spectra*Star Model 280 uses the Intel 33-MHz 80960CF RISC processor and comes with 10 MB of RAM (which is expandable to 32 MB), 52 professional fonts, and two Pockette slots, which can accommodate a plug-in Ether-

net LAN cartridge and a 120-MB hard drive cartridge.

Contact: General Parametrics, Berkeley, CA, (800) 223-0999 or (510) 524-3950.

Circle 992 on Inquiry Card.

CABLE MANAGEMENT TOOL

The PentaScanner+ with 2-Way Injector+ (\$4595), PentaScanner Cable Admin with Super Injector (\$2795), and PentaScanner+ with Super Injector (\$3495) all offer hand-held cable certification and diagnostics; 100-MHz operation; support for UPT, STP, ScTP, and coaxial cable; measurement of NEXT, attenuation, length, impedance, resistance, capacitance, attenuation to cross-talk ratio, wire map, and noise; support for network topologies, such as 10- and 100-Mbps Ethernet, Token Ring, and ATM; replaceable, rechargeable nicad batteries; printing of test results; a backlit display; and flash memory. The 2-Way Injector+ accessory measures near-end cross talk and attenuation on both ends of the installed network cable link.

Contact: Microtest, Phoenix, AZ, (602) 952-6400; 70414,2116@compuserve.com.

Circle 991 on Inquiry Card.

DO-IT-YOURSELF CD-ROM RECORDING

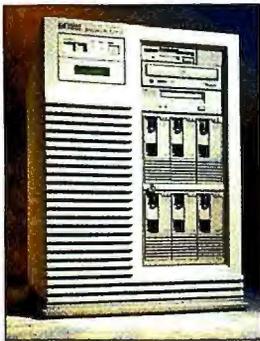
At the heart of the Spressa 920 is an internal CD-R drive with a maximum sustained data transfer rate of 300 KBps, a 1-MB data buffer, and the ability to record a 650-MB disc in about 30 minutes. If a buffer underrun occurs, the drive's disk-recovery algorithm seals off the section of the disc where the error occurred, allowing the Spressa 920 (\$1999.95) to use the rest of the disc. The drive can record in many CD formats, including CD-ROM, CD-ROM XA, CD-Audio, Audio-Combined CD-ROM, CD-I, Photo CD, and Video CD, and offers three recording methods: disc at once, incremental, and multisession.

Contact: Sony Component and Computer Products Group, San Jose, CA, (800) 352-7669 or (408) 432-1600.

Circle 977 on Inquiry Card.



WHAT'S NEW Hardware



SCALABLE NETWORK SERVERS

The NetServer LS Series of network servers (about \$6506 to \$18,611) are scalable from single-processor Intel Pentium/75 systems to quad-symmetric-multiprocessor Pentium/100 and Pentium/133 systems. Features include a 64-bit clock-independent system bus; dual PCI peer buses; dual PCI fast-and-wide SCSI-2 controllers in RAID levels 0, 1, 5, and 6; dedicated Level 2 caches; error-checking-and-correcting memory that's expandable to 768 MB; and MPS support. A hot-swap disk subsystem lets you replace failed drives while the server continues to work and automatically reconstructs data on a spare drive. An Auto-

matic Server Restart feature reactivates the server if the network OS hangs.

Contact: Hewlett-Packard, Santa Clara, CA, (800) 322-4772 or call local HP dealer;
<http://www.hp.com/go/netserver>.

Circle 978 on Inquiry Card.

PCI-BASED MULTIMEDIA ACCELERATOR FOR POWER MAC

The Diamond Javelin Video 3000 series includes the Javelin Video 3240XL (\$399), which provides 2 MB of video memory (upgradable to 4 MB) and supports 16.7 million colors at resolutions of up to 1152 by 870 pixels, and the Javelin Video 3400XL (\$569), which contains 4 MB of video memory. Both models feature a 220-MHz DAC, which provides flicker-free refresh rates of up to 120 Hz, and the S3 Vision968, which provides digital-video scaling of up to 1280 by 1024 pixels.

Contact: Diamond Multimedia Systems, San Jose, CA, (800) 468-5846 or (408) 325-7000;
<http://www.diamondmm.com>.

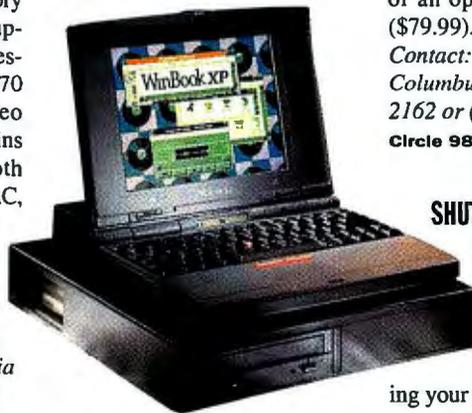
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FAST ETHERNET ADAPTER

The Rockwell 2300-TX provides 10- or 100-Mbps automatic negotiation and connectivity to PCI-based desktop PCs and servers, as well as half- and full-duplex operation. You can port the VDA common-core software architecture across a range of network interface cards, OSes, and network-protocol environments. The Rockwell 2300-TX (\$295) is fully compliant with the emerging IEEE 802.3u 100Base-TX Ethernet standard. Contact: Rockwell Network

Systems, Santa Barbara, CA, (800) 262-8023 or (805) 968-4262; <http://www.rns.rockwell.com>.

Circle 990 on Inquiry Card.



QUAD-SPEED CD-ROM DOCKING STATION AND MORE ▲

WinBook Computer's docking station (\$399) comes with a quad-speed CD-ROM drive, two ISA slots, dual 5¼-inch bays, automatic detection for external pointing devices, VGA, stereo output, and volume control.

In addition, the 100-MHz 486DX4 model of the WinBook XP notebook computer comes in two configurations: with a 10.3-inch dual-scan color screen, 4 MB of RAM (expandable to 32 MB), and a 340-MB removable hard drive (\$1999); or with an 810-MB removable hard drive, an active-matrix screen, 16 MB

of RAM, and a 14.4-Kbps internal fax modem (\$4199). You also get your choice of pointing device—the standard Lexmark pointing stick, an optional Logitech 19-mm trackball (\$29.95), or an optional Alps touchpad (\$79.99).

Contact: WinBook Computer, Columbus, OH, (800) 468-2162 or (614) 481-8041.

Circle 989 on Inquiry Card.

SHUTTLE BIG FILES AMONG YOUR MACS

If you need to transport large data, graphics, or digital-video files without burdening your network, the DataDock may help. Two configurations are available: a \$799 desktop unit, which accommodates two modules, and a rack-mount unit (from \$885), which accommodates up to six modules. The hard drive modules (\$870 to \$2499) are available in fast SCSI-2 configurations with capacities of up to 4 GB each. Options include fast-and-wide SCSI-2 hard drives in the same capacities (from \$3420); DAT drives of up to 8 GB (\$1695 each); 270-MB Syquest modules (\$790 each); and 230-MB magneto-optical drives (\$1050 each).

Contact: MicroNet Technology, Irvine, CA, (714) 453-6100; micronet@aol.com.

Circle 984 on Inquiry Card.

DESKTOP-RECORDABLE CD-ROM SOLUTION

With CD-Write Now, you can record your own CD-ROM discs, storing 650 MB of data on each disc. Multisession support lets you write to the disc incrementally, performing up to 99 writing sessions on each CD-ROM. An optional recording-simulation mode enables you to test applications by simulating CD performance without actually writing to a disc. The basic package (\$2495) includes a double-speed drive (a quad-speed drive is also available), authoring software for Windows or the Macintosh, and two discs.

Contact: Ten X Technology, Austin, TX, (800) 922-9050 or (512) 918-9182; tenx@zilker.net.

Circle 987 on Inquiry Card.

STORAGE SERVERS FOR NOVELL LANS ▼

The GlobalNet family of storage servers give up to 1024 users access to SCSI mass-storage devices over an Ethernet network. Each unit has built-in software and configures itself, registering on NetWare's server list as another attachable Novell server. The servers, which provide data transfer rates of up to 450 KBps, include GlobalNet SST (\$7995), designed for large-capacity optical jukeboxes, GlobalNet Shuttle (\$5995), for midrange optical jukeboxes, and GlobalNet Route 101 (\$3995), for large hard drives and RAID drives.

Contact: Optisys, Glendale, AZ, (800) 327-1271 or (602) 997-9699; rzwick@optisys.com.

Circle 993 on Inquiry Card.



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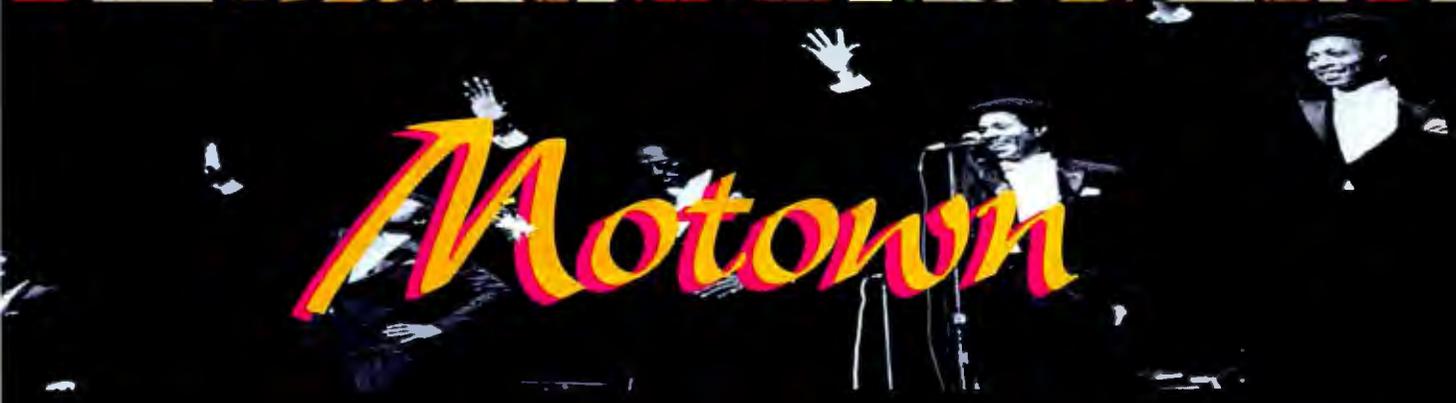
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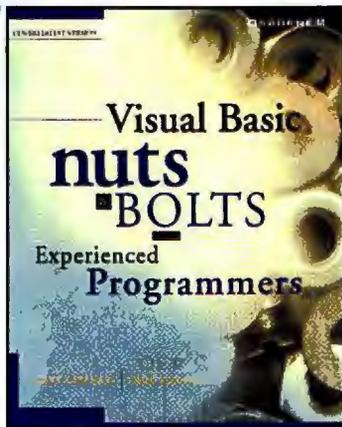
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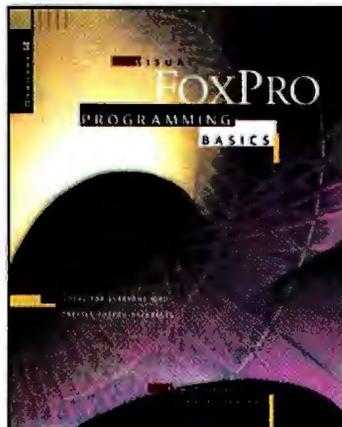
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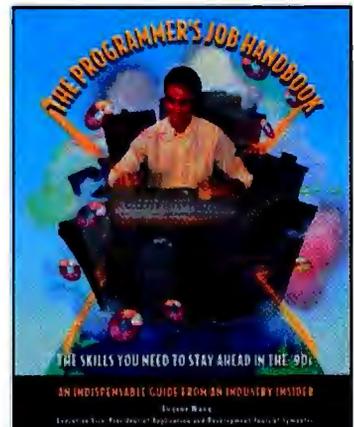
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WHAT'S NEW Software

PREVIEW SMALL-BUSINESS ACCOUNTING

Juggle Many Projects with QuickBooks Pro

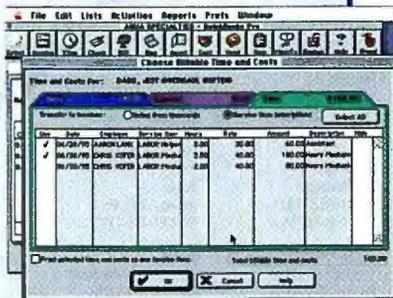
QuickBooks Pro, the enhanced version of Intuit's small-business accounting program, integrates time-tracking, estimating, and job-costing features that are not normally found in inexpensive packages. The program is available in versions for Windows 3.1 and the Mac (\$189 each); BYTE looked at a prerelease version of QuickBooks Pro for the Mac.

One intriguing feature is QuickBooks Pro's ability to maintain running time sheets for each employee, tallying the number of hours spent on a particular client's projects. Formerly, you had to track this information using a specialized application or spreadsheet or, worse, scrap paper. But with just a few mouse-clicks in QuickBooks Pro, you can transfer billable hours to invoices for individual jobs or clients. You can also create reports that evaluate the profitability of an employee, client, or specific project. The time sheets are simple to maintain and could be an invaluable tool for businesses that juggle several projects at once. In addition, time-sheet information readily flows to the payroll module for computing pay for wage-based employees.

QuickBooks Pro also lets you produce estimates, a small-business chore that's typically performed on a spreadsheet. You can easily convert estimates to invoices and modify the invoices without changing the original estimates. The program also lets you generate reports that compare estimates with actual sales.

Like Quicken, QuickBooks Pro is designed for people who have minimal accounting skills but need to rapidly and economically manage their business finances. The program is powerful and multifaceted, but it's accessible to the novice. With QuickBooks Pro, you can focus your business on the talents that generate income rather than getting bogged down in managing a paper trail of invoices, estimates, and cost-accounting.

—Chris Kofler



Intuit
Menlo Park, CA
(800) 624-8742
(415) 322-0573
Circle 994 on Inquiry Card.

ON-LINE COMMUNICATIONS FOR WINDOWS 95

Among the features of Qmodem-Pro for Windows 95 version 2.0 (\$129) are TAPI support, which allows the sharing of communications devices among multiple applications; MAPI support, which lets you transfer text, images, and files to major E-mail programs; OLE 2.0 support, which lets you drag a phonebook entry directly to the Windows 95 desktop and connect to

that service right from the desktop by clicking on the icon; support for long filenames; and path support. A script language with QuickLearn capabilities lets you automate on-line sessions and create custom interfaces; it also contains a compiler, a debugger, and a syntax-highlighting editor. *Contact: Mustang Software, Bakersfield, CA, (800) 999-9619 or (805) 873-2500; <http://www.mustang.com>.*

Circle 997 on Inquiry Card.

MUNICIPAL ENGINEERING OFFICE

A CAD solution for the modeling, analysis, and design of water-distribution networks and wastewater-collection systems, Municipal Engineering Office (\$5000) for Windows NT includes the InWater, InSewer, and Relational Information System

components. InWater enables you to graphically model and analyze water-distribution systems with data transfer to and from analysis engines, such as KYPipe. A modeling solution for analyzing and designing wastewater collection, transport, and disposal systems, InSewer combines automated design and engineering tasks with relational-database capabilities. Relational Information System is a generic interface for communicating information across a networked environment. The package also includes DraftWorks, an automated drawing-production application.

Contact: Intergraph, Huntsville, AL, (800) 345-4856 or (205) 730-5499; <http://www.intergraph.com>.

Circle 1005 on Inquiry Card.

DISTRIBUTED SOFTWARE MANAGEMENT

A software management solution designed for PC LANs, NetWizard 2.5 (10-user pack, \$595) provides automated software and hardware inventory, software distribution, software metering and licensing, and remote configuration. NetWizard lets you install software on hundreds of desktops from a single location; generate scripts automatically using the Package Editor; use visual script editors to develop complex scripts without any programming; compress distribu-

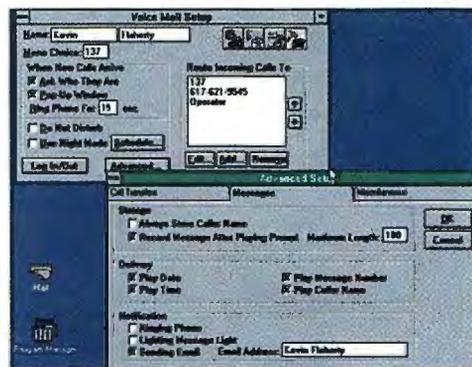
tion packages for efficient transmission; and eliminate redundant software installation/update overhead.

Contact: Attachmate, Bellevue, WA, (800) 426-6283 or (206) 644-4010; <http://www.attachmate.com>.

Circle 998 on Inquiry Card.

32-BIT OLE CONTROLS FOR WINDOWS TELEPHONY

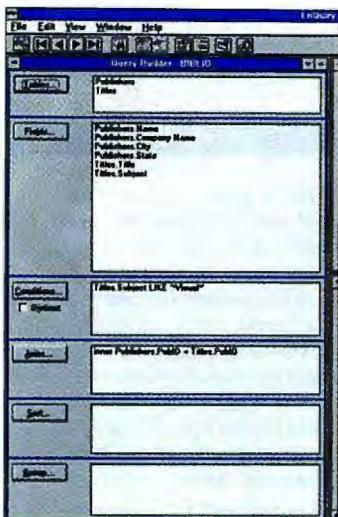
Using Visual Voice for Win32 (for Windows NT, from \$795; for Windows 95, from \$495), you can create applications—including fax-on-demand, interactive voice response, and voice mail—that can interact with most data sources and networks. The program provides high-level interfaces to functions such as answering inbound calls, placing



outbound calls, prompting for Touch-Tone input once calls are established, recording and playing back voice files, sending and receiving faxes, and integrating with a PBX to perform call-control functions. The Voice Workbench tool visually defines the telephony components of an application and generates the corresponding application logic. A 32-bit DLL interface allows 32-bit development environments that support DLLs to take advantage of Visual Basic's telephony features.

Contact: Stylus Innovation, Cambridge, MA, (617) 621-9545; <http://www.stylus.com>.

Circle 1009 on Inquiry Card.



CLIENT/SERVER CAPABILITIES FOR VISUAL BASIC ▲

EnQuery (\$395) lets Visual Basic programmers rapidly and visually build forms and queries without coding. With the Query Builder, you can graphically manage and control virtually all aspects of the SQL query-and-control layout process. The Query Advisor reveals the status of the query-building process as it proceeds, flagging errors and providing advice and guidance for correcting problems. The EnQuery Form Preview displays the results of your queries and the way data is presented to users. *Contact: Progress Software, Crescent Division, Bedford, MA, (800) 352-2742 or*

(617) 280-4000; crescent@progress.com.

Circle 1002 on Inquiry Card.

CASH-FLOW FORECASTS FOR EXCEL 5

PFP Maxima II for Excel 5 for Windows (US\$199) formats your company's financial statements and calculates federal, state, and local taxes; interest; management bonuses; long-term loans; cash flows; bank-credit-line working limits; ratio analysis; and break-evens. You can add, delete, or change accounts where appropriate, and the program's report capabilities include up to 17 presentation-quality financial statements and supporting schedules (monthly and annually).

Contact: Pendock Mallorn, Toronto, Ontario, Canada, (416) 264-2126.

Circle 999 on Inquiry Card.

INTERNET INTEGRATION AND WORKGROUP COLLABORATION

Ecco Pro 3.0 (\$175) adds more than 100 features, including an Internet Address Book; AutoAssign, an organizer that categorizes information into specific Ecco folders based on user-definable rules; and a cor-

respondence manager, which lets you automatically send faxes, E-mail, and letters to any number of contacts simultaneously. Enhancements include Notepads for outlining the details of your projects, a Rolodex card interface, tabs to switch between views, revised menus and dialog boxes, icon balloon help, and a print coach for print layouts. The Internet Address Book comes pre-



configured with over 2000 gopher, World Wide Web, and FTP sites. While surfing the information highway, you can use the Shooter to send selected information from the Internet to Ecco Pro 3.0, where the information and its Internet address are stored. The Time and Expenses feature lets individuals and workgroups track expenses for activities such as projects and calls.

Contact: NetManage, Cupertino, CA, (408) 973-7171; <http://www.netmanage.com>.

Circle 1000 on Inquiry Card.



SOFTWARE FOR MOBILE WORKERS

Mobilizer for Windows (single-user package, \$299) integrates office-mail, file, and database applications and mobilizes them for use on a remote laptop, giving mobile workers the flexibility to communicate over traditional wired phone lines or wireless telecommunications services. The product consists of four components. File Mobilizer allows transparent access to LAN network drives and lets you specify the files you want to mobilize. ConnectSoft's E-Mail Connection software lets you download, review, and respond to mail off-line through one integrated user interface. With Database Mobilizer, you can cache and query corporate data-

bases in a store-and-forward manner using ODBC drivers. The Mobile Communications Manager automates connections over both wired and wireless communications services.

Contact: Digital Equipment, Littleton, MA, (800) 344-4825 or (508) 486-2254; <http://www.digital.com/info/mobile>.

Circle 995 on Inquiry Card.

Software Update

Conversions Plus 3.0 for Windows, the PC-to-Mac file-exchange utility, adds translators for TIFF, JPEG, GIF, BMP, PCX, and EPS graphics; Quattro Pro 5.0 and 6.0 and Lotus WK4 4.0 and 5.0 spreadsheets; WordPerfect 6.1; Microsoft Works 4.0 Macintosh; ClarisWorks 2.x, 3.x, Mac, and PC; and WordPerfect Works 2.0 Windows. The package also offers enhanced graphics capabilities and a file-preview feature. \$149.

Contact: DataViz, Trumbull, CT, (800) 733-0030 or (203) 268-0030.

Circle 1011 on Inquiry Card.

A data-query, reporting, and analysis tool, **Forest & Trees 4.0** offers an expanded query capability, including the ability to conduct ad hoc queries without having knowledge of SQL or the target-database structure; data-analysis features, such as alarms, graphs, cross-tabs, and single-click data interpretation; and customization facilities. Administrative version, \$995; Enterprise version, \$790.

Contact: Trinzic, Redwood City, CA, (800) 952-8779 or (415) 591-8200.

Circle 1012 on Inquiry Card.

WinDelete 2.0 for Windows monitors application installation to enable better application removal, covers most types of applications and system-support files, previews its changes before making them, offers a one-step undo/restore feature, and has tools to facilitate better system management, such as intelligent uninstalling of more file types, effective management of system files, and personalized system tips and information. \$49.95.

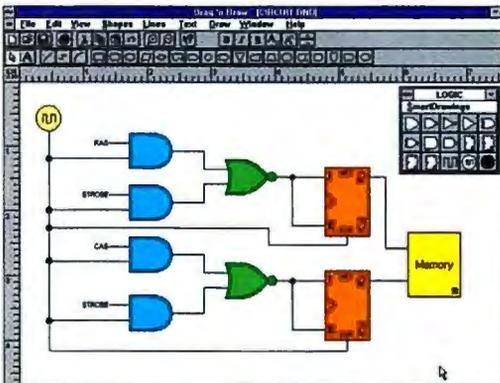
Contact: IMSI, San Rafael, CA, (800) 833-8082 or (415) 257-3000; <http://www.imsiisoft.com>.

Circle 1013 on Inquiry Card.

WHAT'S NEW Software

CREATE DESIGNS AND DIAGRAMS ▼

Designed to meet your drawing and diagramming needs, Drag 'n Draw for Windows (\$149) provides SmartDrawing Libraries that are aimed at the scientific, technical, and business communities; tools to simplify the draw-



ing process from start to finish; and a system for customizing objects and drawings and linking them to other objects. Drag 'n Draw enables you to create such diagrams as electrical schematics, fish-bone charts, flowcharts, landscapes, network diagrams, organizational charts, time lines, quality-control diagrams, and space-planning and technical drawings.

Contact: DeltaPoint, Monterey, CA, (800) 446-6955 or

(408) 648-4000; <http://www.deltapoint.com>.

Circle 1007 on Inquiry Card.

PC DIAGNOSTICS

With PC Certify Pro, you can conduct thorough diagnostic testing of IBM PC and compatible systems. The program features 10 test-group profiles, 18 command-line switches, and unlimited reporting. In addition to quick diagnostics, the system-load test can perform a 24-hour system burn-in in just 2.4 hours. The test roster includes all the major system components,

including CPU, FPU, memory, motherboard, video adapter, serial and parallel ports, hard disks, disk drives, system load, keyboard, internal speaker, mouse, joystick, printer, SCSI, CD-ROM, and other devices, such as sound card, fax, and stacker. PC Certify Pro (\$249) also comes with 11 diagnostics utilities to help you pinpoint system errors.

Contact: Landmark Research International, Clearwater, FL, (800) 683-6696 or (813) 443-1331; 71333.2735@compuserve.com.

Circle 1008 on Inquiry Card.

FREEHAND 5 FOR WINDOWS

A native 32-bit application for graphic design and illustration, FreeHand 5 for Windows (\$595) comes with more than 500 fonts and 10,000 clip-art images and provides cross-platform graphic illustration. New features include an expandable architecture, style sheets, a spelling checker, search and replace, strike-through, highlighting, optional text-edit windows, an optional text ruler, and special effects. FreeHand 5 also supports text-handling capabilities, which let you lay out multi-page brochures and advertisements, and floating palettes. Import/export capabilities let FreeHand open and place CorelDraw 3 and 5 files, as well as files from Illustrator.

Contact: Macromedia, San Francisco, CA, (800) 288-4797 or (415) 252-2000; <http://www.macromedia.com>.

Circle 1001 on Inquiry Card.

Software Update

The Windows version of the relational database, 4th Dimension 3.5 provides built-in multitasking, a 4GL with more than 350 commands for customizing applications and adding extensions to databases, a graphical interface that supports Windows and the Mac, and an optional compiler that compiles code into machine language. \$895.

Contact: ACI US, Cupertino, CA, (408) 252-4444.

Circle 1014 on Inquiry Card.

The Secure Workplace for OS/2 3.0, a product that provides workstation security, extended control of the Workplace Shell, and workplace management utilities, includes increased compatibility with OS/2 Warp; the ability to secure every object on the Workplace Shell, including disk and file objects; new audit-trail and user-authentication facilities; a new desktop-switching utility; and improved desktop management utilities. Standard edition, \$59.95; Enterprise edition with 10-station-license minimum, \$549.

Contact: Syntegration, Chino, CA, (909) 464-9450; 73707.3331@compuserve.com.

Circle 1015 on Inquiry Card.

An analysis and presentation-graphics program, Stanford Graphics 3.0 has been ported to Digital Equipment's Alpha systems running Windows NT. Enhancements include a Formula Visualizer, which graphically solves user-defined equations; custom line styles; speed improvements of 650 percent for data import and 150 percent for spreadsheet calculations; intelligent data axes for plotting time-series or financial data; and various graphics import and export options. \$895.

Contact: Visual Numerics, Houston, TX, (800) 729-4723 or (713) 784-3131; <http://www.vni.com>.

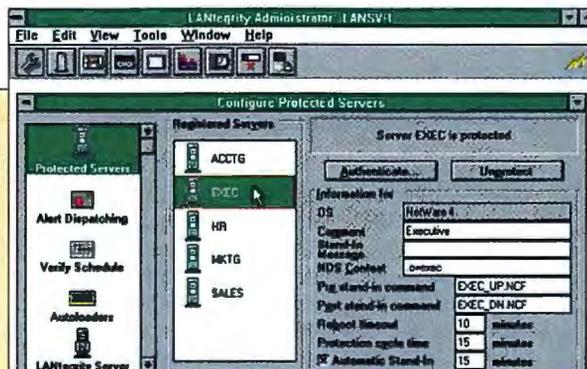
Circle 1016 on Inquiry Card.

SERVER-FAULT RESILIENCE

Initially available for NetWare, LANtegrity (license for 100 users, \$4950; for 1000 users, \$11,500) is a hot standby solution that provides instant recovery for failed servers. The program continuously monitors all protected servers and can automatically stand in for any server within 15 seconds of detecting a failure. Users simply log in and access the same user accounts, files, and client software as if they were connected to their usual server. An Intelligent Data Vault feature maintains archival copies of all current and previous versions of files and manages the most active files in disk storage and all the current files in tape auto-loader storage. LANtegrity also lets you upgrade or reconfigure servers without disturbing users' access to their files.

Contact: Network Integrity, Marlborough, MA, (508) 460-6670.

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Title: VP Product Administration Systems

Company: Lincoln National Life Insurance Company

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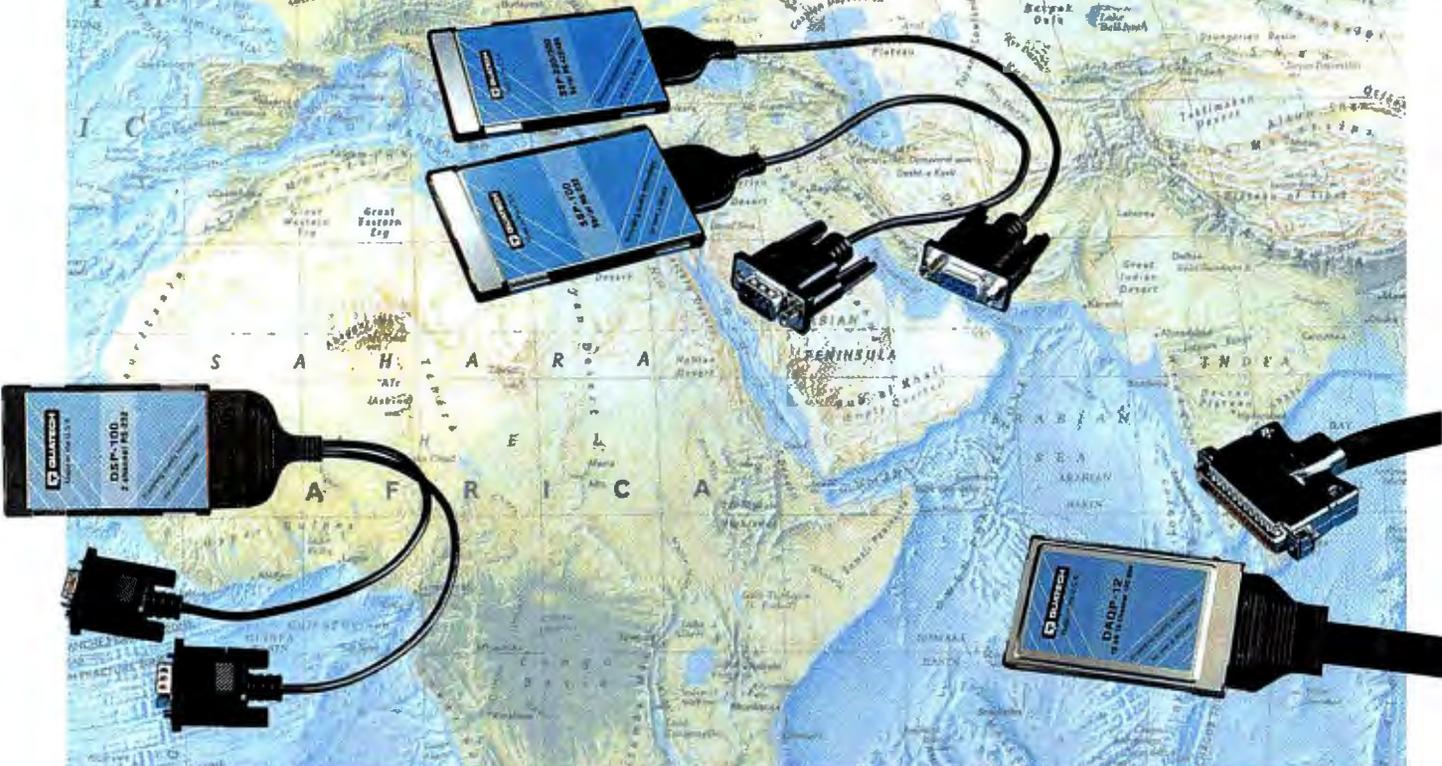
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Zip drive 100MB SCSI interface.....199.00
Zip disks 100MB, 3pk.....49.95
Ditto 420MB tape drive internal.....89.00
Ditto 800MB Travan tape drive internal.....199.00

MICROSOLUTIONS

Backuppack 3.5" 1.44MB floppy parallel.....146.32
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Backuppack 250MB tape backup parallel.....259.65

TAPE & REMOVABLE MEDIA DRIVES

CONNER

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Tape'Stor 800MB Travan parallel.....343.81
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Tape'Stor 850MB parallel.....366.25
Tape'Stor 4GB internal IDE.....359.78



FileSafe TD-350, 350MB internal.....104.33
FileSafe 800MB Travan internal.....174.50



EZ135 135MB internal IDE interface.....198.99
EZ135 135MB external SCSI interface.....231.40
EZ135 135MB cartridge.....18.97

MULTIMEDIA AND CD-ROM

Creative Labs

Multimedia Home CD 4x kit internal.....448.89
Blaster CD 4x kit.....213.89
Sound Blaster Value CD 4x kit.....298.99
Sound Blaster Digi Schoeties CD 4x kit.....258.72
Sound Blaster Discovery CD 4x kit.....348.33
Sound Blaster Performance CD 4x kit.....428.89
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Modem Blaster 14.4K.....82.26
Modem Blaster 28.8K.....202.55
Sound Blaster 16 value edition (IDE).....99.99
Sound Blaster 16 SCSI-2.....178.99
Sound Blaster AWE32.....298.99
Sound Blaster AWE32 (IDE).....180.99
Wave Blaster II GamePak.....154.50

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Microsolutions 4X CD parallel w/sound.....488.15
Advent PP570 speakers 35W.....240.87
Advent PP222 spkrs/subwoofer.....188.84
Diamond 5000 Quad CD kit internal.....298.78
Diamond 5000 Quad CD kit internal.....398.82
Jensen JPS35 speakers 5W.....54.86
Jensen JPS45 speakers 10W.....80.93
Logitech SoundMan Wave.....119.49
Microsolutions 4X CD parallel.....354.88
NEC 3Xp Plus.....264.54
NEC 3Xp Plus Kit.....458.93
NEC 6Xi.....456.14
NEC 6Xi.....547.58
Pioneer DRM24X 8 disc 4X changer.....574.48
Plextor 4pxq quad external.....559.95
Plextor 4pxq quad internal.....427.55
Plextor 6Xi internal.....499.87
Sigma Designs RealMagic Lite.....258.99
Sigma Designs RealMagic MPEG.....491.41
Sigma Designs RealMagic CD Kit.....830.81
Sony 4X internal w/IDE interface.....229.63
Sony 4X internal w/SCSI-2 interface.....316.82
Tec SuperQuad 4X internal.....184.15
Toshiba 3601 SCSI 4X internal.....309.88
Turtle Beach Monaco Carlo.....84.71
Turtle Beach Tropez.....193.87
Turtle Beach Monterey.....318.84

DIGITIZERS & SCANNERS



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DB III 12X12 16 button.....299.87
DB III 12X12 pressure pen.....309.87
Drawing Slate II 12X12 4 button cordless.....228.80

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EPSON

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ES-1200-ProPC.....1295.72



ScanJet 3P.....319.57
ScanJet 3P document feeder.....209.46
ScanJet 3C W/ISA interface.....938.65
ScanJet IICX document feeder.....468.50
ScanJet IICX transparency adapter.....833.28

MICROTEK

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Scanmaker IJ color.....306.66
Scanmaker IIS color.....485.32
Scanmaker IIR color.....748.88
ScanMaker III color.....2409.95
Scanmaker 35T slide scanner.....699.59

Summagraphics.

Summasketch III 12 X 12 16 button.....211.88
Summasketch III 18 X 12 4 button.....488.33

MONITORS

Mag Innovation DX15F.....379.80
Mag Innovation DX17F.....689.78
Mag Innovation MKP17F.....678.87
Mag Innovation MKP21F.....1889.47
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Magview CM2089 14" 28" HI.....248.87
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Magview CM4015 15" 1200.....378.84
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Magview 20CM64 20".....1087.08
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NEC XV14 14".....811.63
NEC XV15 15".....433.03
NEC XV17 17".....789.48
NEC XE15 15".....575.77
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NEC XP15 15".....579.88
NEC XP17 17".....1086.39
NEC XP21 21".....1993.43
Samsung 150U 15".....406.74
Samsung 170U 17".....737.71
Samsung 17GL6 17".....884.80
Sony CPD-1425 14".....213.33
Sony 15SF 15".....489.27
Sony 17SF1 17".....874.48
Sony 20SE1 20".....1829.28
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Diamond SpeedStar 64 ISA 2MB.....199.00
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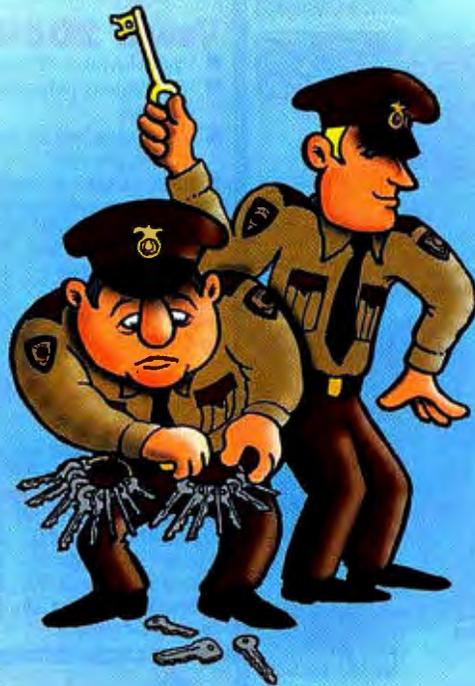
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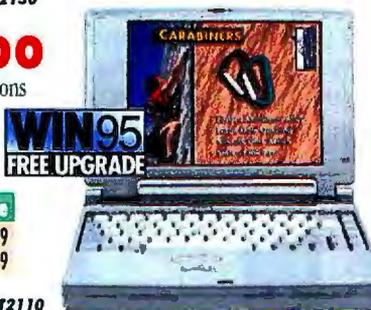
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- Integrated Accupoint - small, accurate & easy to use

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	330MB	\$1979
486DX4/75	10.4" Dual Scan	500MB	2459
486DX4/75	10.4" Active	500MB	3059

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486DX2/50	8.4" Active	330MB	2399



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486DX4/75	9.5" Active	350MB	2299*
486DX4/75	9.5" Active	350MB	2599
486DX4/75	9.5" Active	540MB	2799

Additional NEC Products

Chassis	Processor	HD	Price
NEC Ready Multimedia			
Minitower 5010	486DX4/100	540MB	\$1499
Minitower 7020	Pentium 75	850MB	1799
Minitower 9010	Pentium 90	850MB	2099
Minitower 9510	Pentium 90	1.2GB	2499
Minitower 9520	Pentium 100	1.2GB	2799

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Pentium 75	10.4" Dual Scan	540MB	\$3499
Pentium 75	10.4" Dual Scan	540MB	3799*
Pentium 75	10.1" Active	540MB	4199
Pentium 90	10.1" Active	810MB	4899*
Pentium 90	10.4" High Res.	810MB	5099

* Features built-in CD-ROM drive standard

TEXAS INSTRUMENTS



Extensa 450

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- GlidePad pointing device
- Advanced battery pro
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	340MB	\$1799
486DX4/75	9.5" Active	340MB	2399



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- Built-In Dual Lithium Ion batteries
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	\$3799*
Pentium 75	10.4" Active	772MB	4499*
Pentium 90	10.4" Active	1.2GB	5299

* Includes \$100 instant rebate through 9/30/95

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Processor	Screen	HD	Price
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Pentium 75	10.4" Dual Scan	800MB	3589
Pentium 75	10.4" Dual Scan	1.2GB	4059
Pentium 75	10.4" Active	800MB	4719
Pentium 75	10.4" Active	1.2GB	5189

Processor	Screen	HD	Price
Ascentia 910N			
486DX4/75	10.3" Dual Scan	510MB	\$2469
486DX4/75	10.3" Dual Scan	700MB	2649
486DX4/75	10.4" Active	510MB	3119
486DX4/75	10.4" Active	700MB	3199

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Chassis	Processor	HD	Price
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Minitower (812)	Pentium 100	1.2GB	CALL
Minitower (814)	Pentium 100	1.2GB	CALL*
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Processor	Screen	HD	Price
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486DX4/100	10.4" Active	810MB	5099
486DX4/100	10.4" Active	540MB	5649*
486DX4/100	10.4" Active	810MB	6099*
Pentium 75	10.4" Active	540MB	4749+
Pentium 75	10.4" Active	810MB	5199+
Pentium 75	10.4" Active	540MB	5799
Pentium 75	10.4" Active	810MB	6249
486DX4/100	10.4" Active LCD	540MB	6099
486DX4/100	10.4" Active LCD	540MB	7099*
486DX4/100	10.4" Active LCD	810MB	7549*

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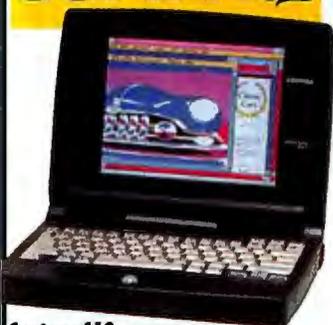
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- Built-in infrared for no hassle printer connections
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Processor	Screen	HD	Price
486DX2/50	10.4" Active	360MB	\$2999
486DX2/50	10.4" Active	540MB	3299
486DX4/75	10.4" Dual Scan	360MB	3149
486DX4/75	10.4" Dual Scan	540MB	3449
486DX4/75	10.4" Active	360MB	3699
486DX4/75	10.4" Active	540MB	3999

COMPAQ



LTE Elite

Contura 410
Product differs slightly from photo.

Contura 420/430

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486DX4/100	10.4" Active	720MB	3499

LTE Elite

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- Built-in AC adapter - small, sleek design & reduced weight
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	\$2739
486DX4/75	9.5" Dual Scan	510MB	2999
486DX4/75	10.4" Active	510MB	4159
486DX4/75	10.4" Active	810MB	4539

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HP OmniBook 5000

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Processor	Screen	HD	Price
Pentium 90	10.4" Active	1.2GB	\$5579
Pentium 90	10.4" Active	1.2GB	6239*

*16MB RAM standard

WIN95
INSTALLED

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Processor	Screen	HD	Price
486DX2/50	8.5" Dual Scan	260MB	\$2169
486DX4/75	8.5" Dual Scan	260MB	2599
486DX4/75	9.5" Active	260MB	3099

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- HP DeskJet 600C printer ... 299.00
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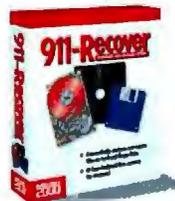
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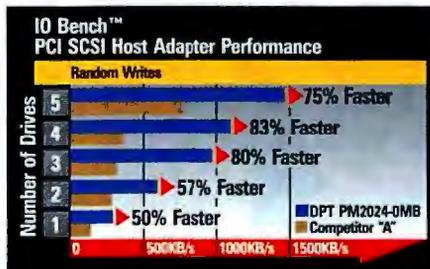
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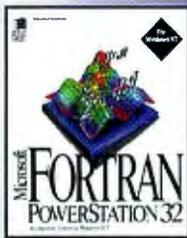
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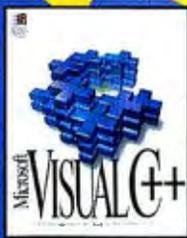


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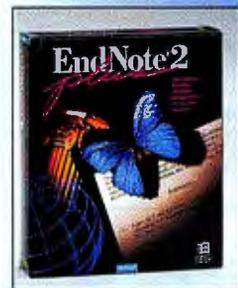
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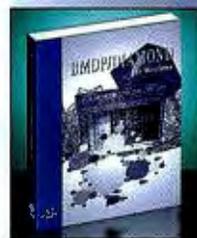
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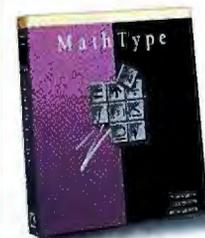
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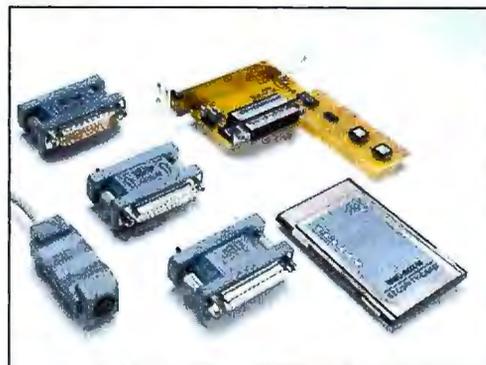


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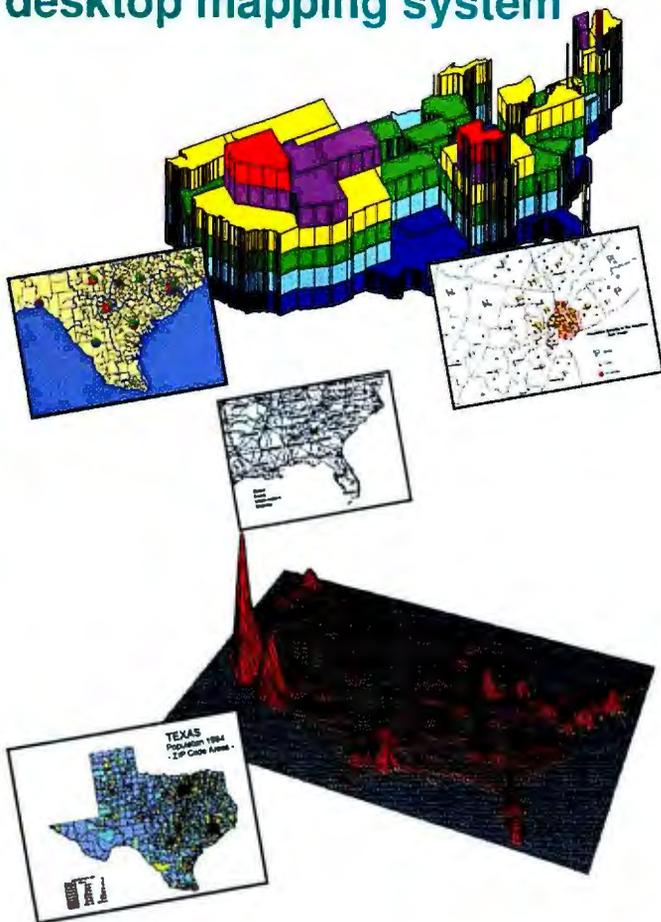
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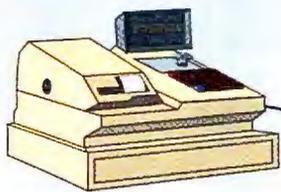
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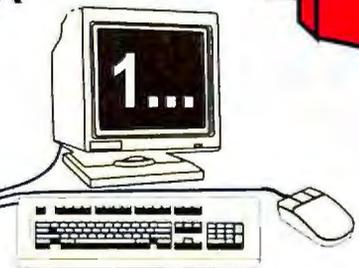
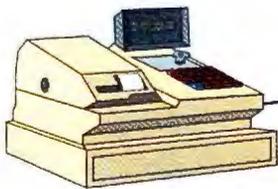
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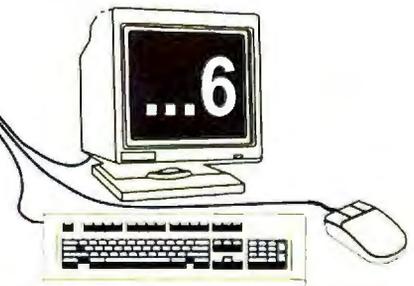
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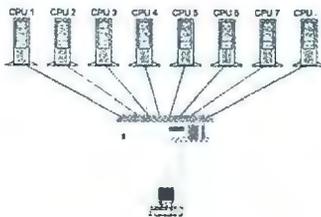
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1Mbit x 8 4Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 8Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 16Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 32Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
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1Mbit x 8 4096Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 8192Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 16384Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 32768Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 65536Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 131072Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 262144Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 524288Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 1048576Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 2097152Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 4194304Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 8388608Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 16777216Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 33554432Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 67108864Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 134217728Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 268435456Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 536870912Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 1073741824Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 2147483648Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 4294967296Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 8589934592Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 17179869184Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 34359738368Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 68719476736Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 137438953472Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 274877906944Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 549755813888Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 1099511627776Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 2199023255552Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 4398046511104Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 8796093022208Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 17592186444416Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 35184372888832Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 70368745777664Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
1Mbit x 8 14073749155328Mbit	48.00	48.00	45.00	42.00	40.00	41.00	41.00	41.00	41.00
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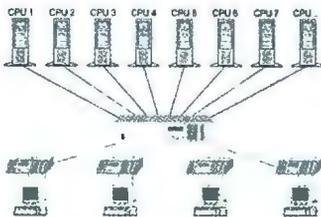
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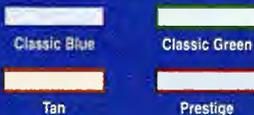
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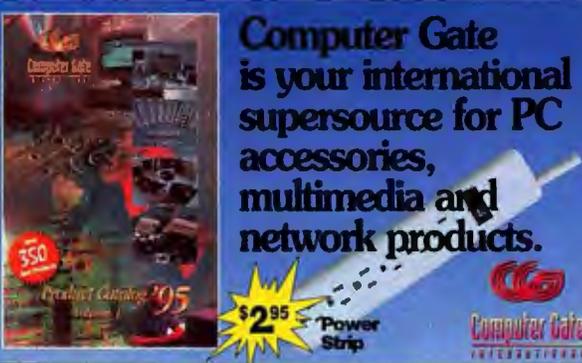
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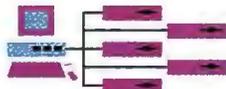
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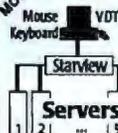
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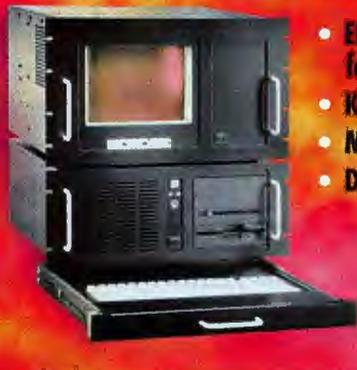
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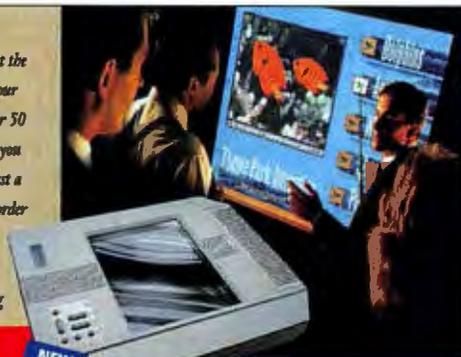
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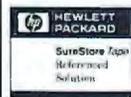
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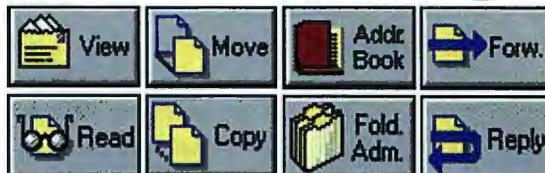
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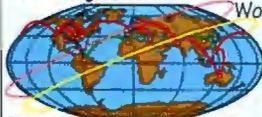
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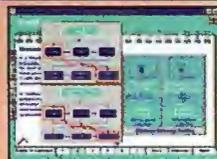
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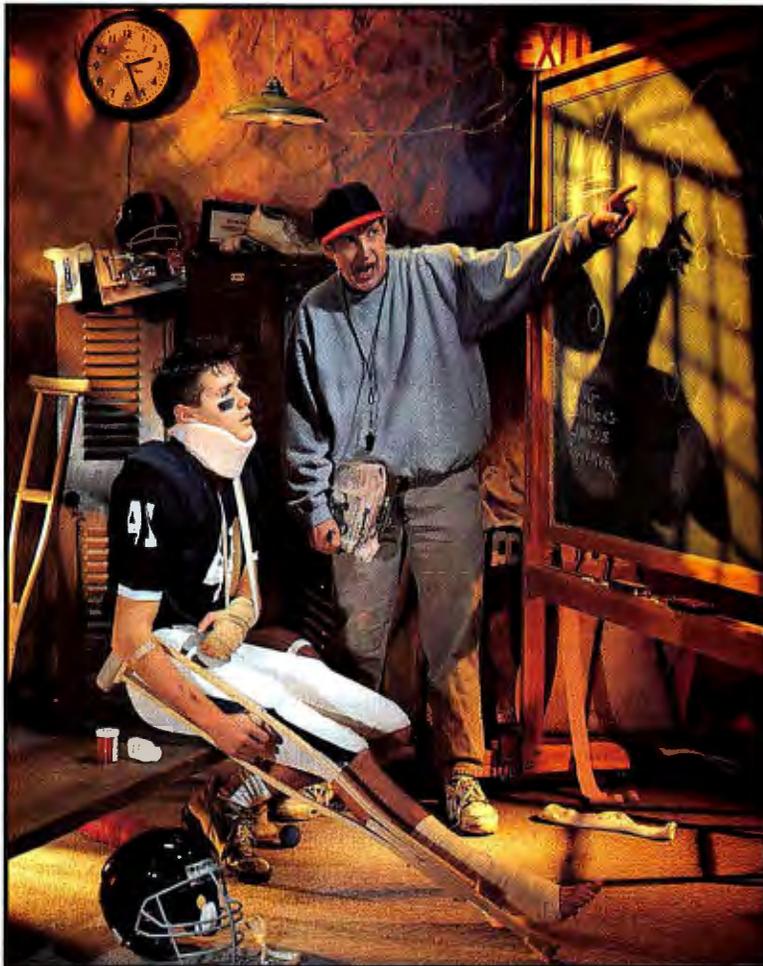
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Ambiguity Machines

Precision, hah! Computers are better at poetry than they are at math.

It should not have taken the Pentium math-bug debacle to remind us that computers do not always deliver absolute precision. On the contrary, for all their grounding in mathematical exactitude and their annoying literal-mindedness, computers are really ambiguity-generating machines.

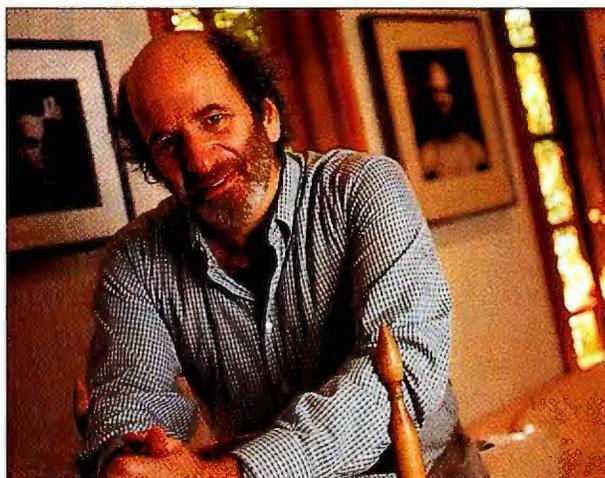
Consider humble E-mail, perhaps the simplest form of computer-mediated communication. At first glance, the difference between a message written on paper and sent through the postal service versus its identically worded electronic counterpart seems insignificant: Both contain the same language, so their meaning is the same—or is it?

One is an artifact of the material world, with intimations of permanence. The other, a captive of cyberspace, can be eliminated in a keystroke. One is evocative—its paper quality, handwriting, and scent all convey nuances of meaning—while the other is framed within the bland uniformity of ASCII. Moreover, it is unlikely that the two messages would use precisely the same words. The tendency in E-mail is toward informality: *Gonna* and *gotta* replace *going to* and *must*. The shift in E-mail is toward oral speech patterns, a rejection of the precision of written discourse in favor of spontaneity.

In publishing, the distinction has starker ramifications. A conventionally printed book may be valued not just for the words inside it but as an object, whose worth is often dictated by such factors as whether it is a first edition, whether its author signed it, or whether a famous person owned it. In contrast, an electronically published book is an entirely different animal. For starters, the idea of copyright is undermined, since the digital book is infinitely reproducible. The notion of authorship is weakened, for the new medium encourages collaboration, often by anonymous contributors. Even the idea of the book itself is threatened, as publishers of electronic scholarly journals have already discovered.

Photography is also rendered fuzzy by digitalization. The malleability of digitized photographs has caused people to look on all photos with deepened skepticism. It is now virtually impossible to tell which images are digitally manipulated. Although photographic trickery has been around for almost as long as the camera, digital technology makes it much easier to doctor an image. Digital art has also broken down the distinction between an “original” and its copies, for all possess the same digital components.

In some digital pursuits, ambiguity is exactly the point. In Multiuser Dimensions, or MUDs, those adolescent computer playgrounds in which players take on imaginary identities while cavorting within a fictional universe,



DAVID TOERGE © 1995

much of the excitement stems from the simple fact that few players know with certainty anything about one another. The player with whom I’m conversing may be a man who presents himself as a woman, a woman presenting herself as a man, or, for that matter, a cleverly designed “bot” that responds to comments in ways that produce the illusion of personhood.

Digital audio raises interesting questions. Composer John Oswald’s *Plunderphonics*, for example, consists of works by musicians ranging from Beethoven to Michael Jackson that Oswald had digitally manipulated in startling and amusing ways. By creating “new” works out of familiar ones, Oswald demonstrated that musical authorship is a surprisingly complex issue, since all music borrows from all the sounds that surround us.

One reason for the rise of computer-generated ambiguity surely is the newness of digital technology. Just as in the early years of electrification and the telephone, we’re still trying to figure out what we want computers to do for us, and in the meantime we’re confused.

But something else is going on here as well. We like to think of computers as innately masterful at computation (thus, our ridicule for the Pentium when it returns inaccurate results). But we tend to forget that because some number strings are infinitely long, even the most sophisticated computers must settle for numerical approximation—which is to say, imprecision. And imprecision doesn’t apply just to computation. While computers’ breathtakingly broad impact stems from their capacity to render so much of reality in 0s and 1s, we forget that those combinations of 0s and 1s are all approximations or, put another way, metaphors. Of course, metaphors rightfully dwell in the province of poetry, where they don’t mimic reality but use ambiguity to evoke it. ■

Jacques Leslie (jacques@well.com) writes frequently on the social impact of computers. He is the author of The Mark: A War Correspondent’s Memoir of Vietnam and Cambodia (Four Walls Eight Windows, 1995).

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