

JUNE 1996

12 Best Color Ink-Jets

JUNE 1996

**WIN**  
a WinBook  
See page 136NA 5

# BYTE

*ISDN Adapters: The Best for Business*

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the global authority for computing technology

BYTE

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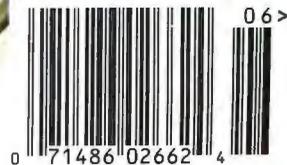
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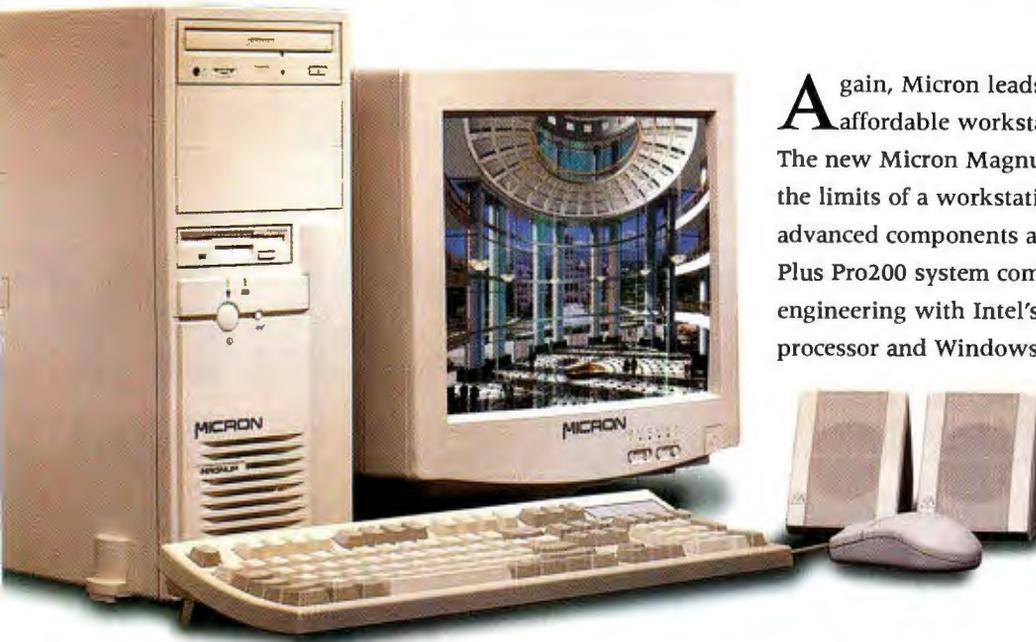
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- Power Clusters
- Storage Breakthroughs

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Volume 21, Number 6

# MAGNUM PRO AND



Again, Micron leads the industry by making affordable workstation performance a reality. The new Micron Magnum Plus Pro200 expands the limits of a workstation with the most advanced components available. The Magnum Plus Pro200 system combines superior Micron engineering with Intel's advanced Pentium® Pro processor and Windows® NT for the fastest, most reliable system on the market today. The Micron Magnum Plus Pro200—just what you'd expect from Micron Electronics, the technology leader.

*"The Micron Magnum Plus Pro200 is the workstation to beat."*

—PC Magazine, February 6, 1996

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- 256K internal cache, flash BIOS
- 8X EIDE CD-ROM drive, 3.5" floppy drive
- 16-bit stereo sound & speakers
- PCI 64-bit video, MPEG, 2MB EDO
- Tool-free mini-tower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 3.51 CD
- Microsoft Office Pro 95 & Bookshelf 95 CDs
- 5-year/3-year Micron Power<sup>SM</sup> warranty\*



**A** • 16MB RAM • 1.0GB EIDE hard drive  
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**\$2,999** Business lease \$102/month

**B** • 32MB RAM • 1.6GB EIDE hard drive  
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- PCI 64-bit video, MPEG, 2MB EDO
- Tool-free mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 3.51 CD
- Microsoft Office Pro 95 & Bookshelf 95 CDs
- 5-year/3-year Micron Power warranty\*



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 • 15" Micron 15FGx, .28dp (13.7" display)  
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**B** • 64MB RAM • 4GB Fast SCSI-2 hard drive  
 • 17" Micron 17FGx, .26dp (15.8" display)  
**\$5,799** Business lease \$182/month

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- 3-year limited parts-only system warranty
- 1-year optional on-site service agreement
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- 30-day money-back policy
- 24-hour technical support

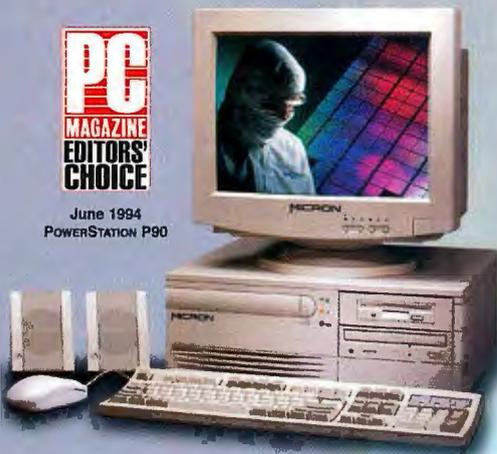
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June 1994  
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Designed for  
  
Microsoft  
Windows 95

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- Microsoft Windows® 95 CD & MS Plus! CD
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- PCI 64-bit graphics accelerator (1MB)
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- Tool-free mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 & MS Plus!
- Microsoft Works 95
- 5-year/3-year Micron Power warranty\*



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- Intel 133MHz Pentium® processor
- Dual Pentium SMP ZIF sockets
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- PCI 64-bit video, MPEG, 2MB EDO
- Full-size tower with 10 drive bays
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95 CD & MS Plus! CD
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- With Windows NT Workstation 3.51 CD.....add \$99

## POWERSERVER SMP P266

- Dual 133MHz Pentium processors
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- PCI 32-bit Ultra SCSI Fast-20 controller
- 8X SCSI-2 CD-ROM drive, 3.5" floppy drive
- PCI 64-bit video, MPEG, 2MB EDO
- Full-size tower with 10 drive bays
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- Microsoft Windows NT Workstation 3.51 CD
- 5-year/3-year Micron Power warranty\*



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POWERSERVER P133 SMP



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January 9, 1996  
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- Tool-free mini-tower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95 CD & MS Plus! CD
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May 30, 1995  
MILLENNIA P120



December 1995  
MILLENNIA P133

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- PCI 64-bit, 3D video, MPEG, 2MB EDO
- Tool-free mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
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• 15" Micron 15FGx, .28dp (13.7" display)

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- C** • 64MB EDO RAM • 4GB Fast SCSI-2 hard drive  
• 17" Micron 17FGx, .26dp (15.8" display)

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- With 150MHz Pentium processor....subtract \$100



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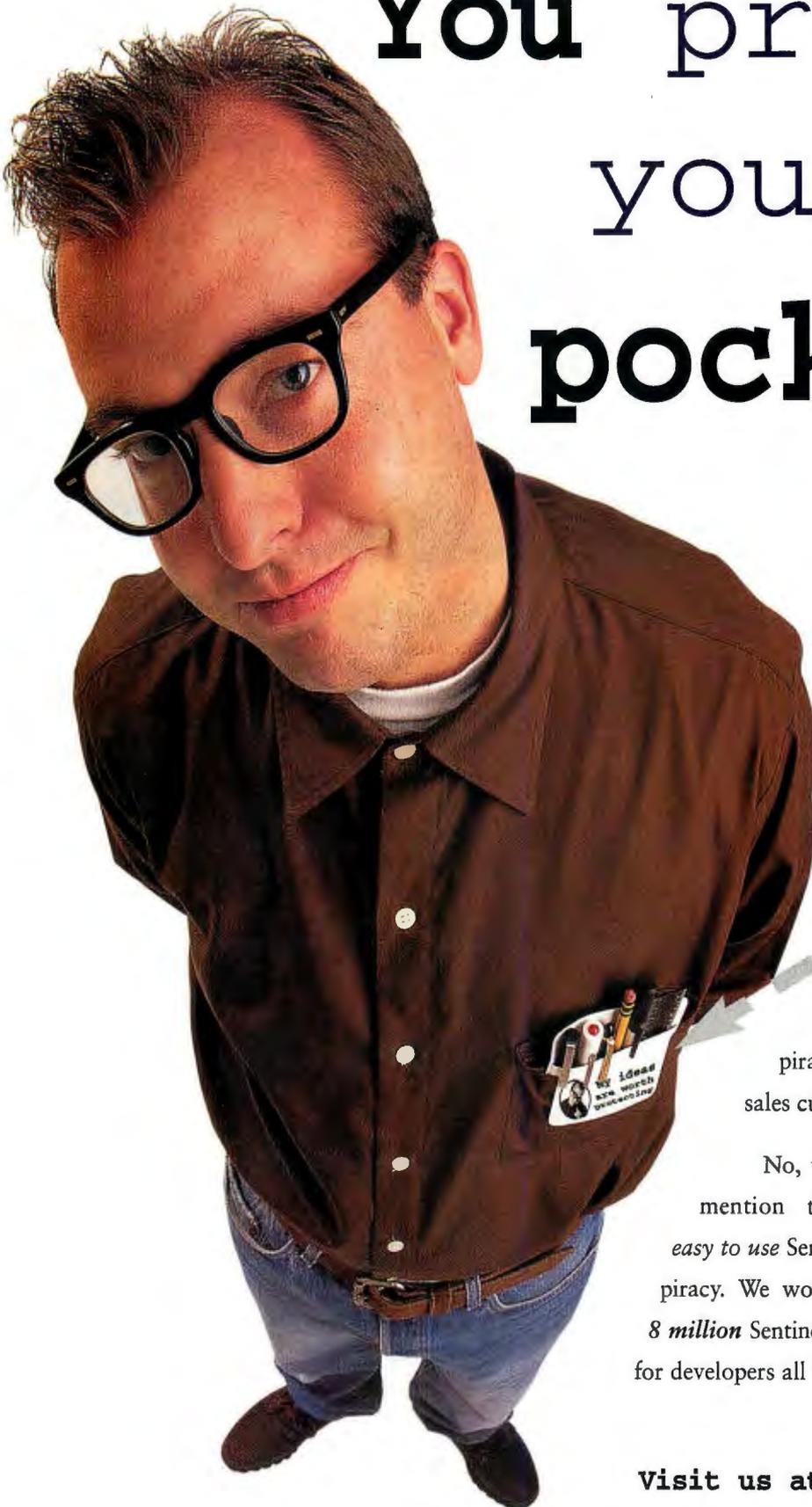
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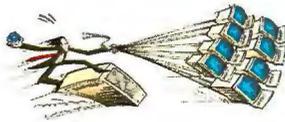
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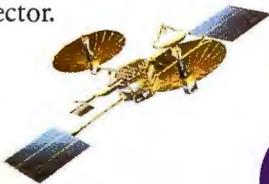
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# Electric Money

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By Udo Flohr

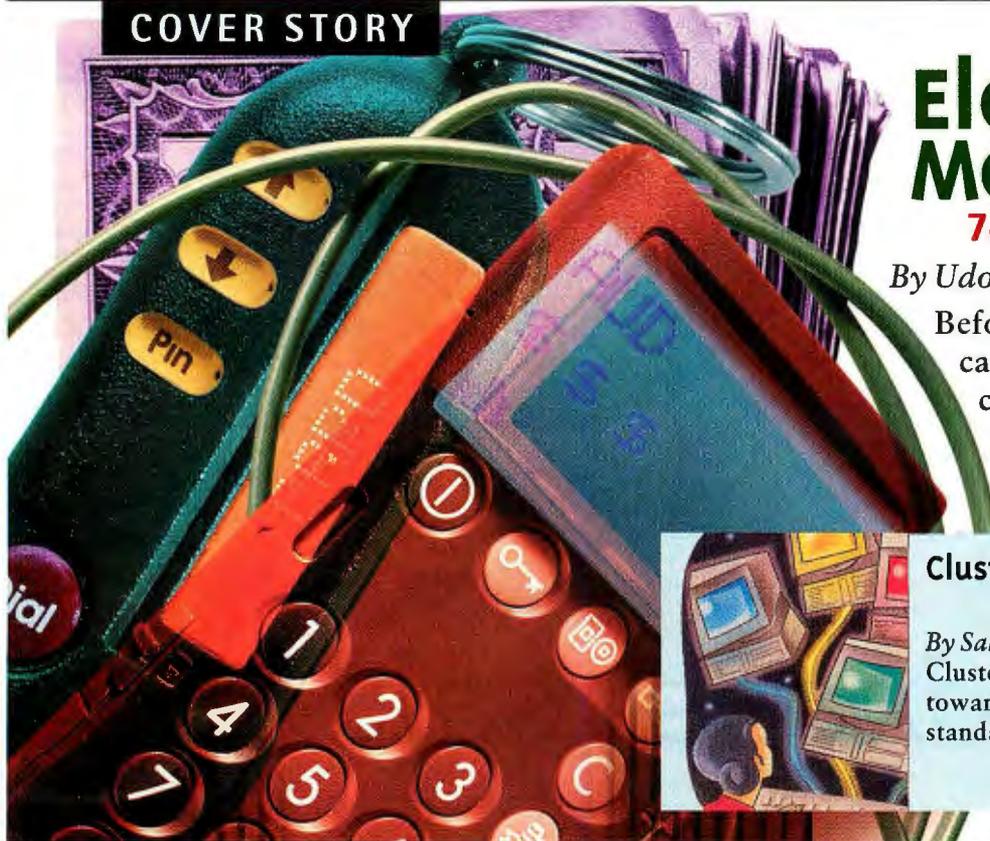
Before digital currency can replace paper and coin, four technology issues need to be resolved.

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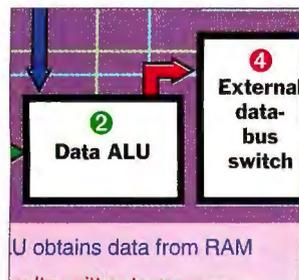
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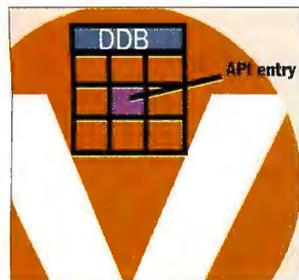


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### PROGRAM LISTINGS

FTP: ftp.byte.com  
From BIX: Join "listings/frombyte96" and select the appropriate subarea (i.e., "june96").  
From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow instructions at the prompt.

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**12 Ink-Jet Printers for Quality Color** .....114  
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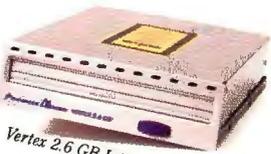
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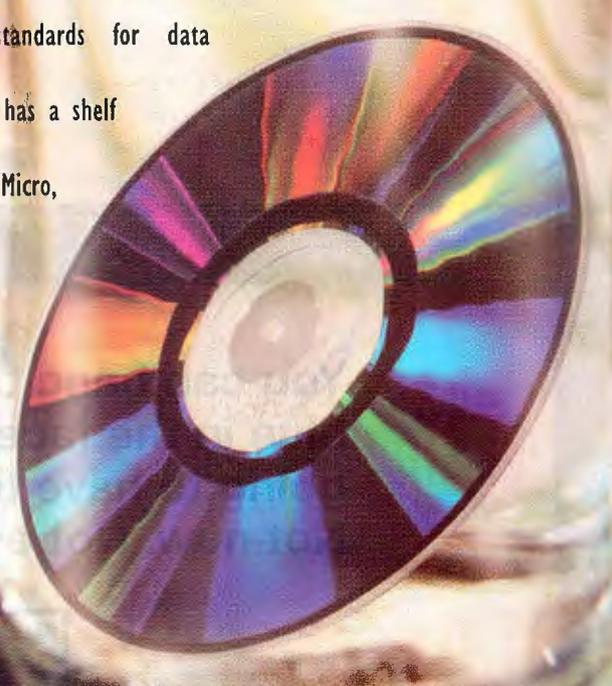
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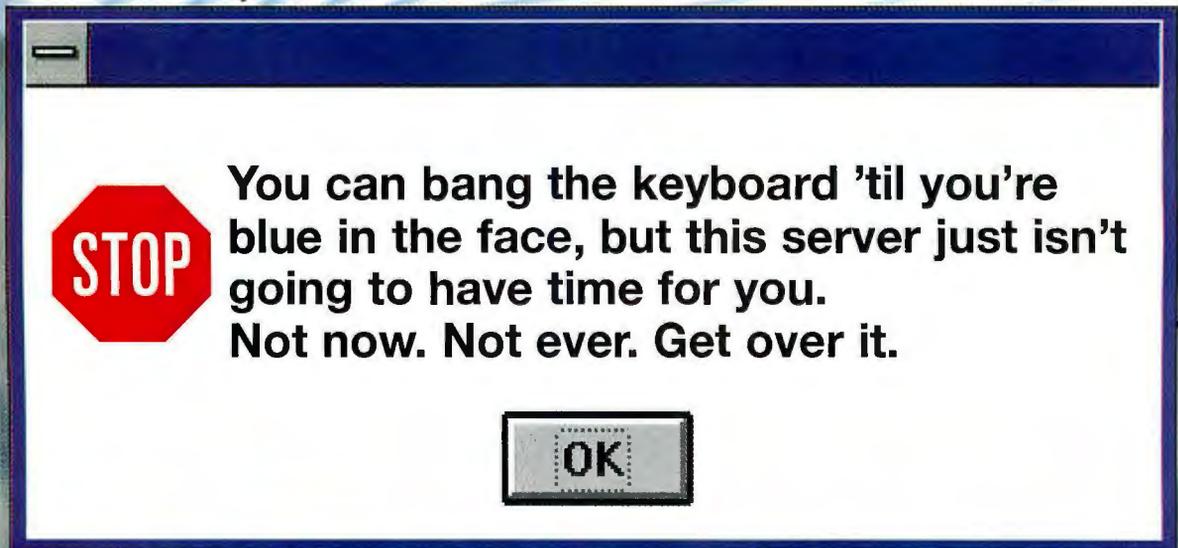
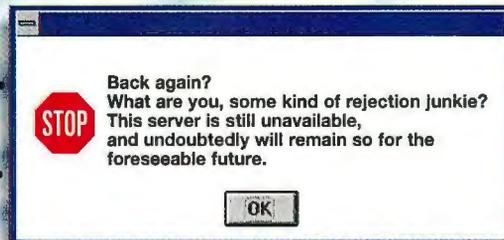
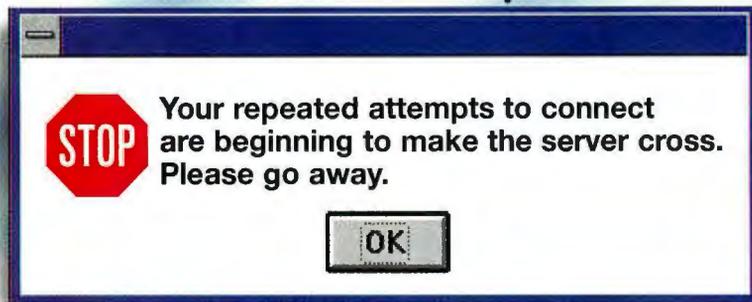
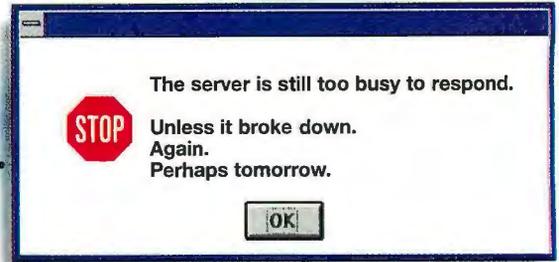
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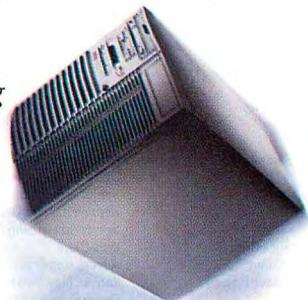
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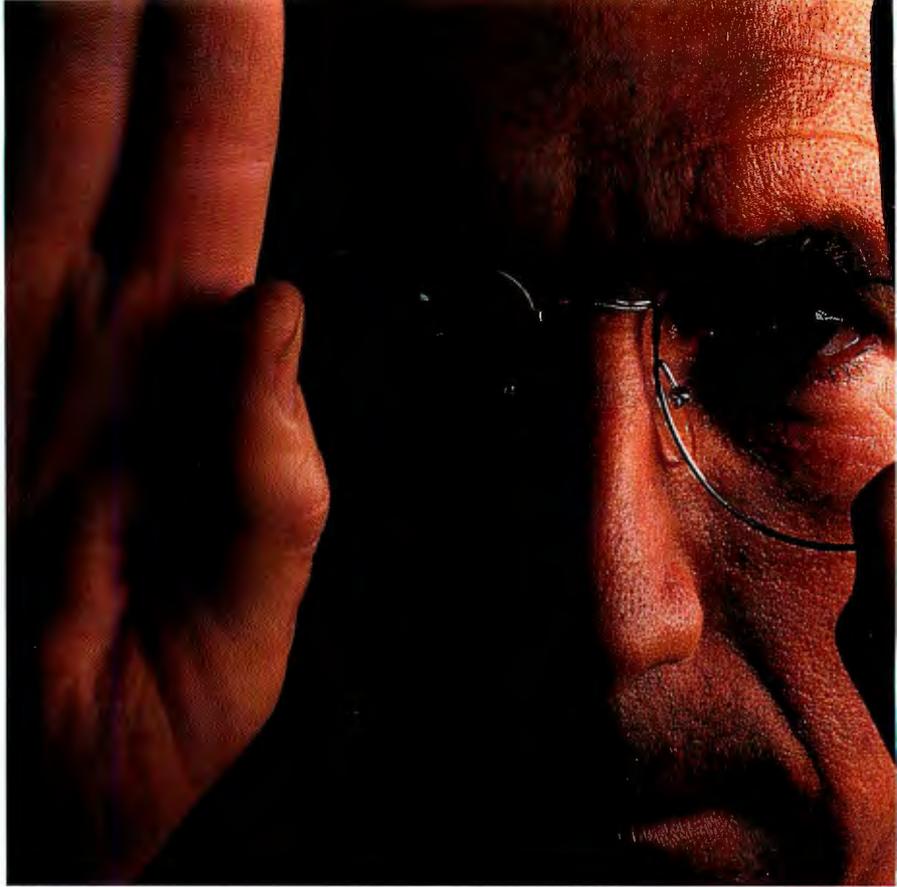
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## BYTE's New Interface

*Don't panic! BYTE looks different now, but there's one thing we didn't change:  
Our commitment to technology.*

**A**fter three years in its current clothing, it's time for BYTE's interface to change, and that's what happens this issue. Some of the changes are cosmetic and obvious (they're the ones you've probably already noticed). But there's more to the new BYTE than just looks.

First of all, let me explain that there's one thing that is not changing: BYTE's commitment to bringing you the latest analysis of computer technologies you can use to make your business more competitive. We are not "dumbing down" BYTE or in any way reducing the amount of information in these pages. Our new typeface, in fact, is more efficient, allowing us to put more text in the same area, so we can increase the space devoted to graphics.

Speaking of graphics: You'll find that more of our graphics now convey information on multiple layers. First, there's the base layer, the static "architecture" of the information under discussion (for example, in a diagram of a CPU's architecture, this would be the block diagram). Then there's the flow layer, where we will illustrate a process on top of the base, to show how the technology or product works. Finally there's the editorial layer, which will have our opinion and judgment on top of the other layers. This philosophy will not be obvious in all graphics, but we hope that over time you'll notice that the pictures in BYTE have more information in them.

Also starting in this issue, the "reviews ghetto" in the back of the book is eliminated. Instead, reviews will run throughout the magazine, in five different sections. We are doing this to acknowledge that it's not just technology that you care about: It's the products that realize the promise of the tech-

nology. So now you can read about the hottest technologies and the hottest products without having to flip from the front to the back of the magazine.

Starting in this issue we'll also rate the products we review. See this month's Lab Report, "12 Ink-Jet Printers for Quality Color," to see what I mean.

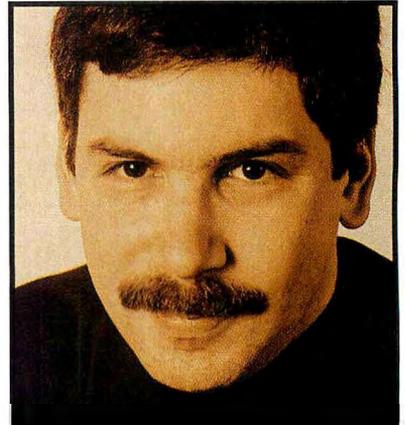
The front of the magazine gets the biggest changes. Our new Bits section replaces News and Views. Bits contains not just the news and analysis you're used to, but also new elements that will educate and entertain, like "Geek Mystique," "Yeah, But...", and the occasionally requested "Bug of the Month" (see, I do listen when you write to me). There's more in the new Bits section, as I'm sure you'll notice.

Other parts of the magazine have been moved around and renamed—all

### Here's what's new in BYTE: More reviews, better news, and improved graphics. Not to mention a few surprises.

in the interest of improving your reading experience. And at the end, we're going to have some fun: The back page of the magazine now has coverage of the latest, hottest technology gizmos we can get our hands on.

The artist behind our new look is Gary Koepke. Gary has designed such diverse publications as *Spin* magazine and the J. Crew catalog. His work has appeared in several top design journals, including *ID* and *Graphis*. BYTE is Gary's first computer magazine, but as Gary and I came to understand while we worked through the new design, the necessities of magazine design transcend magazine genre: What makes for a good music or news magazine also makes for a good computer magazine. I hope you like BYTE's brand new look. It has been



a very enjoyable challenge to create it.

BYTE has always been about the new. This version continues that tradition in an era when all of us have too much to read, too much to think about, and too much to do. Behind our new interface,

we remain committed to filtering the noisy stream of data about new computer technology and delivering meaningful, useful packets to you.

#### Farewell

I'm off to a new project: running the Web magazine C|Net Online. My successor here will be Mark Schlack, who's been with BYTE for four months as its Editor. I know Mark will do a great job. And he had better—because as of today, I'm one of his customers: a paying BYTE subscriber. **E**

A handwritten signature in black ink, reading "Rafael Needleman".

Raphael Needleman  
rafe@well.com

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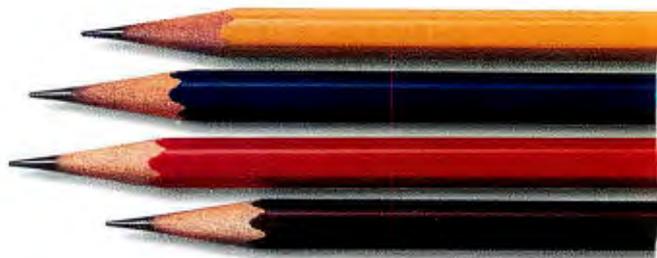
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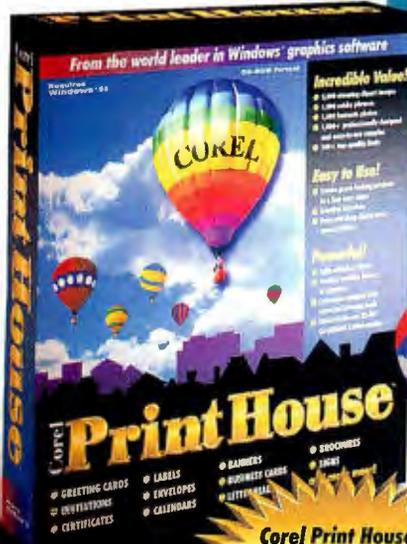


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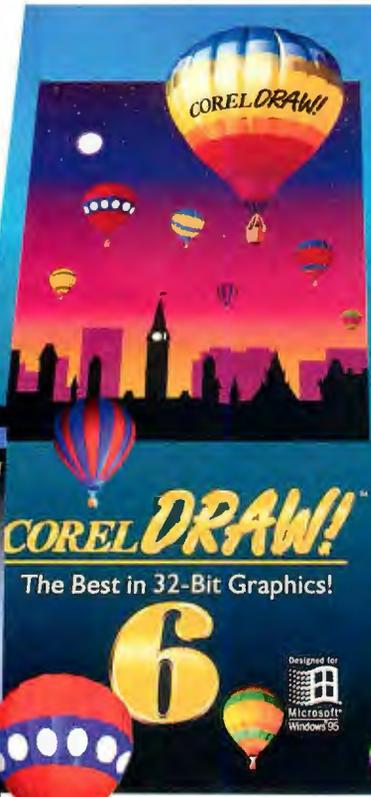
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(PC DATA, Jan '96)



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## Tracking the Web PC

"Inside the Web PC" (March) expanded beyond its title subject to examine emerging—and often competing or conflicting—technology trends, as well as products now available or under development. I've been in the business for 33 years, 20 of them tracking advanced product trends for IBM. I can appreciate the hard work and knowledge that went into that article.

Jon Dwyer

Dwyer Associates

JBDWYER@delphi.com

## The BYTE Distribution

I was immediately impressed with the simplicity and enhanced navigation of the emulation of tabbed indexes you described in "Web Design" (Network Project, March). If you don't mind, I've used this with my TCT information pages ([www.ebicom.net/~twicker/TCTinfo.htm](http://www.ebicom.net/~twicker/TCTinfo.htm)) and will probably implement it throughout my other sites as well. Great idea!

Tom Wicker

twicker@ebicom.net

*We don't mind at all. In fact, I've posted the Perl code that does this on The BYTE Site. The openness of HTML—the fact that anyone can see how a page is constructed by using the browser's "View Document Source" feature—is one of the factors propelling the warp-speed*

*evolution we see on the Web today.*—Jon Udell, executive editor

## BYTE on the Web

I tried to find some of the articles in the March printed issue of BYTE on the BYTE Web Site but didn't succeed. Have you chosen to include only some of the printed articles on the Web?

Birgit Pedersen

Library of Computer Science

& Mathematics

Aarhus University

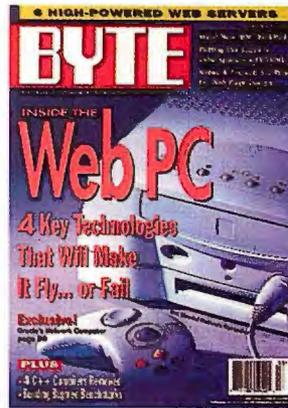
Denmark

*The full content of BYTE appears on the BYTE Web Site three months after the printed issue appears. We post selected articles within a few weeks of our newsstand date; these include the editorial, the cover story, the Web Project column, Jerry Pournelle's column, and the international section of the magazine, which is otherwise distributed only to those who subscribe to that edition.*—Eds.

## Synchrotrons Are Simple

In the enjoyable article on the future of computing, "When Silicon Hits Its Limits, What's Next?" (April), you state, "Finally, there is the issue of having a reliable X-ray source."

Ouch! Since 1992, IBM's Helios 1, located in Fishkill,



New York, has had an average uptime of about 97 percent. The Helios 1 ring has only two moving parts, and in its support systems the major moving parts are water pumps to cool magnets and the like. This is the key to its reliability; additional redundancy against breakdowns can easily be implemented.

There is a cost issue, but the cost of a synchrotron light source to 20 steppers is in line with stepper costs of \$5 million to \$8 million each and is competitive with the cost of laser systems, which can run in excess of \$2 million per stepper. Alan J. Weger, site manager Helios 1 Synchrotron Operations Team

*The article did state that IBM is using X-ray lithography for research in chip design, but we didn't make clear that the real problem with an on-site synchrotron is its operating expense. Such expenses aren't trivial, but they are certainly much less than the total cost of a fab. Unfortunately, in my conversations with IBM personnel, they did not point out the presence of the Helios facility.*—Tom Thompson, senior technical editor at large

## More Linux, Please

According to research done in February, more than 500,000 people around the world use Linux. How about more articles about it? Hetz Ben Hamo malibu@netvision.net.il

*There will be more coverage. I recently began tracking the search terms applied to the BYTE Web site. Linux was the third most frequent search, after Microsoft and Java. I'm running Linux on a*

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## WEB-SERVER BROADCAST STORM

BYTE has received a flood of e-mail criticizing our March Lab Report, "6 Servers Tangle on the Web." Here's a sampling of the comments.

"... picked the overpriced DEC server" even though  
"... Digital fails one of their tests working with WAIS."

"... don't let us see what they're using as test data."

"Not real-world" ... "Should have used a T1 line instead of a 10-Mbps link."

"[BYTE] snubbed Apple ...," "ignored Open Transport 1.1," and generally used incorrect terminology to describe the Apple server.

*First, our stated goal was to see which Web servers were best for high-volume use. Our test-bed scaled up to simulate nearly 10,000 simultaneous users. We consider price in our reviews, but price does not make or break a product's score. We gave the Digital Equipment AlphaServer 1000 4/266 the highest marks because it not only performs well but also has considerable upward scalability in the storage, memory, and open slots that would be needed for some high-volume Web use.*

*Not your cup of tea? We made it very clear in the review that the Silicon Graphics WebForce Indy "offers an outstanding price/performance ratio" for busy, but lower-volume, sites. That might have been clearer still had we had space to include all the performance-versus-load tests that NSTL performed. We're updating this review on our Web site ([www.byte.com](http://www.byte.com)) to include performance-versus-load data. In the future, we will selectively expand such unpublished data on our Web site.*

*High volume was also the key to our decision to use a 10-Mbps network link. While T1 is used by many Internet servers, it's too light a link to simulate intranet use or high-volume public access. All the servers tested would have pegged the T1 with no problem.*

*Some features for Apple's Web server were awkwardly or inaccurately described. For example, the network connection was described as AUI, not Apple's AAUI. Most of the information in question was given to us by a new employee at Apple; in the future, we will extend our fact-checking process to better verify vendor-supplied specs.*

*Do we snub Apple? In the February issue, we gave the Power Mac 7500 and 8500 1995 Editors' Choice Awards. We didn't "ignore" Open Transport 1.1; it was not a shipping product at press time. We covered it in some depth in "How Copland Communicates" (April).*

*We stand by our choice of the Digital AlphaServer 1000 4/266 as the overall winner in this Lab Report, with SGI's WebForce Indy and Intergraph's TD-40 as able, if somewhat less scalable, runners-up. We recognize that other Web-site scenarios exist, and we will continue to review Web servers aimed at various segments of the market without preconceived notions. In short, we will maintain our long-standing cross-platform commitment. —Eds.*

*machine that I'm going to incorporate into the server complex that runs our site. It wasn't a flawless installation, but I've got everything going now, including networking and accelerated X Window System, and I'm looking forward to putting it to work alongside our SGI, BSDI, and NT servers. —Jon Udell, executive editor*

## Plan 9

In the article "Plan 9: Feature Film to Feature-Rich OS" (March) you mention that Plan 9 is or will be available on the Motorola 680x0, SPARC, Mips, Intel, and Hobbit architectures. I wonder why an AIX-/Unix-related chip such as the PowerPC is not included on the list.

Bernard Veerman RI  
Schiphol Airport, Amsterdam,  
The Netherlands  
VEERMAN@schiphol.nl

*The simple answer is that the researchers did not have one during the development process. A more technical answer, however, is that the PowerPC lacks consistent standards, although this is being addressed. For instance, the Apple PowerPC and the IBM PowerPC exhibit some differences due to the nature of the OSes that currently run on them. To provide a PowerPC reference port—and the other ports are just that, reference ports—we need a platform with a stable definition. Because the Plan 9 OS is licensed in source code, I would expect that someone out there will consider porting it. Try asking the question on the Net—in the comp.os.plan9 newsgroup, for example.*

Paul Fillinich  
pfillinich@attmail.com

## But It Can't Read

In "CD-ROM Has a New MO" (February), you say that "all these systems use proprietary storage methods." Does this mean that a cartridge written on a Plasmon PD2000e cannot be read by another MO drive, such as the Ricoh RS 9200EII or a Sony?

Hendrik Steyaert  
HSTE@bipsy.se.bel.alcatel.be

*Cartridge interchangeability is an issue with most, if not all, optical drives. Cartridges themselves may be interchangeable, but different formatting techniques may make one vendor's cartridge unreadable by another vendor's drive. While we did not have the opportunity to do cross-compatibility testing for this review, the Plasmon drive uses phase-change media that would not be compatible with drives using magnetic/optical media, such as the Sony or Ricoh devices. Be aware, too, that different OSes (e.g., Windows 95 and Windows NT) may format media using different sector sizes or drive formats.*

—Andrew Froning  
Managing Editor, NSTL  
Publications

## VRML Defined

What does the acronym VRML stand for? BYTE defines it as "Virtual Reality Markup Language." That's what I have always believed it to be. But I've also seen it defined as "Virtual Reality Modeling Language." Can you clarify?

Dave McCarty  
trillion@alliance.net

*The confusion is understandable. At the first annu-*

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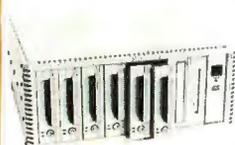
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al World Wide Web Conference, held in 1994 in Geneva, Switzerland, attendees of a session on virtual-reality interfaces to the Web agreed on the need for a standardized language analogous to the Web's HTML; they dubbed that language Virtual Reality Markup Language, or VRML. However, as the VRML specification evolved, Markup was changed to Modeling to emphasize the graphical nature of VRML.

If you've happened to notice VRML defined as Virtual Reality Markup Language recently in BYTE, it was an accidental archaism on our part. —Eds.

## FIXES

The URL <http://www.ant.co.uk>, which we listed under Acorn Computer's name in "Inside the Web PC" (March), is actually the

site of ANT, Ltd., an independent developer of networking software for Acorn RISC computers.

The toll-free number we listed for PowerQuest on page 176 of the April issue was incorrect. The company's toll-free number is (800) 379-2566.

In "Web Publishing Made Easier" (December 1995), the features table should have indicated that InContext Systems' Spider directly supports four file formats (ASCII, HTML, GIF, and JPEG) and that a Web-page viewer, though not fully integrated into the main program, is included in a bundled browser.

The telephone number that we listed for Pinnacle Micro on pages 150 and 151 of the May issue was incorrect. The correct number is (714) 789-3000.

## COMING UP IN JULY

### COVER STORY:

#### THE WEB TAKES ON GROUPWARE

How do Web-based intranets stack up against Notes and Exchange as groupware platforms? We examine the essentials—standards, security, replication, applications development, object storehouses, and the messaging models.

### SPECIAL REPORT:

#### WINDOWS NT 4.0

BYTE analyzes what's new in NT 4.0, how to smooth the migration from NetWare to NT, and how to build effective NT applications servers.

### WEB-SITE BUILDERS

Netscape and Microsoft are dueling for mind and market share in the Web-site arena. The weapons of choice are Microsoft's FrontPage and Netscape's LiveWire. We test both.

### BORLAND C++ 5.0

Borland's long-awaited upgrade of its C++ compiler features 16- and 32-bit targeting, as well as Java support. BYTE tests the redesigned development environment and benchmarks it against the competition from MetaWare, Microsoft, Symantec, and Watcom.



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PC MAGAZINE, FEBRUARY 6, 1996

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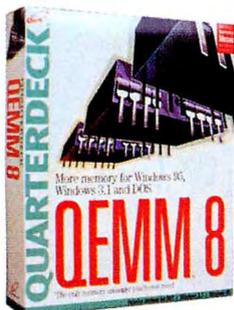
PC COMPUTING, MARCH 1996

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INFOWORLD, NOVEMBER 27, 1995

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INFOWORLD, JANUARY 22, 1996



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JERRY POURNELLE, BYTE, APRIL 1996

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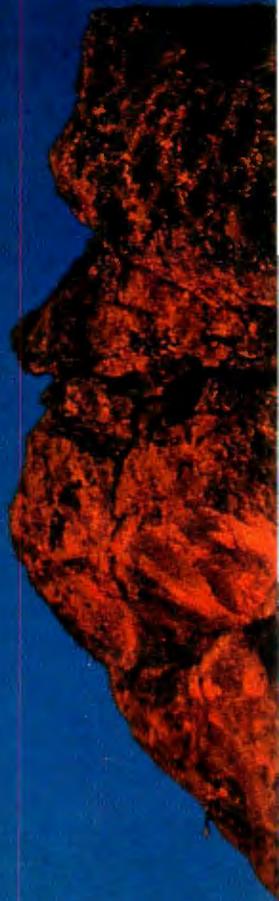
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# Pentium Pro Moves to the Desktop

*With Pentium competition increasing, Intel is now preparing to make its Pentium Pro THE desktop PC processor by late 1997.*

**N**ow that the Pentium microprocessor faces competition—at the high end and the low end—from Cyrix and AMD's latest x86-compatible processors, Intel is reportedly preparing new low-cost desktop versions of its Pentium Pro. Sources say Intel hopes the new Pentium Pros, code-named Klamath and Deschutes, will do what previous Intel chips, such as the 386SX and 75-MHz Pentium, did to the 286 and clock-enhanced 486 processors: bury the previous generation.

AMD's 75- and 90-MHz Pentium equivalents, the 5K86-P75 and 5K86-P90 (\$75 and \$99 each, respectively), offer low-cost alternatives to Intel's 75- and 90-MHz Pentiums (\$106 and \$198 each, prior to Intel price cuts expected at the end of April). In addition, AMD says it will roll out 120-, 133-, and 150-MHz Pentium equivalents throughout the year. AMD's first Pentium Pro competitor, the K6, will arrive in the first quarter of 1997.

Meanwhile, tests show Cyrix's 6x86 is a worthy high-end Pentium competitor (see the What's New Hardware Preview on page 220). Cyrix says its next 6x86, due this summer, will run at 150 MHz, have a 75-MHz (instead of a 66-MHz)

### Four Paths to a Less Expensive Pentium Pro

The Pentium Pro is an expensive desktop processor. For example, as of April 15, a 200-MHz Pentium Pro with a 256-KB cache costs \$1018. Here are several ways in which Intel might make the Pentium Pro a better desktop processor.

- Burn the Cache:** A Pentium Pro processor (code-named Klamath) due in late 1996 or early 1997 reportedly eliminates the integrated secondary cache. Intel might compensate for the missing secondary cache by increasing the size of the L1 cache.
- Shrink the Die:** The Deschutes (due in mid-1997 or later), a Pentium Pro successor to the Klamath, could be built on a 0.25-micron (instead of 0.35-micron) process, which would result in a smaller die size. Smaller die sizes
- allow Intel to harvest more chips per wafer.
- Cut System Prices:** New PCI chip sets, such as Intel's 440-FX, allow less-expensive PC designs.
- Improve 16-bit Performance:** As long as the Pentium delivers a better 16-bit or mixed 16-/32-bit price/performance ratio, most Windows users will choose it over the Pentium Pro. Intel could tweak the Pentium Pro to improve 16-bit performance, or the Pentium Pro might run fast enough to render this issue moot.

memory bus, and outperform Intel's 200-MHz Pentium, which may ship in the third quarter of this year. And Cyrix says its M2 processor, slated for end-of-1996 arrival, will outperform the 200-MHz Pentium Pro. "We're at the beginning of the transition to sixth-generation processors," says Bill Blagdan, marketing director for desktop processors at Cyrix.

However, Intel needs to overcome several challenges before the Pentium Pro can make the transition to mass-market desktop PCs. Currently the Pentium Pro

is too expensive and doesn't excel at executing 16-bit code or the mixed 16- and 32-bit code found in Win 3.x and Win 95. Intel declined to provide details on future Pentium Pros, but sources say the company will modify the Pentium Pro in several ways (see the chart above).

PC vendors hope Intel's anticipated modifications will help them sell more Pentium Pro-based desktop systems. "Enhancing support for 16-bit code and making the Pentium Pro more price-attractive would help stimulate demand

## geek mystique

### Computer Lessons from the Movies

- Never connect air traffic- or missile-control computers to a modem (WarGames, Sneakers).
- Never create killer slice-'n'-dice robots that look and act exactly like real people (Screamers, Blade Runner, Terminator).

- Never click on a little pi symbol in the lower right corner of a Web page unless Kevorkian's line is busy and you're in a hurry (The Net).

- Don't forget to include an "off" switch when designing invulnerable machine-gunning robots with a homicidal-psychopath-brain-based OS—no, we don't mean DOS (Robocop 2).

- Never implant explosive flash memory chips directly into your own brain; go with a hard drive (Johnny Mnemonic).



### Top 10 Uses for Free AOL Disks

1. Coaster
2. Jimmy doors open without damaging credit cards
3. Wedge legs on wobbly tables
4. Bathtub plug
5. A stack of five makes a great doormat
6. Scrape gum off sneakers
7. Keep shirt pocket flat when ironing
8. Include in next chain letter
9. Back up that XT 10-MB drive
10. Bookmark in Sex for Dummies

and clearly position the Pentium Pro as the next-generation processor," says Paul Col-laf, desktop-line marketing manager at Gateway 2000. "You can't increase volumes unless you address the mainstream's need."

Until that happens, however, the Pentium will remain king of the x86 desktop world. And, thanks to healthy competition, PC buyers will find plenty of Pentium PC bargains.

—Tom R. Halfhill and Dave Andrews

## ActiveX Chases Java

Sun Microsystems' Java is gaining popularity among Web publishers and has an early lead over Microsoft's new ActiveX. But developers say both technologies, though imperfect, are promising and should be carefully monitored. *ActiveX* is an umbrella term for a set of new technologies, including the WinInet APIs (which are wrappers for HTTP, FTP, gopher, and other Internet standards) and ActiveX controls.

ActiveX controls encapsulate the WinInet APIs. Programmers can write to these controls using Visual Basic, Borland's Delphi, and other programming languages. ActiveX began life as OLE Controls, or OCXes. But Microsoft has rechristened OLE as a standard for linking Component Object Model (COM) objects across the Internet.

Beginning with Internet Explorer 3.0 (Microsoft's Web browser for Windows 95, which is slated to ship by midyear, with the Mac version to follow later this year) and Internet Information Server (IIS) 2.0 (Microsoft's Web server), ActiveX will be used to transfer active data across the Internet and intranets. The ActiveX Server Framework, which is based on IIS integrated with Windows NT Server, enables Web developers to write to the Microsoft BackOffice family, which includes Microsoft SQL Server.

One troublesome aspect of ActiveX is that several components aren't yet ready. Visual Basic Script, a Visual Basic-like language for automating objects, hadn't entered beta testing as of April. Microsoft's Internet Control Pack, which has several ActiveX controls for implementing HTTP, FTP, e-mail, and other Internet technologies into an application, wasn't slated to ship until the third quarter, nor

were the tools for creating other ActiveX controls. And support for OLE on the Macintosh remains elusive.

Some members of the object-oriented community react to ActiveX with pessimism. "With ActiveX, nothing has changed except the name: It's still COM and OLE," says Chris Stone, president of the Object Management Group (OMG, Framingham, MA). OMG's own Common Object Request Broker Architecture (CORBA) and its object request brokers (ORBs) are already alive and well in such systems as DEC's ObjectBroker, Hewlett-Packard's ORB+, and IBM's System Object Model (SOM). The OMG has also adopted an interface that fosters bidirectional communication between CORBA and COM, allowing both object models to exist in the same environment.

SunSoft and OMG have come up with a standard for Java applets to connect with CORBA applications: Java Objects Everywhere (JOE). Java applets that can work with a CORBA ORB (known as ORBlets) will be compiled with the OMG's Interface Definition Language compiler. Iona Technologies, Postmodern Computing, and SunSoft are all working on such compilers. This development might be just the boost Java needs to become a major tool in the Web-page developers' toolbox.

Still, all is not perfect with Java, either. Kevin Hsu, software engineering manager at Web development company Proxima (Vienna, VA), says "Java is nice, but it's dog slow due to its interpreted nature." Just-in-time compilers that compile interpreted Java applications downloaded by a user will help, but Hsu notes that Netscape and Microsoft browsers don't yet have such compilers built in.

Another problem is the possibility of Java security holes. One group, the NASA Automated Systems Internet Response Capability (NASIRC), says that Java is insecure by its very nature. By running on-line programs, such as those that Java and ActiveX enable, client systems cannot check for those programs' compliance with local security requirements.

That's in the short run. In the long run, CORBA's use of proxies and other security features could make JOE applets safe. Microsoft says its security measures will also make ActiveX safe. For now, though, Java and JOE, security risks and all, are the only real interactive, distributed-object Web languages. ActiveX probably won't have any real impact until the fourth quarter. —Steven J. Vaughan-Nichols

## yeah, but...

Microsoft has rebounded strongly from a slow initial start in recognizing the importance of the Internet.

Yeah, but the commercial toolkits for writing ActiveX controls, and Microsoft's Internet Control Pack, aren't due until the third quarter of this year. The new Windows version of Microsoft's ActiveX-enabled Internet Explorer 3.0 is slated to ship soon, but IE 3.0 for the Mac isn't slated to ship until the second half of the year.

Microsoft is not as Windows-centric as it was a year ago.

Yeah, but where's Microsoft's Unix Web server or browser? At press time, Microsoft was in the process of porting the Internet Services API to other, non-Microsoft Web servers for NT, but no time frame was given as to when that will be finished. Ditto support for ISAPI on Unix.

The message that programmers should stick with what they know (e.g., Visual Basic and Windows) and let Microsoft make it run on the Internet—is powerful.

Yeah, but Java is here now, with lots of toolkits from multiple vendors. Microsoft has a good story for Windows-based companies, but it has a lot of work to do to support the multiplatform enterprise.

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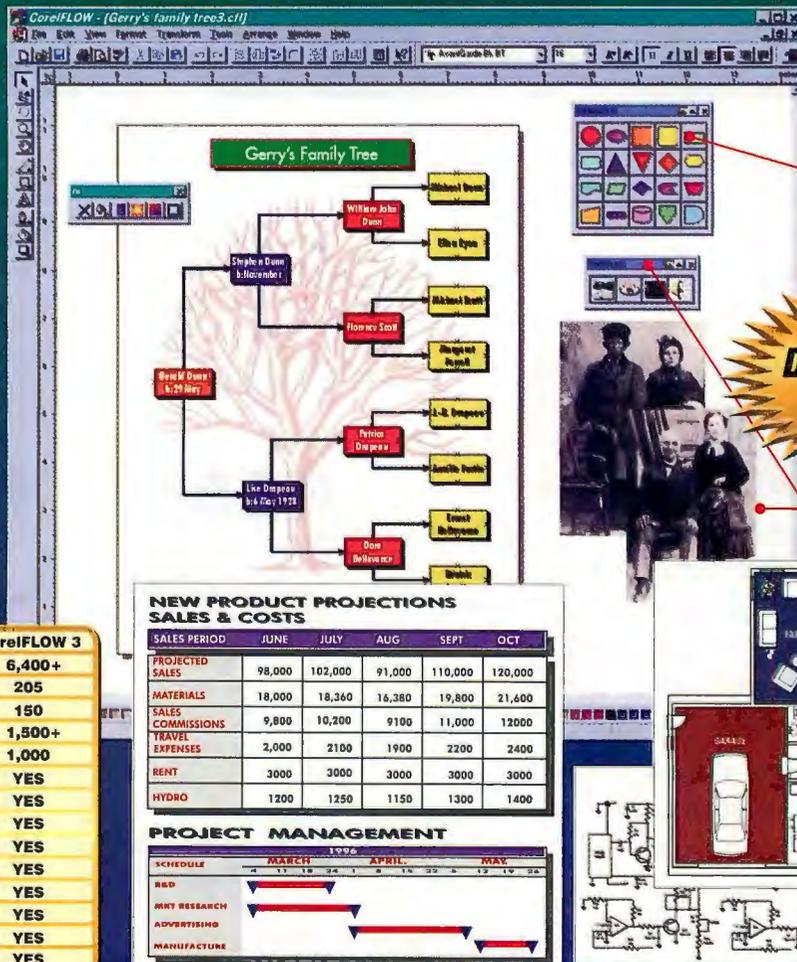
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## Tool Makers Take It to the Net

New components from Centra Software, Microsoft, Spyglass, and others provide Web-browser functions and lower-level Internet access that developers can integrate directly into their applications.

"You shouldn't have to leave an application to access the Web," says Dan Johnson, product manager at Spyglass. "We've never viewed a browser as a product." Developers can apply tools from the three vendors mentioned above to implement features such as Web-resident dynamic help files, Internet-based software distribution and registration, and built-in browsers aimed only at selected sites.

Microsoft (Redmond, WA, (206) 882-8080; [www.microsoft.com](http://www.microsoft.com)) offers two paths to the Web, both Win32-only. First, its Internet Control Pack provides Web-access components (e.g., a browser and the FTP, POP3, and NNTP protocols) packaged as ActiveX Controls. Second, its ActiveX Development Kit, formerly known as Sweeper, covers an array of lower-level technologies. Chief among these are extensions to the Win32 API that offer access to the HTTP, gopher, and FTP protocols, and a new Persistent Cache API for storing information from intermittent sources. An OLE-based technology called URL Monikers allows containers to bind asynchronously to objects via their URLs.

Microsoft's two paths are currently separate; controls in the ICP don't run on top of the Win32 extensions. Microsoft plans to merge the two with an update to ICP by the end of this year. Mac versions of these products should be available in the same time frame. MFCs that further abstract these extensions should ship in the third quarter.

The new Web Technology Kit from Spyglass (Naperville, IL, (708) 505-1010; [www.spyglass.com](http://www.spyglass.com)) provides a full set of components for building a browser; its modules are arranged into Media Viewers (e.g., HTML or Java), protocols (e.g., HTTP), and various utilities. In contrast to Microsoft's current offerings, the Web Technology Kit is indiscriminating of OS

or component technology. It runs on Windows, the Mac OS, and Unix platforms; in addition, Spyglass licenses the kit to QNX Software Systems (Kanata, Ontario, Canada, (613) 591-0931; [www.qnx.com](http://www.qnx.com)) and expects to see small-footprint kit components running in set-top boxes.

Each module is available as both an OLE server and an OpenDoc component and is accessible through a Spyglass API. Spyglass's HTML module can act as a container as well as a control, and the company promises support for all Web entities, including ActiveX controls and NetScape plug-ins.

Spyglass's technology fits OEM customers only, with current licensing agreements starting at 10,000 units. Centra Software (Cambridge, MA, (617) 547-6300; [www.centra.net](http://www.centra.net)) offers a more accessible option with its Centra Internet Classes, or CICs, a C++ class library built on MFC. CICs' multithreaded library abstracts Internet protocols and implements a shareable document cache. Centra says a port to the Mac OS is under way (although no release timetable has been set); the current release runs only under Windows.

Centra, like Spyglass, targets commercial programmers developing games or entertainment applications more than

it targets corporate developers. "Our approach is to provide an Internet solution right out of the box," says Leon Navickas, Centra's president and CEO. "This way the end user doesn't have to hunt for a Web browser."

Other vendors also provide options that aren't browser specific. Mac developers can turn to Apple's (Cupertino, CA, (408) 996-1010; <http://cyberdog.apple.com>) Cyberdog. As a set of Internet OpenDoc parts, the still-beta Cyberdog can provide FTP, gopher, NNTP, and HTML access to any OpenDoc application. The modules that constitute Cyberdog can also be swapped in and out to, say, add support for new protocols. Also, the W3C ([www.w3.org](http://www.w3.org)) maintains its own freely distributed C library (the W3C Reference Library), which can be built under Windows, on the Mac, and under most varieties of Unix.

Another option for developers wishing to implement browser-specific Internet access in their applications comes from such companies as Sax Software (Eugene, OR, (541) 344-2235; [www.saxsoft.com](http://www.saxsoft.com)), which offers Sax Webster control, a Web browser built as a 16- and 32-bit OLE Control. Whatever scenario you choose, the number of options is increasing on a daily basis.

—Steve Apiki

## Bug of the Month

### A Better UAE Than GPF...

Windows 95 users may be shocked to learn that, Yes, Virginia, there is a System Crash. It's not too difficult to cause one, either, as one BYTE editor discovered when attempting to dial up the Microsoft Network using Internet Explorer 2.0.

The bug shown in the screen shot at right occurs at odd times under Win 95 with the Plus pack when the editor is attached to the BYTE LAN or attempts to dial the Microsoft Network access number in Nashua, New Hampshire. At press time, we followed the advice of the generic error message and were attempting to determine the bug's cause with help from Microsoft.



Please send e-mail about your favorite bug to [edejesus@bix.com](mailto:edejesus@bix.com).

## Send yours!

## Portable Devices Highlight Best of CeBIT

Portable computing devices with built-in connectivity took top honors in BYTE's second annual Best of CeBIT awards. The awards recognize important and innovative new products shown at the annual international technology exposition held in Hannover, Germany. The Nokia 9000, a GSM-standard phone from Nokia Mobile Phones (+358 10 5051; [www.nokia.com](http://www.nokia.com)) won Best of Show and Best Communications Hardware for its integration of personal-organizer applications and communications (e.g., fax, e-mail, and Web browsing). The Pilot, a 5.5-ounce personal organizer with built-in PC connectivity, from Palm Computing ((800) 881-7256; [www.usr.com](http://www.usr.com)), won Best Portable.

Best Technology winner was the Cyrix 6x86, from Cyrix ((214) 968-8388; [www.cyrix.com](http://www.cyrix.com)) and manufacturing partner IBM. Although Cyrix's sixth-generation P166+ actually runs at 133 MHz, it delivers equivalent or better performance on most applications than a 166-MHz Pentium processor.

Compaq Computer's ((800) 888-5858; [www.compaq.com](http://www.compaq.com)) 166-MHz Pentium-based Deskpro won Best System, thanks to its 120-MB floppy drive, optional scanner keyboard, and other features. Best Peripheral was Tektronix's ((800) 835-6100; [www.tek.com/color\\_printers](http://www.tek.com/color_printers)) Phaser 550, a 1200-by-1200-dot-per-inch color laser printer.

Visual Web, from Innovative Software (+49 211 903130; [www.isg.de](http://www.isg.de)) won Best Internet Product. Available now for Windows 95 and NT and OS/2 Warp (and,



soon, other OSes), this browser and off-line reader provides a panoramic view of Web sites and enables you to download pages for off-line browsing. Best Communications Software winner was RVS-COM, a suite of programs for ISDN connectivity from RVS Datentechnik (+49 89 357 157 0; [www.rvscom.com](http://www.rvscom.com)).

An unusual six-way tie for Best Multimedia Hardware went to companies that released 2-D/3-D graphics-accelerator cards based on S3's ViRGe chip, which accelerates 3-D DOS and Windows (including the forthcoming Direct3D) applications. The six companies, Diamond Multimedia, Elsa, Hercules, Number Nine Visual Technologies, Orchid (a Micronics company), and STB Systems, expect to release these boards for about \$250.

Best Multimedia Software winner was DataPath's (+49 6071 9630 0; [www.realimation.com](http://www.realimation.com)) Realimation. This Windows-based environment enables you to create virtual worlds and interactive 3-D multimedia presentations. The award for Best Application went to Star Division's (+49 40 23 646 810; [www.stardiv.de](http://www.stardiv.de)) StarOffice, a multiplatform office suite for Windows, OS/2, Power Macs, and Unix.

Best Development Software winner was the ComUnity Open Technology Framework from Siemens Nixdorf (+49 5251 810585; [www.siemens-nixdorf.com](http://www.siemens-nixdorf.com)). ComUnity, a development environment for Microsoft's Visual Basic 4.0, provides a framework for building large-scale client/server applications.

## Best of CeBIT Finalists

**Systems:** UPKE 2626, a multimedia PC from UPKE Systems (+33 1 53 83 13 13; [www.upke.com](http://www.upke.com)). Gateway 2000's ((800) 270-3094; [www.gw2k.com](http://www.gw2k.com)) G6-200 Professional Plus.

**Portables:** Toshiba's ((800) 999-4273; [www.toshiba.com](http://www.toshiba.com)) Tecra 720CDT. Digital Equipment's ((800) 344-4825; [www.pc.digital.com](http://www.pc.digital.com)) HiNote Ultra II.

**Internet Products:** MicroTouch's ((888) 932-7828; [www.microtouch.com](http://www.microtouch.com)) Prospector. Iterated Systems' (+44 1734 880 261; [www.iterated.com](http://www.iterated.com)) Fractal Imager.

**Peripherals:** Vierte Art's (+49 89 141 7151; [www.vierte-art.com](http://www.vierte-art.com)) X-Ist Facial Expression Tracker. SCM Microsystems' (+49 8441 896 0; [www.scmmicro.com](http://www.scmmicro.com)) SwapSmart.

**Communications Hardware:** AVM Computersysteme's (+49 30 399 76 0; [www.avm.com](http://www.avm.com)) Mobile ISDN-Controller M2. Xylan's ((818) 880-3500; [www.xylan.com](http://www.xylan.com)) Pizza Switch.

**Communications Software:** Aries Australia's (+61 9 221 9393; [www.aries.com.au/](http://www.aries.com.au/)) Phone-Control. MediaPhonics' (fax: +41 38 46 96 01; [sales@mediaphonics.ch](mailto:sales@mediaphonics.ch)) Easycom 1.5.

**Multimedia Hardware:** Fast Multimedia's (+49 89 502060; <http://fast-multimedia.com>) AV Master. Virtuality's (+44 116 233 7000; [www.virtuality.com](http://www.virtuality.com)) Elysium Ultrascaler.

**Multimedia Software:** NetPresenter's (+31 464 370 886; [www.eureka.nl/netpresenter](http://www.eureka.nl/netpresenter)) NetPresenter 2.0. Perceptix's (+41 1 257 4569; [www.ifi.unizh.ch/spin-off/perceptix.html](http://www.ifi.unizh.ch/spin-off/perceptix.html)) Perweb+ Web browser.

**Applications:** NewLog's (+33 1 53 26 46 04; [74434.126@compuserve.com](mailto:74434.126@compuserve.com)) Open Backup 3.0. Siemens Nixdorf's (+49 89 6 36 5 32 04; [www.siemens-nixdorf.com](http://www.siemens-nixdorf.com)) SmartAssist.

**Development Software:** Oberon Microsystems' (+41 1 445 1751; [www.oberon.ch/customers/omi](http://www.oberon.ch/customers/omi)) Direct-to-COM compiler. Aladdin's (+972 3 5375795; [www.aks.com](http://www.aks.com)) HOPE, which offers granular version control.

*Compression may relieve the demands on Internet bandwidth.*

Tired of waiting for porky Web pages to load? Web pages consisting of mostly text can compress on the server end and decompress on your machine. Such a compressed page can be half the size of the original, which reduces transfer time. Look for

## future watch

competition among decompression "viewers" using standard squishmeister formats, such as ZIP and Stuffit.

These products are fine for text, but what about slow-motion GIF and JPEG graphics? Iterated Systems

already uses its patented fractal-compression technology to deflate Web graphics. Fractal Imager compresses an image. A free viewer is available for downloading from [www.iterated.com/fracview/download/fv-loadp.htm](http://www.iterated.com/fracview/download/fv-loadp.htm).

Iterated Systems is also addressing Web-based multimedia with its CoolFusion, for video, animation, and sound. For now, CoolFusion is a codec-independent Netscape 2 plug-in. But the real fun begins this summer when Iterated releases its ClearVideo video-compression drivers. Iterated claims ClearVideo will compress video to data rates as low as 1.25 KBps (up to about 64 KBps).

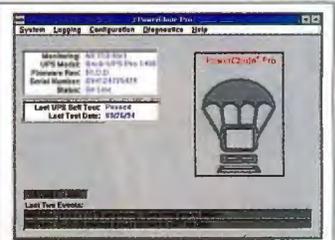
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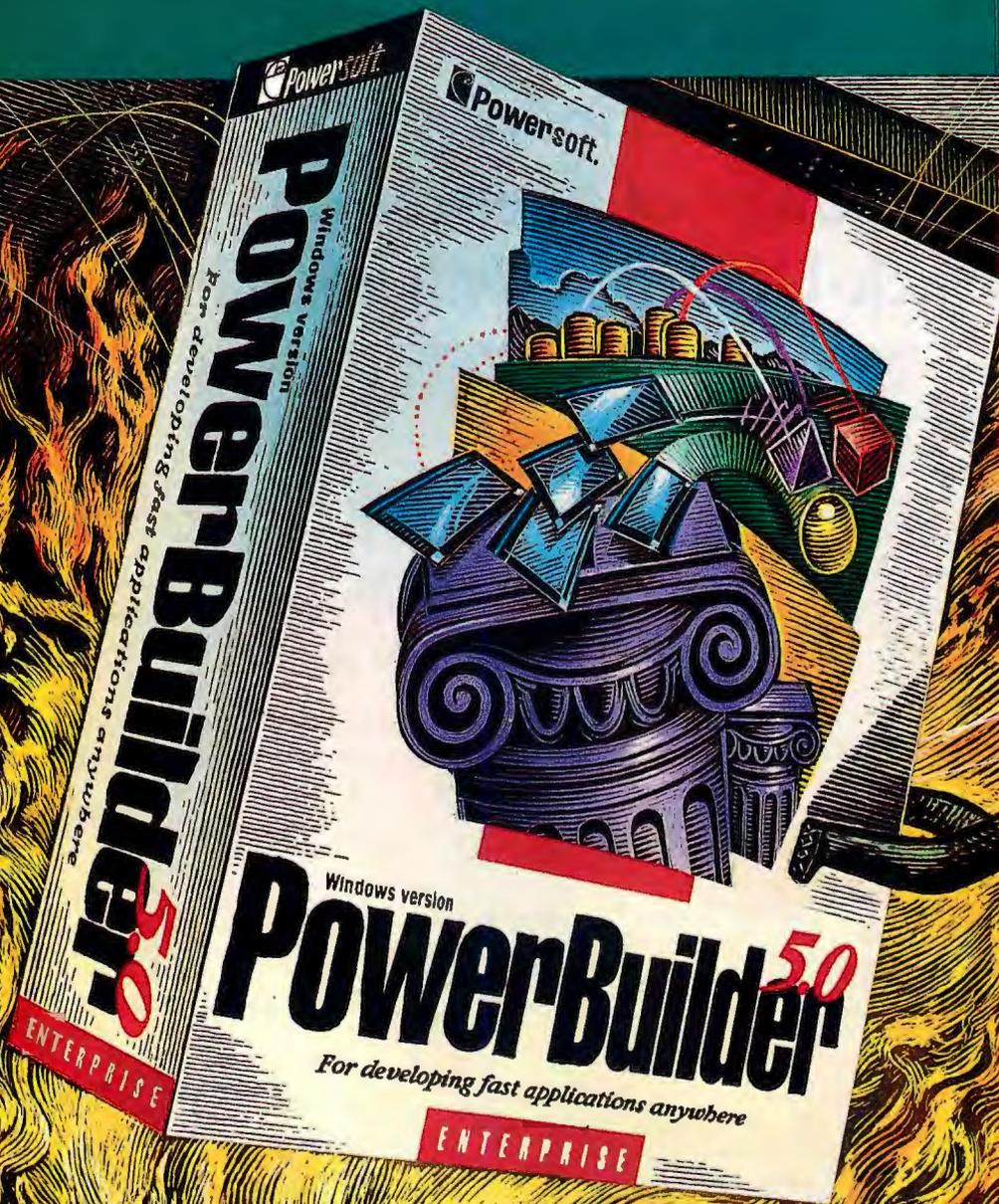
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## NT Notebooks Get Plug and Play—Sort of

Notebook vendor Digital Equipment is adding limited support for Plug and Play-like functionality to its Windows NT notebooks to please businesses that want NT on all their desktop and portable PCs. Although Digital ((800) 344-4825) cautions that it isn't doing a full implementation of the Plug and Play standard for Windows NT, the company is looking to add certain capabilities to its latest crop of notebooks, including the Hi-Note Ultra II.

"I think there are significant market demands to make NT more mobile-friendly," says Steve Smith, product manager for Hi-Note Ultra II (NT configurations). Customers are increasingly asking how well a portable system runs NT." Later this year, Digital hopes to make its

NT notebooks capable of recognizing when they're connected or disconnected to a docking station and make the appropriate adjustments.

Components that Digital has control over, such as its own port replicator, docking station, mobile media module, and other components, will be supported first. The company may also support a few popular third-party network interface cards (NICs), hard drives, and modems, but this will be a greater challenge. "We can add Plug and Play-like functionality where we control both ends," says Smith. "However, it's harder when you don't have access to the source files for the drivers of other companies' peripherals."

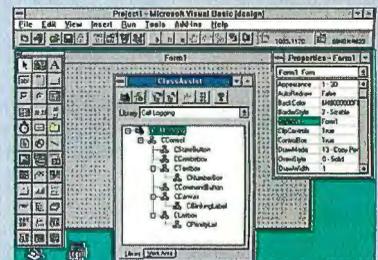
Digital's efforts in this area illustrate the growing importance of NT in the corporate desktop arena. With Microsoft saying Plug and Play won't be introduced to NT until the version code-named Cairo ships later this decade, notebook vendors will need to roll their own solutions to make NT a better notebook citizen.

## Codetalk

### Real Classes for Visual Basic

Visual Basic 4.0 added a touch of class to its environment, but the implementation was incomplete. The raison d'être of VB 4.0 classes was to serve as a framework for building OLE automation servers. Consequently, some class-like characteristics—most important, inheritance and polymorphism—were not built into VB 4.0 classes.

Sheridan Software's ((516) 753-9885) Class-Assist adds inheritance and polymorphism in such a way that VB 4.0 is not aware that these additional capabilities have been infused. For example, suppose I've declared a class Polygon and I want to derive from it a subclass



Rectangle. Rectangle can override Polygon's methods, but should Rectangle wish to explicitly call a Polygon method, it does so by using the syntax `Polygon.<methodname>`. Polymorphism is achieved through a clever naming convention applied to source code.

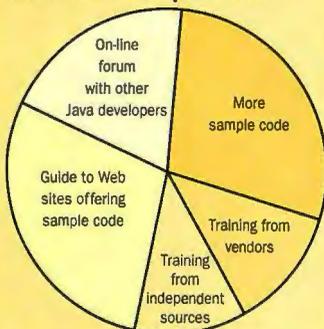
However, more than just source code is involved. ClassAssist keeps all classes in a structured library that can be shared across a network. To perform any edits to a class, you must first check it out of the library; when you do so, you can optionally lock the class so that other users are barred from checking it out.

ClassAssist's Class Explorer window is the gateway into the ClassAssist IDE, a structured collection of windows through which you create and edit classes, their properties, and their methods.

ClassAssist automatically generates the .CLS files that VB 4.0 uses and will import classes into your VB 4.0 project at your command; it even keeps everything in synchronization. That is, if you edit a ClassAssist-generated class from VB 4.0, ClassAssist sees the change and asks if you want to pass your edits on to the ClassAssist library. Bundled with ClassAssist are the WinAPI Oblets, a collection of objects crafted by in-process DLLs that encapsulate significant parts of the Windows API. ClassAssist is well worth its \$249 price.

## Survey

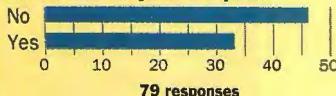
### What Java Developers Want



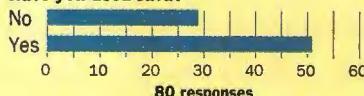
Java developers want sample code. Based on responses we collected from a survey of visitors to BYTE's Web site ([www.byte.com](http://www.byte.com)), respondents are excited about new Java-related programming opportunities, but they also need to increase their Java expertise. When respondents were asked what they need to help improve their expertise, 50 of a total 173 responses (28 percent) indicated a need for sample code from already-developed applets. Other responses included training from vendors (12 percent), a guide to Web sites offering sample code (28 percent), and on-line forums (19 percent).

### Vital Statistics: Java Developers

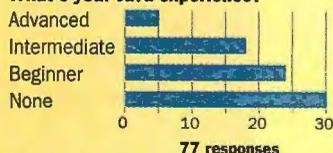
#### Is Java used in your workplace?



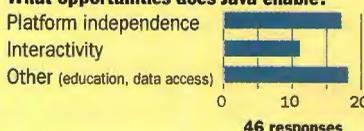
#### Have you used Java?



#### What's your Java experience?



#### What opportunities does Java enable?



Source: BYTE survey

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## How Java Can Pay the Rent

Developers eyeing Java development as a modern-day gold rush need to carefully weigh the pros and cons of marketing their wares. The anticipated avalanche of download-on-demand Java applets

may or may not revolutionize software development and distribution, depending on whom you listen to. But answers are emerging about how applet-based applications will be best marketed so that Java developers can make money.

Applications development might be the first part of the industry to be transformed by the Java model. Java proponents say that teams of developers creat-

ing huge, monolithic applications will gradually give way to individual developers creating cooperating components that are downloaded by users as needed. But one issue in this scenario is how well independently developed applets gathered from across the Web will cooperate as a single application. Poor-quality "crapplets" that crash or perform poorly might discourage early adopters and drive them back to well-known commercial software packages.

The reputation of some Web-based software has withered as a result of the practice where every bug-fix release includes a host of new features—and often new bugs to go with them. With no stable version available, users feel like perpetual beta testers.

Bryce Wilcox, a Java consultant employed by DigiCash (Palo Alto, CA), a firm specializing in secure electronic commerce, says that although dependability and quality control will be issues for Java applets, these problems aren't new to the software industry. "This would be a wise time for developers to start paying more attention to maintenance issues," he observes. "We need to trade off development speed for dependability and design software that upgrades gracefully."

Developers still debate whether the evolution of the Web as a distribution channel will have a profound impact on software marketing. Following today's shareware model, an individual could develop and market an applet independently, eliminating the distributor. But adequate exposure remains the greatest hurdle.

"The single most attractive feature of a Web site is traffic," says George Paolini, a spokesman for Sun Microsystems. "People want to go to a shopping mall. So, a distributor that sets up and advertises a Web site with a great variety of applets will generate sales that an individual with a personal Web page couldn't." However, the marketing model for single applets that don't work closely with other applications (e.g., a game as opposed to a spelling checker) might evolve differently and resemble an "impulse rack" at a supermarket checkout line rather than a shopping mall.

"The latency between viewing a description of an applet on a Web site and downloading that applet is measured in seconds," says Wilcox. "And the elimi-

## book reviews

### A Gosh-Wow Look at the Future

By Rick Cook

One thing about paradigms: Shift happens. And when you're up to your neck in shift of the paradigmatic variety, there's a strong desire to find someone to explain it all to you.

The Digital Economy is one such attempt. It follows a long line of predecessors, including Megatrends, Future Shock, The Greening of America, and The Affluent Society, all written in times of societal stress in an effort to tell us where we're going.

The author does yeoman work in pulling together the predictive threads about our common, digital future. The result is presented in the requisite half-hopeful/half-hypeful, gosh-wow prose.

Don Tapscott's book wins shelf space less for his brilliant insights than for his assiduous rounding up of the usual suspects. There is very little in The Digital Economy that's original, but there's a lot of collected thought about what our digital future will be like. The result is a smorgasbord of food for thought—from the intellectual equivalent of Hostess Twinkies to that of haute cuisine.

Your job as reader is to examine the goods and then pick and choose what you want on your plate. The quality of the predictions varies. For example, the office-supply auction described in chapter 6 is a policy wonk's dream and a politician's nightmare. The idea of having sellers bidding for a contract simultaneously via an electronic network is also unlikely, because it ignores the way governments use their purchasing power as a policy tool.

However, another scenario, on the digital transfer and monitoring of government benefits, is not only insightful but probable.

Using smart cards and databases rather than pieces of paper (e.g., checks, food stamps, and so on) to dispense benefits not only increases efficiency but could reduce crime, fraud, and abuse.

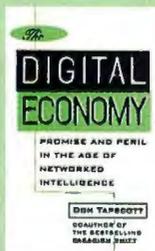
Some of Tapscott's comments are just plain fatuous, notably those on the role of capital in the digital economy and open systems. He sees capital in his new world as key but fleeting, with capital goods overshadowed by corporate brain power as an asset. This will come as a bitter surprise to anyone who has tried to raise capital for one of the new information-age enterprises of the sort Tapscott admires. In fact, the difficulty of obtaining capital investment is probably the biggest check on moving us into Tapscott's Digital Economy.

Some of the topics merely hint at possibilities and don't follow them through, as in the discussion of Multi-user Object-Oriented dungeons (MOOs), Multi-User Dungeons (MUDs), and such in business. As Tapscott notes, MUDs, MOOs, and their ilk were developed as electronic movie sets for role-playing games.

However, his vision of their uses doesn't extend beyond a virtual-reality meeting room. In fact, they are already being employed in more sophisticated ways in training and troubleshooting, and some companies, such as Xerox, are looking at their use in employee socialization.

I wouldn't recommend that anyone restructure his or her corporation or life based on Tapscott's analysis. But I would recommend that you read this book carefully and with an open mind.

*Rick Cook keeps up with many future trends by reading science fiction. You can contact him at rcook@bix.com.*



THE DIGITAL ECONOMY  
 Promise and Peril in the Age of Networked Intelligence  
 by Don Tapscott; McGraw-Hill; ISBN 0-07-062200-0; \$24.95



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nation of the overhead of packaging and retail distribution will make the cost of an applet minute."

In addition to resolving the distribution question, developers must solve an equally important problem: getting paid. The traditional practice of charging a one-time fee is a poor fit for the download-on-demand world of Java applets. Alternate paradigms include paying per use and paying per elapsed time. Both require a system for billing micropayments.

Felix Kramer, marketing director at Clickshare (Williamstown, MA), another company that's exploring the field of electronic commerce, sees this as one of the functions of the Web distributor. "People are going to deposit their applets at payware sites on the Web," he explains. "Other people will collect the fees for them and send them a monthly check."

Kramer envisions a billing model for applet use based on data transferred, not on time used. Each download of an applet might cost a few cents or dollars but would allow the use of an applet during an entire session. The alternative, in which the applet might be equipped with a built-in expiration timer, interrupting your application to demand another nickel, is not as likely to occur. "The Internet is a stateless system," Kramer says. "Time as a method of measurement will go away."

The mechanics of development and distribution of Java applets aside, some observers believe that in the long run, there may not be enough financial incentive to lure many developers to go out on their own. If Java becomes a popular language in the business community, you'll begin to see more ads in the classified section of your local newspaper searching for Java programmers who can develop intranet applications.

It's unrealistic to expect that a significant percentage of Java developers will choose to make their living marketing applets independently, or even through distributors, according to Alex Newman, executive director of Sun User Group/Java-SIG. "There are a lot of great C++ coders out there, but they don't walk around selling code," he says. "They go around looking for jobs. Knowing how to program in Java will be a resumé item." —Robert L. Hummel

## DataPro Report

### IBM to Improve Enterprise Support in OS/2 Warp Server

IBM hopes to improve upon an already-solid server OS by adding support for multiprocessing as well as directory and security services to OS/2 Warp Server later this year. OS/2 Warp Server 4, released in late February, is the latest update of IBM's network OS (NOS).

OS/2 Warp Server 4 combines the OS/2 Warp version 3 OS with OS/2 LAN Server 4.0. It supports multitasking for 16- and 32-bit applications and standards-based system management and enterprise connectivity through IBM's SystemView. Warp Server also features a built-in gateway for accessing Novell NetWare servers, provides applications-server capabilities and remote connection for NetWare clients, and permits single sign-on to OS/2 Warp Server and NetWare servers alike.

With OS/2 Warp Server, IBM addresses a broad clientele, ranging from small- and mid-size businesses to organizational departments. Warp Server is especially well suited for workgroups—particularly those that must be integrated into their organization's management systems and services—because of its interoperability with Digital Equipment, Hewlett-Packard, and IBM enterprise-level systems and NetWare LANs.

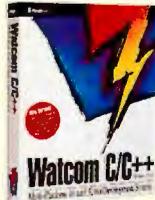
With its software distribution, license management, and remote access, OS/2 Warp Server shows strong potential as an applications server. However, despite excellent reported performance, OS/2 Warp Server lacks a key component: symmetric multiprocessing (SMP). Competing products, such as Windows NT Server, can already take advantage of multiple-processor servers through SMP support. NetWare also has an SMP configuration option. IBM expects to have Warp Server SMP ready by the third quarter. Also not yet ready for prime time is Directory Security Services, IBM's global directory software, currently in beta testing. DSS will let users access any connected OS/2 resource; provide a unified client view; offer Distributed Computing Services security; and let administrators maintain resources locally, remotely, or centrally. DSS will give Warp Server significant advantages over NT, which provides applications services but has no centralized directory, and NetWare, which has a directory but doesn't include Warp Server's built-in software administration and performance monitoring.

—Deborah Hess is a senior analyst at DataPro Information Services Group (Delran, NJ, (609) 764-0100), a division of The McGraw-Hill Companies, Inc.

	OS/2 Warp Server 4	Windows NT Server 3.51
<b>Target market</b>	Small business/departmental	Departmental/enterprise
<b>Interface</b>	OS/2 Workplace Shell	Win 3.1; version 4 will have Win 95 GUI
<b>Clustering</b>	No	Expected by 1997
<b>Server hardware</b>	x86	x86, PowerPC, Alpha, Mips
<b>Network management</b>	SNMP, IBM SystemView, DMI	SNMP, IBM NetView (via SNA Server)
<b>Networks</b>	Ethernet, Token Ring, PC-Net, FDDI, Asynchronous Transfer Mode (ATM)	Ethernet, Token Ring, FDDI
<b>LAN protocols</b>	NetBEUI and Apple EtherTalk (client); NetBIOS; TCP/IP; IPX/SPX; 802.2; Named Pipes; AppleTalk and Unix/NFS via additional software	NetBIOS, NetBEUI, TCP/IP, IPX/SPX, SNMP, LU6.2, SMB, AppleTalk, XNS, DLC
<b>Clients</b>	DOS, OS/2, Win 3.x, Win 95, Win for Workgroups, Win NT client; AIX and Mac with additional software	DOS, Win 3.x, Workgroups, Win 95, Win NT Workstation



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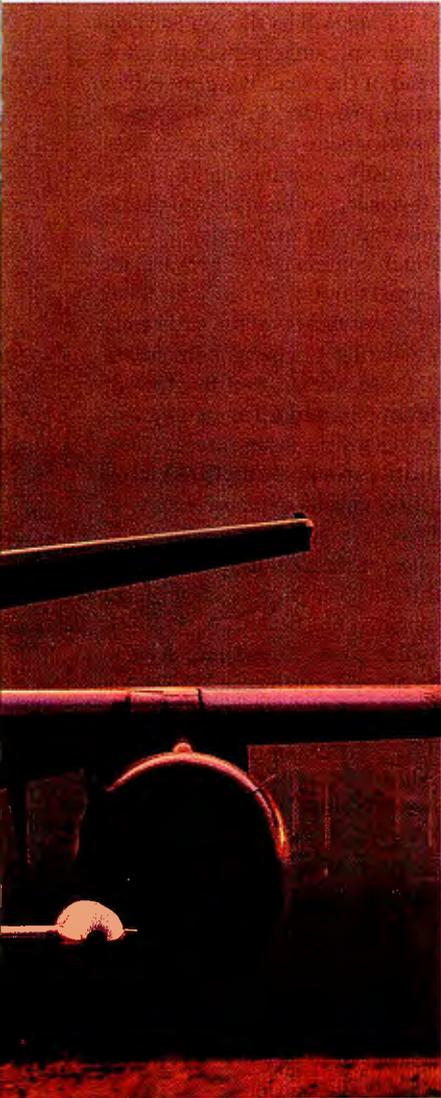
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## cd-rom review

### Personal Guitar Tutor

Learning how to play an instrument takes time and usually involves costly lessons. The eMedia Guitar Method CD-ROM is a remarkably helpful instruction program for beginning guitar students that's an order of magnitude ahead of any book and that does things even a personal tutor can't do. The CD-ROM (available for Windows now, with a Mac version slated to ship in June) gently leads you through a series of 60 comprehensive lessons, ranging from stringing the guitar to playing chords, strumming styles, finger picking, and much more.

The lessons are varied and self-paced and build on previous material. You learn how to replace a string; hold the guitar; learn the different sounds of an acoustic, steel, and electric guitar; and advance at your own pace. There are 30 full-motion instructional videos, 3 hours of audio that contains over 100 exercises and songs, and a dictionary that contains fingering charts and sound for more than 250 chords. Using your computer's microphone, you can record your playing and even tune



The eMedia Guitar Method CD-ROM includes instructional videos that you can view as you learn a new technique, such as a bass note strum.

your guitar against a simple-to-use tuning program.

The instruction is not geared toward a specific style of music; it includes songs from such genres as folk, popular, blues, and country. For those who have the patience, discipline, and desire to learn to play a guitar without a personal instructor, eMedia Guitar Method will get you off to a good start. —Rich Friedman

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## Faster, Fatter CD-ROM Titles on Hold

Although the next wave of CD-ROM drives promises higher performance than today's quad-speed and  $\times 6$  drives, developers say that they will wait for the next CD-ROM standard, Digital Videodisc (DVD), to arrive before they release the next generation of "edutainment" titles.

New  $\times 8$  drives have already arrived, and more are on the way. By June, most drive vendors will offer  $\times 8$  drives with up to 1200-KBps data transfer rates for \$250 or less; at least one vendor says it will release an even-faster  $\times 10$  drive in the third quarter of this year.

But while the latest drives offer improved seek-time performance and potentially smoother video playback than current drives, they're still shackled by the CD-ROM standard's 640-MB memory restriction. This limit has developers waiting for the DVD standard and its 4.7-GB storage minimum before they release the next wave of titles with optimized (i.e., full-screen, 30-frame-per-second) video.

"When we develop titles, we want our products to run well on the majority of the CD-ROM drives on the market today, and those are two-speed and quad-speed drives," says Dave Wooldridge, director of marketing for L3 Interactive (Santa Monica, CA, (800) 644-2823), whose edutainment titles include *Mathemagics* and extreme-sports instructional programs. The double-speed drives' low data transfer rate means they can't play back video that's recorded at 30 fps without dropping frames. This is why content developers often use 256-color video recorded at 8 to 10 fps. If your title doesn't run well on the lowest common denominator, Wooldridge says, "you lose your mainstream market."

However, content developers say that even if all consumers were to install new  $\times 8$  CD-ROM drives, developers still couldn't optimize for the drives' higher performance without having to eliminate content. Officials at Graphix Zone (Irvine, CA, (800) 828-3838) say they already have a problem squeezing all the content they want onto a CD-ROM disc. The company's titles, including its latest, *Nixon*,

already have a lot of video and audio clips squeezed into a standard CD-ROM. Increasing the quality of the video (e.g., by including 30-fps instead of 12- or 15-fps video) would force the company to include fewer video clips.

Graphix Zone officials say DVD's increased storage will let the company include longer-playing, full-screen movies instead of the small-window videos it currently provides. More disc space also allows for better-quality audio: DVD can more easily accommodate 16-bit, 44-kHz (CD-quality) audio instead of the 22-kHz audio typically used today.

Although content developers are, for the most part, not optimizing for  $\times 8$  or  $\times 10$  drives, purchasers of the latest technology will still see benefits in the area of CD-ROM disc access, according to software developers and drive manufacturers. Vendors say the faster rotation of  $\times 8$  and  $\times 10$  drives results in improved access times; this benefits database-intensive programs.

To achieve the maximum performance benefit from  $\times 10$ , Pioneer New Media Technologies (Long Beach, CA, (800) 444-6784) will release a dual-mode drive in the third quarter of this year. One mode, Constant Linear Velocity (CLV), has the disc rotate at a faster rate while the drive reads inner tracks and at a slower rate while it reads outer tracks. This ensures consistent and smooth video playback when video stored on the outer tracks is accessed.

But CAV mode spins the disc at a fixed rate, eliminating the access delays that occur when a disc is slowed down in CLV mode. Pioneer says CAV mode's 80-millisecond access time will make its Super 10X drive a better solution for applications that require fast access times.

In general, the faster CD-ROM drives also allow for less expensive components, says Scott Elrich, product development/marketing manager at Teac America (Montebello, CA, (213) 727-7669), which will release a  $\times 8$  drive in June for about \$200. For example, as access times drop (e.g., a 300-ms access time was typical about two years ago), cache sizes can also decrease, from 256 to 128 KB. Higher production volumes from drive makers also contribute to lower prices, and that's good news for game players who will want to buy drives offering the latest technology in order to get smooth-playing video. —D. A.

Mike wants to upgrade his company to Lotus Notes Release 4.

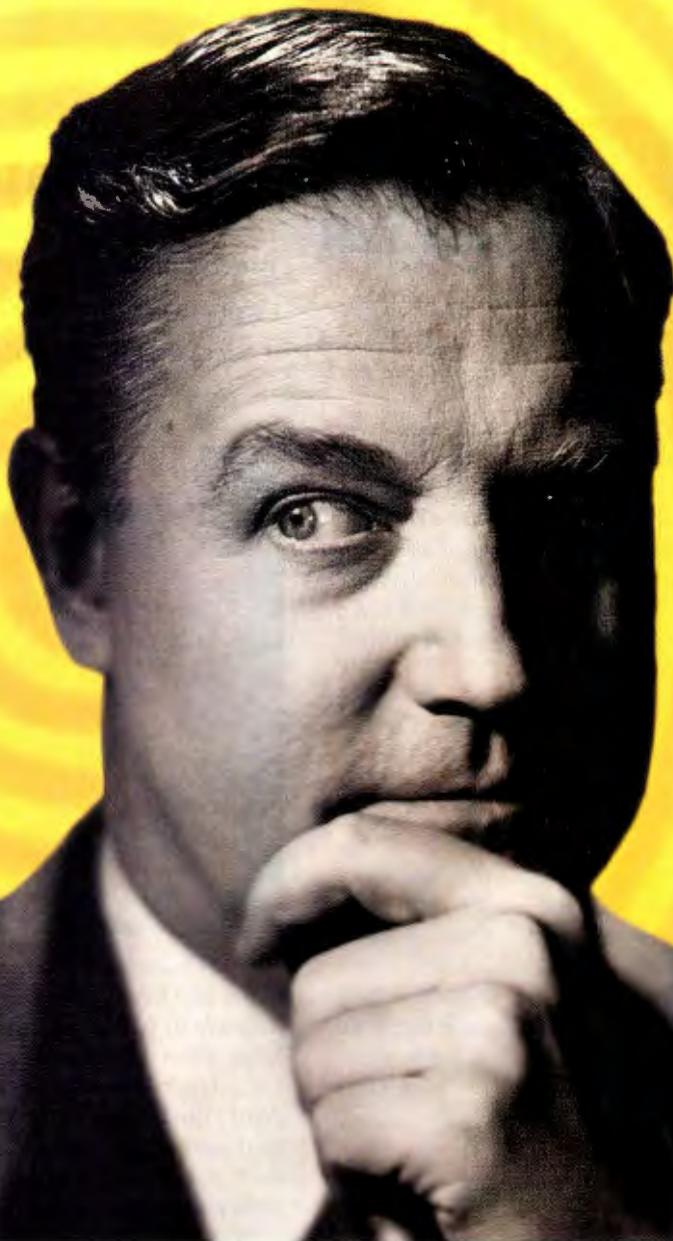
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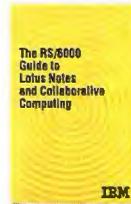
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## Blasts from the Past

5  
Years ago in BYTE

ACE, the Advanced Computing Environment consortium, made noise with its 21 big-name vendors, including Compaq and Microsoft, who promised big things for next-generation workstations. But then Intel accelerated its rollout of x86 processors, and such companies as Compaq left the organization, saying the x86 architecture offered pretty good performance after all.

10  
Years ago in BYTE

BYTE took an early look at the Mac Plus, a \$2599 system that came with 1 MB of RAM, a 9-inch display, a 7.8-MHz Motorola 68000 processor, and an optional 20-MB hard drive (but no expansion slots). The Compaq Deskpro 286, which we also reviewed, had 512 KB of RAM, a 30-MB hard drive, and four expansion slots; it cost \$6245 with a monitor, but it was faster than IBM's AT.

15  
Years ago in BYTE

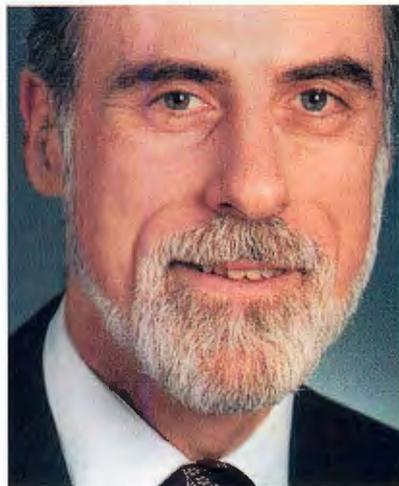
Apple Computer's Steve Wozniak wrote about his experiences in computing the mathematical constant  $e$  to 116,000 digits of precision on an Apple II computer. He theorized that one could build a dedicated "e-machine" for under \$10,000 that could calculate  $e$  to 100,000,000 places in three months.

In the same issue, Digital Research's Gary Kildall wrote about CP/M, a popular OS that by 1983 had lost market share to Microsoft's MS-DOS on the IBM PC; MS-DOS got on the PC first. The same issue also contained an article about Microsoft's Xenix OS. Now Microsoft positions Windows NT against Unix.



## A Road Map to Better Bandwidth

Widely known as the father of the Internet because of his pioneering work in creating TCP/IP, Vinton Cerf, senior vice president of data services architecture at MCI, comments here on technologies that will improve Internet bandwidth.



**BYTE:** *It seems the Internet is slowing down. MCI recently announced plans to upgrade its backbone from 45 to 155 Mbps. When does that take effect?*

**Cerf:** It takes effect approximately April 15 and runs over an ATM substrate that uses MCI's Sonet transmission backbone. I expect increases in capacity throughout the course of the year.

**BYTE:** *Even with the upgrade to 155 Mbps, with all the people creating new Web pages, will that be enough?*

**Cerf:** No, and we'll be working to increase the capacity this year.

**BYTE:** *What other technologies could improve the bandwidth situation?*

**Cerf:** We look forward to tens of megabits per second on direct-broadcast satellite in 1997. Meanwhile, cable modems and ADSL may be alternatives to modem and ISDN access. We are very interested in advanced services, such as multicast, that could reduce some of the load from streaming audio and video services. Web host mirroring can also help to reduce the load.

**BYTE:** *What's your reaction to magazine articles that predict the death of Web-based media due to bandwidth problems?*

**Cerf:** I think that's premature.

**BYTE:** *Why is business migrating from private WANs to the Internet?*

**Cerf:** Dedicated services are expensive. We see a lot of interest in virtual private networks derived from frame relay, SMDS, and ATM and look forward to similar capabilities over the Internet with, for example, MCI's Safenet [a hardware-based security service for open networks and electronic commerce over the Internet]. Since most intranets ultimately need to connect to the public Internet, via firewall typically, we see companies interested in either using the Internet directly or interconnecting their virtual private nets with the Internet. Private WANs will stay around where they make economic sense. In general, the Internet is needed for interorganization communications, so the two will complement each other.

**BYTE:** *What needs to be fixed most in the move from private WANs? Internet security? Performance? Both?*

**Cerf:** Private WANs—if by this you mean dedicated-circuit nets—are often replaced with virtual private nets because VPNs are more cost effective until you get to really intensive use. Use of the Internet for intranet communications requires strong cryptographic security end to end, at least between the routers linking the local corporate net or nets to the Internet. Performance is always an issue in a shared net, but I see vastly increased Internet capacities as time advances and demand increases.

**BYTE:** *How will MCI address voice and data communications for countries with poor infrastructures?*

**Cerf:** First, we will use satellite links where there's no other means of providing international access. We will always look for terrestrial fiber where it's economically feasible and available. Wireless is a fast way to get going for local access in the absence of local loop infrastructure. I would not be surprised to find voice and data services ultimately merging on the Internet once the technology for providing multiple qualities of service is available.

Apple hopes a primitive 3-D interface will lead to sophisticated 3-D games. **By Peter Wayner**

## Crave the RAVE

**N**ow that hardware acceleration for 3-D computing is about to enter the mass market for home PCs, software developers are scrambling to come up with a standard language that will make it possible for their applications to run on as many machines as possible. Apple Computer (Cupertino, CA) is trying to establish one such standard with 3D RAVE (Rendering Acceleration Virtual Engine), which is a low-level 3-D rendering system that should smooth differences between all machines, be they Wintel or Mac.

The goal is simple: If a developer wants to draw a triangle on-screen, he or she makes one call to the 3D RAVE API. It's then up to RAVE to do the right thing depending on the end user's hardware. If the software is running on a computer equipped with a hardware accelerator for 3-D graphics, the RAVE layer should use this fast hardware to render the triangle as fast as possible. If the software is running on a plain machine with no special equipment or video hardware, a software rendering engine should step onto the stage and do the job correctly, if more slowly.

A smart API like this is a big time-saver for developers and accelerator manufacturers. Thousands of games and dozens of video accelerator cards are on the market. The RAVE structure lets each accelerator card manufacturer write a single engine that will be accessible to each game designer through the RAVE interface. All engines will accept the same basic calls for rendering points, lines, and triangles, so all software will work with each board.

Actually, 3D RAVE is one of two Apple API sets for rendering 3-D objects. The other one, which is called QuickDraw 3D, is a much-higher-level API that offers developers the ability to simply open up

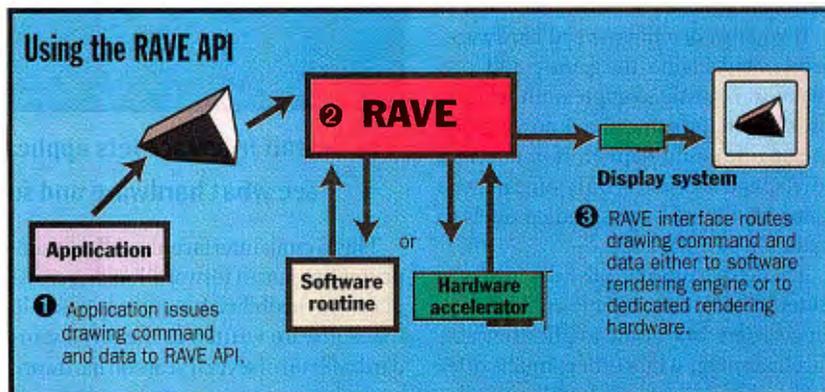
a window and hand QuickDraw 3D a file that describes a complex item. QuickDraw 3D will interpret the complex data structures and break them into such low-level items as triangles, lines, and points before handing them to 3D RAVE to do the right thing with the local hardware configuration.

### Two Halves Are Better Than One

Apple split the APIs into two sets because its engineers realized that not all software developers are alike. Some developers wanted a powerful tool that would do

rendering engines still need an API such as RAVE. This allows them access to multiple machines with different accelerator cards. Their rendering engines break up the complex models into triangles and then RAVE handles the local details.

Although the RAVE API layer is meant to be a low-level API, it still offers a strong collection of the most important features. You can texture-map triangles with textures that are as detailed as 4000 by 4000 pixels. Z-buffering is available, but you can turn it off to save memory and add



### Applications write to the RAVE interface, which deals with the hardware accelerators and software libraries on that machine.

all the rendering work for them. Those developers would use the full version of QuickDraw 3D.

However, others had invested a great deal of time and effort in their own rendering engines that provided a distinctive "look" for their games. Game designers may concentrate on different effects. One developer might include a complex rendering engine for dealing with effects such as smoke and fog; another developer might choose for the action to occur in clear light. Visual styles such as these are important.

Software companies with their own

speed. Some game programmers have already calculated distance information in their code, and they're able to draw programs from back to front and present the correct information without help from a z-buffer. You can clip these operations to fit into windows and other shapes.

The API does not offer access to any higher-level features that might be found in the full QuickDraw 3D API. That API offers commands that will open standard 3-D files and import them. Game developers must do this for themselves if they want to deal only with RAVE. Also, such

higher-level constructs as smooth polygonal object models are missing. These constructs are a large part of the heavy overhead that graphics languages such as GL impose on the systems that run them. With RAVE, game developers don't have to worry about losing memory to these functions.

### The Difference Engines

A general API (like RAVE) should offer the same effect on different platforms in a manner that is completely transparent to the software. For instance, the standard window accelerator will move rectangles around in the same way. A 3-D API must also offer consistency across platforms, but it would actually be better if it weren't perfect. This is because software developers don't want exactly the same thing to happen on each machine. They want the best possible image to emerge on each machine.

This flexibility is offered by RAVE's Gestalt interface and the different rastering engines. A game program might poll RAVE to find out which of the engines are available and also determine their performance.

If you install a high-speed hardware-accelerated engine, the game could load the most realistic, complex models and use them in the game play, knowing that the engine could deliver. If you have a low-speed software-only engine, the game would use lower-grade models to maintain performance.

The Gestalt interface also describes the different features available on the different accelerators. Some might offer texture-mapping, while others might offer higher-grade mapping with interpolation. Some might offer transparency blending, while others might use an alpha channel.

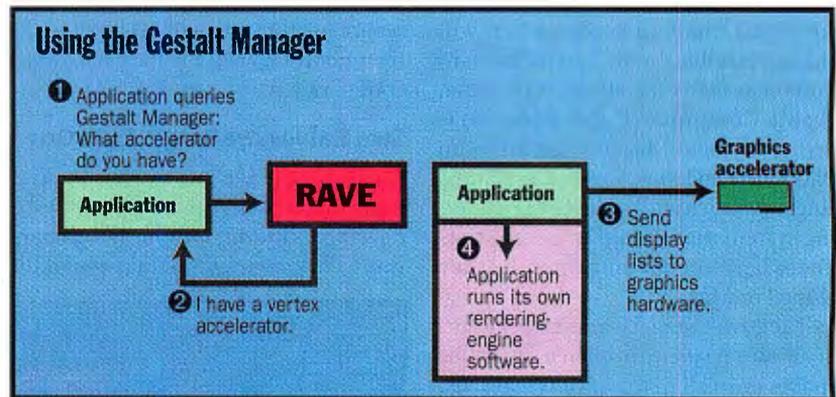
Some might handle depth through simple z-buffering, while others might add deep z-buffering or perspective correction. Through the Gestalt interface, the game can poll the local hardware and choose the appropriate object models to fit the performance characteristics of the board.

<info on the www.>

[www.info.apple.com/qd3d/qd3d.html](http://www.info.apple.com/qd3d/qd3d.html) (Netscape frames)  
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When the software begins executing, it can flip through a list of the available low-level RAVE engines and choose the best one for the job. It is quite possible that a package might forgo a zippy hardware accelerator engine for a slower software-only engine because the software-only engine offers features that are not available on the accelerator engine. If the software-only engine still renders the image fast enough, it would be the right choice for that situation.

This information is available through the Gestalt interface. Giving the software developer access to these choices is an important item if they're going to be able to tailor the drawing to present the best possible image on each machine.



The Gestalt interface lets applications query the RAVE subsystem to see what hardware and software are on that machine.

This Gestalt interface also offers a surprising amount of forward-looking cross-platform flexibility. It is entirely possible that software written to the RAVE standard will run in several years on hardware accelerators that weren't even designed when the software was written. The software will access the Gestalt interface and choose the best-performing engine that's available.

### Cross-Platform Wintel and Mac

The original core of RAVE was designed as a hardware abstraction layer (HAL) that would hide the details of each accelerator card from the Mac programmer. Once the abstraction is set up, it is not much trouble to extend this to work well on Windows machines as well.

As of this writing, Apple has said it will ship a version of RAVE for Windows programmers. This will let game programmers write to a single low-level standard and have their software run on either machine. In essence, the game program-

mer makes the same call to draw a texture-mapped triangle on either a Mac with a Matrox card or a PC with an ATI Technologies accelerator card.

The Windows development kit contains a Software Development Kit (SDK) with DLLs for the game programmer and a device-driver kit (DDK) for the board manufacturer. Both kits contain the definitions for the data structures that work consistently across both platforms—they are just recompiled for use on the PC. The Mac kit's SDK for the game programmers includes the headers for the system calls that are part of the QuickDraw 3D system extension. The board manufacturers can develop their own system extensions.

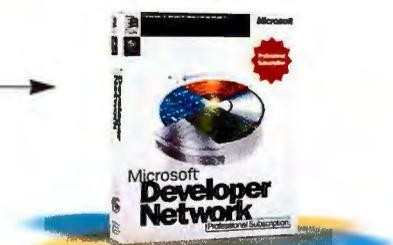
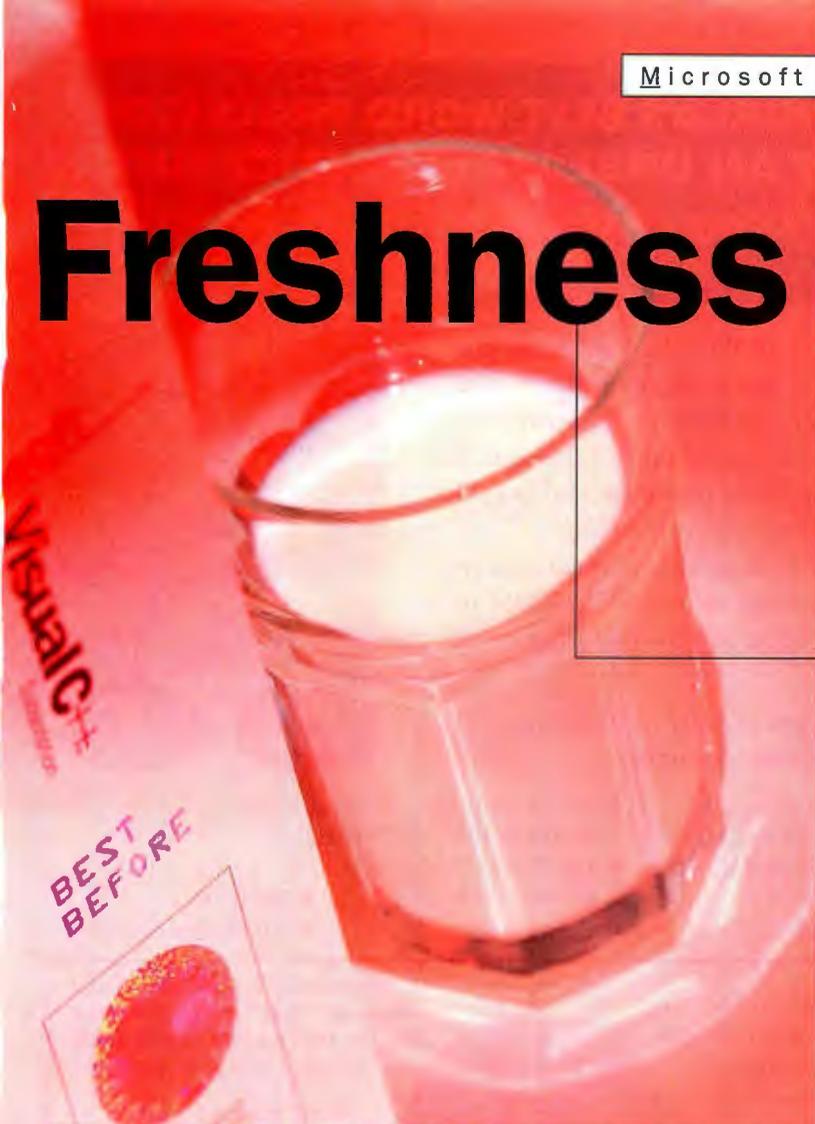
Apple has been the source of a wide variety of cross-platform standards, but its most successful ones have come in the graphics arts world. QuickTime and its virtual-reality cousin QuickTime VR are used on a number of CD-ROM games and graphics additions. The domination of the Mac platform in the graphics arts world helps this process.

If RAVE succeeds in helping 3-D game developers market their products, Mac users will benefit. Porting PC games to the Mac will be a relatively simple process, and there will be more games. The work may also flow in the other direction. Porting games from the Mac to the PC will be an easier process. That will allow graphic designers who cling to the Mac to stick with it into the future. **B**

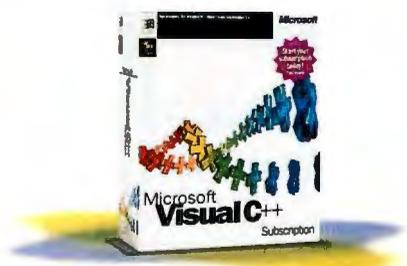
*Peter Wayner is a regular BYTE contributor in Baltimore, Maryland. His latest book is Disappearing Cryptography: Being and Nothingness on the Net. His home page is at <http://access.digex.net/~pcw/pcpage.html>.*

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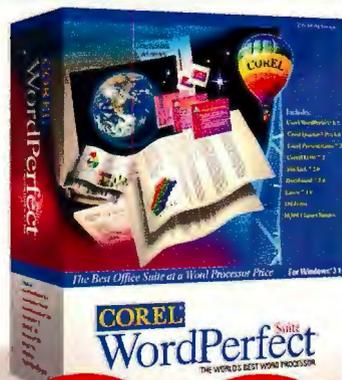
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Web browsers can offer a common front end to mainframe data. *By Salvatore Salamone*

## How to Put Mainframes on the Web

**I**s the Web browser the ultimate corporate front end? The hype about intranets certainly indicates this is the case. Trouble is, one vital component is missing from Web technology: access to all that mainframe data.

And that's a problem. "Approximately 75 percent of all real-time transactions in the world still run on mainframe-based networks," says John Dunkle, president of Workgroup Strategic (Portsmouth, NH), a consulting firm. In other words, the data on which corporate America runs is currently inaccessible through browsers and intranets.

You can fix that.

### Pick One, Any One

There are a couple of fundamentally different ways to give browsers access to IBM hosts. The two basic methods can generically be called native 3270 and Hypertext Markup Language (HTML) conversion. Each method has technical merits and deficiencies.

With native 3270, you need to have a special browser. In this case, the browser needs some form of built-in 3270 terminal emulator and applets that know what to do with the 3270 data streams once they reach the desktop system.

With conversion, 3270 screens are changed to HTML format and posted to a Web server. The converted screens can then be viewed using any browser.

HTML conversion comes in two flavors. One is a static approach, where the user has what amounts to read-only access to data made available by an administrator. The other method is more dynamic (and similar to your typical transaction-oriented mainframe data access), where the user queries a database and views the results using a browser.

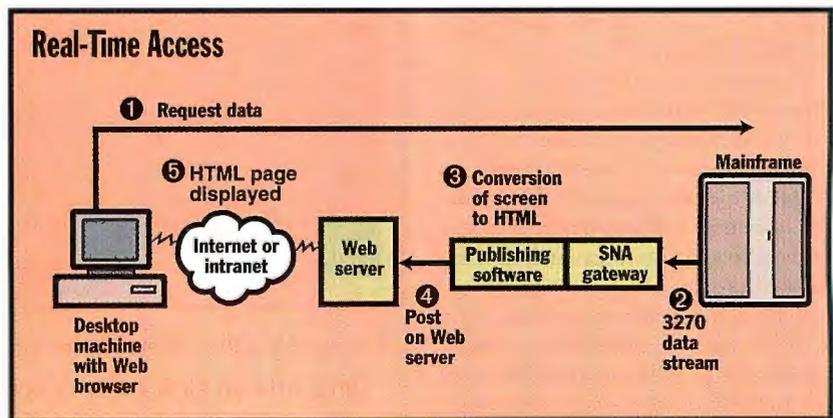
An example of the static approach would be where some mainframe data is

made available to an organization. For instance, a human resources department might, on a monthly basis, post to an intranet server the amount each employee has in the 401 (k) plan.

To do this, the 401 (k) information would be pulled off the mainframe and converted to HTML format. Then employees would be able to look up this information using the browser on their desktop computers simply by entering

embedded HTML scripts. (In a sense, this is the normal HTML process applied to 3270 data streams.)

First, a Systems Network Architecture (SNA) gateway into an IBM host pulls off a standard IBM host screen with embedded data. This screen is then converted to HTML format on-the-fly. That's what Salvo Server Edition from Simware and the Emissary Host Publishing System from Attachmate do.



### One approach is to convert 3270 data on-the-fly to HTML.

the uniform resource locator (URL) of the Web server. (Obviously, security is an issue here and the information would need to be password-protected.)

This approach to making mainframe data available through browsers is fairly limited. And while such access might do in many situations, it's not sufficient when users need access to data that changes more frequently.

For example, you might have an inventory database that sales staffers frequently check when they're taking orders over the phone. For such applications, you need an HTML conversion method that is more dynamic.

The way to accomplish this level of access to mainframe data is through

From a common browser, the user enters the URL of an intranet server that is connected to the server that's performing the HTML conversion. Common Gateway Interface (CGI) scripts are employed to generate the HTML pages based on user queries.

The possible downside to the HTML conversion approach is that you may not, in all cases, be able to support some of the more complex 3270 commands, such as creating built-in function keys that perform a series of operations.

### The Natives Are Wild

An alternative to HTML conversion is to leave the data in native 3270 data stream format and use a special browser. Such a

browser would need 3270 terminal emulation features and would require an applet to handle the data.

These browsers would replace a terminal emulator and would include the underlying technology needed to maintain a connection with the mainframe (e.g., by sending acknowledgments to the host to keep the session alive).

Using a special browser may seem idiotic. Would anyone actually do that? The answer is probably—especially if the browser solves a specific problem, like giving users access to mainframe data. The Aberdeen Group consulting firm believes the browser market will become fragmented and, despite Netscape's current dominance, users will buy browsers based on their personal requirements.

With the native 3270 approach, a user establishes a session with the mainframe, typically by running a Telnet session into the host. The resulting TN3270 data stream would travel across the network to the desktop system. There, the browser would need to have embedded applets to take the data stream and display it as a normal 3270 screen.

The applets could be designed to handle even the most complex 3270 commands. This would overcome the shortcomings you might encounter with an HTML conversion approach. The trade-off, of course, is that you need a special browser that can perform emulation and handle the data.

But that may not be a problem if you decide to use a common applet technology, such as Java. If that's the case, then any of the major browsers will work, since virtually all the browser vendors either support Java or plan to do so.

And when it comes to mainframe connectivity, there's already some movement in Java's direction. For example, OpenConnect Systems, a TCP/IP-to-SNA connectivity company, offers a product

called OC://WebConnect, which is Java-enhanced server software that lets users access mainframes and midrange systems through a Java-enabled browser.

With the OC://WebConnect software, Java applets convert standard data flows into HTML/Java data flows (and vice versa). This conversion enables multisession, multiprotocol access to existing mainframe applications.

### Fast Forward

Giving users access to mainframe data through Web browsers is a big start. But many organizations also want to extend this level of connectivity to other types of IBM environments—specifically, to AS/400 systems.

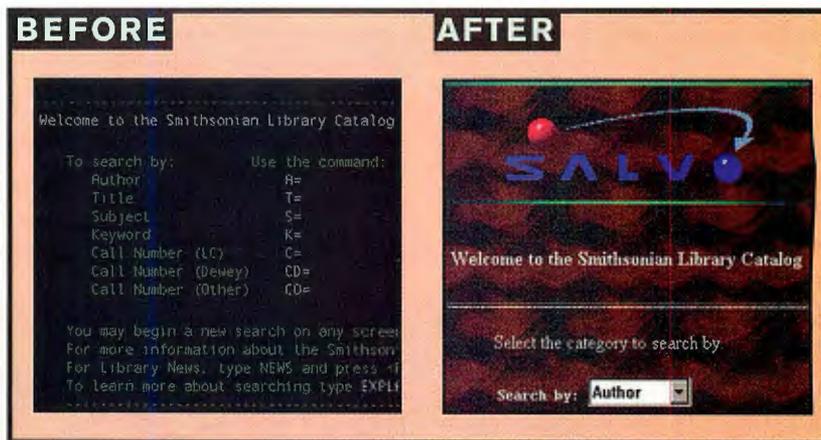
Some help in this area has already arrived. Earlier this year, IBM's AS/400 Division announced it was teaming up

for intranet use by dropping an OLE custom control (OCX) onto a form to display the data in HTML format with a browser.

Regardless of the method used to access mainframe data with a browser, one other issue must be addressed before opening up the corporate treasures. That is security.

Many Web browsers (including the Netscape Navigator) store on-screen images in a local cache and often in a server cache. After a user logs out of a session with a mainframe computer, these screen images can then be viewed by anyone with a Web browser.

That means someone could come along after a session and view data to which the original user gained access only after entering a password and ID when logging onto the mainframe application.



Simware's Salvo allowed the Smithsonian to turn its 3270 screens (left) into an easier way to access information on mainframes.

with I/NET, a research and custom software solution provider, to bring AS/400 users onto the Web. I/NET has a software package called Web Server/400 that enables an AS/400 running OS/400 version 3.1 to operate as a Web server. (About 360,000 such systems are installed today.)

The move to open corporate data to Web technology has just begun. And it's likely that for the next year or so HTML conversion and the native 3270 access methods we've outlined here will be the best ones to consider. But in the future, a better way to access mainframe data may become available.

One idea being considered is to use existing client/server tools, such as Visual Basic, C++, and OLE 2.0, to develop applications that can access mainframe data. You can then ready any applica-

tion for intranet use by dropping an OLE custom control (OCX) onto a form to display the data in HTML format with a browser.

Peeking at the cached screen images also defeats any encryption that would have been used when the data passed over the corporate network. This is an area that will probably be addressed quickly. Web browser vendors will most likely add HTML extensions to tackle this security breach. That's at least something to consider before opening the doors to your mainframe data. But once that's done, you may have an easy way to give users a common interface to all your corporate data, whether it's on big iron or little. **B**

Salvatore Salamone is a BYTE news editor based in New York and author of *Reducing the Cost of LAN Ownership* (Van Nostrand Reinhold). You can reach him at [ssalamone@bix.com](mailto:ssalamone@bix.com).

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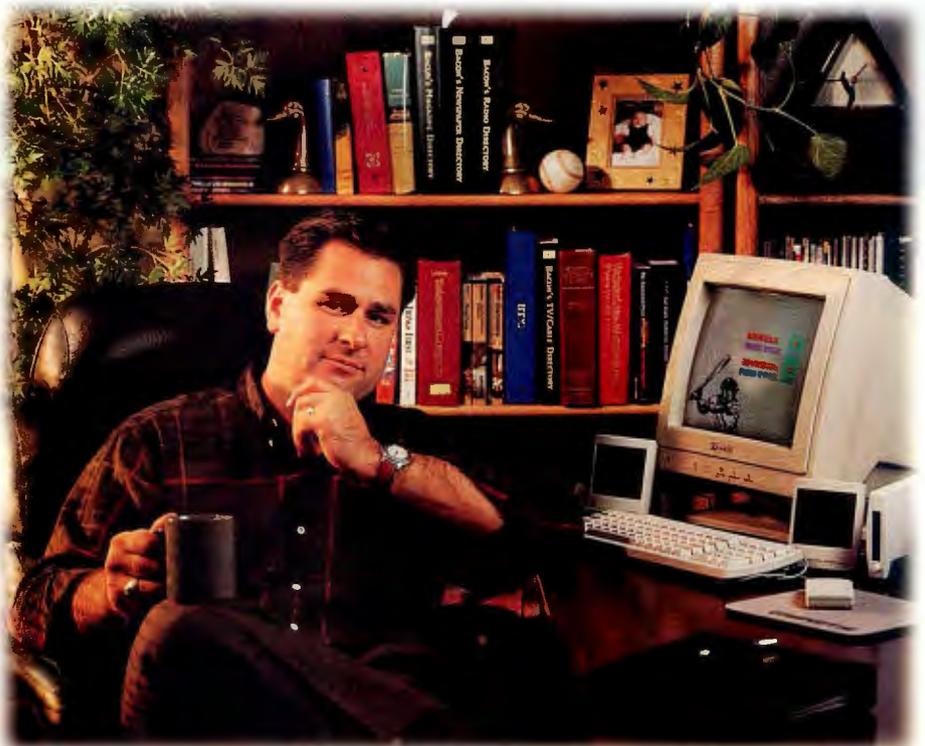
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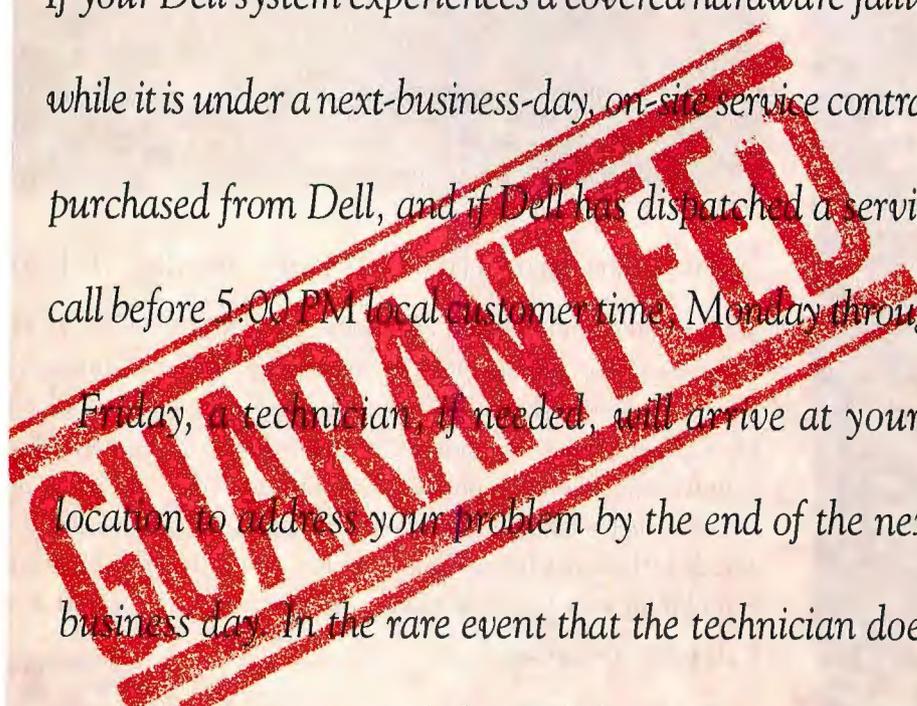
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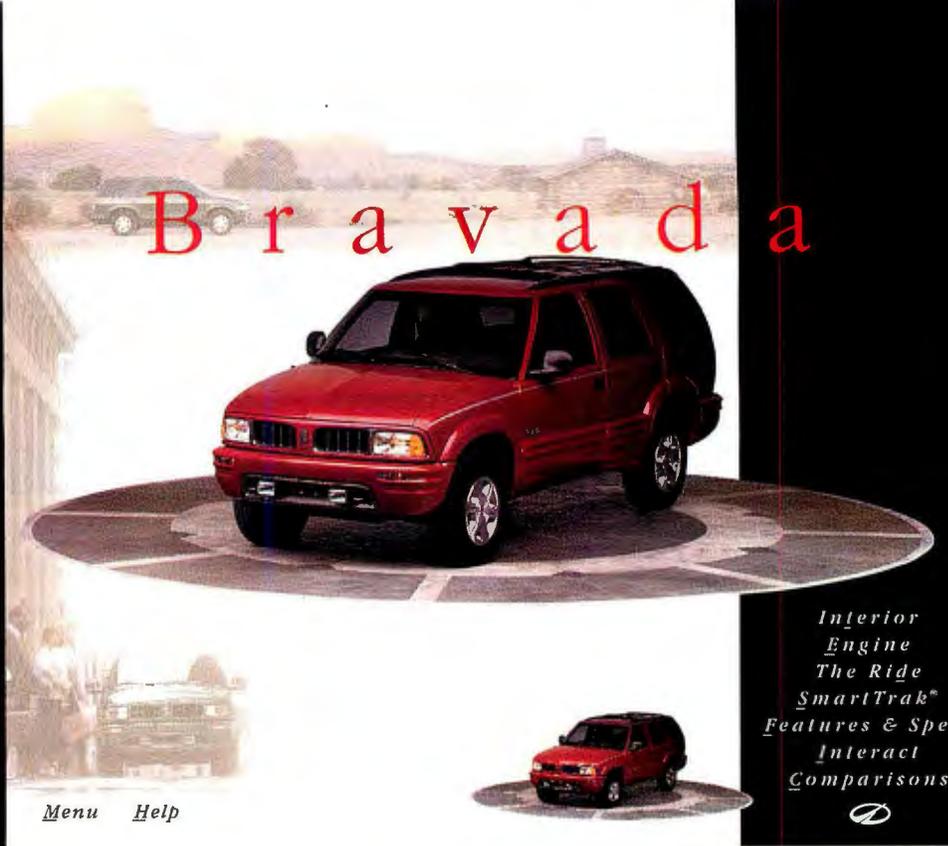
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The Motorola DSP56800 offers DSP and microcontroller functions on a single chip. *By Tom Thompson*

## Two, Two Chips in One!

**D**esigning consumer electronics is a daunting job. Today's equipment must be flexible, smarter, and offer more features, yet remain affordable. These requirements have caused a slow convergence between two disparate devices—the general-purpose microcontroller and the digital signal processor (DSP).

Embedded microcontrollers operate the servo motors in disk drives and the focus control on camcorders. DSPs, on the other hand, enable a cordless phone to filter noisy signals or implement the fax/modem functions in a hand-held computer. Of course, the next-generation cordless phone has to do more: It must not only filter out noise but also perform caller-ID verification and be able to display messages on an LCD screen. Combining these functions traditionally required adding two processors to a product's design.

Early this year, Motorola introduced the DSP56800, a 16-bit processor core designed to tackle low-cost designs that require DSP and microcontroller functions. Because these capabilities are combined into one chip, the DSP56800 core saves board real estate, minimizes power consumption, and reduces a design's parts count. It also trims RAM usage, because you don't have to store separate DSP and microcontroller programs.

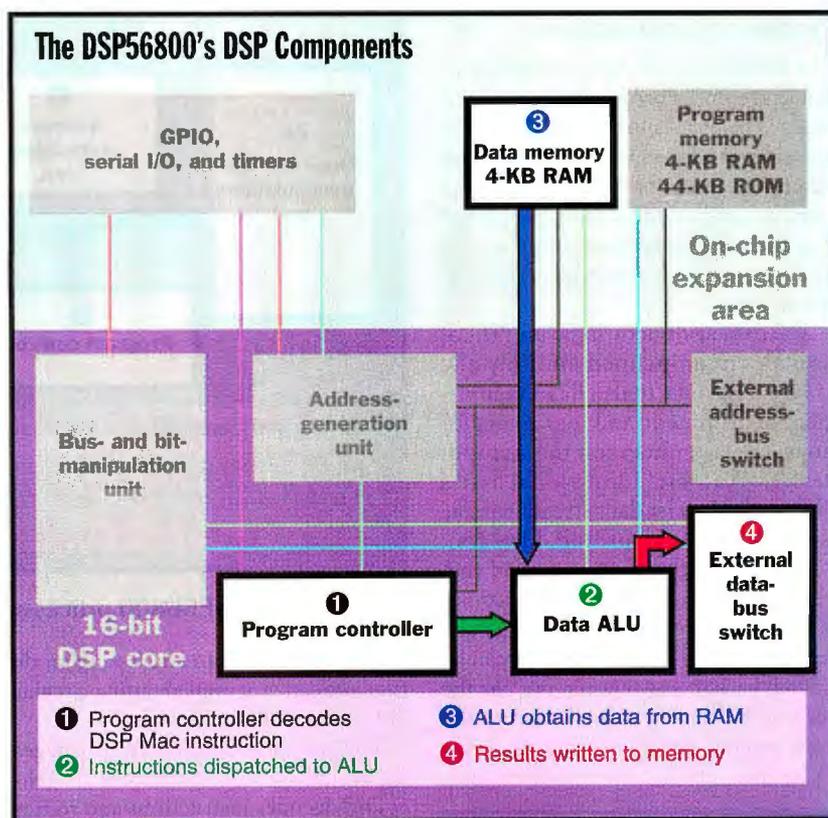
The DSP56800 core offers a streamlined DSP instruction set derived from its 56000 DSP line. This allows existing 56000-based DSP applications written in assembly to run with little or no modification. It also provides a host of microcontroller functions, such as timers for fielding periodic events, serial peripheral interfaces that communicate with peripherals, and up to 32 general-purpose I/O (GPIO) signals that can monitor or control devices.

A phase-locked loop (PLL) enables the

processor to operate at different clock speeds at different times, to either conserve power or boost performance. It's a fully static design that operates from DC (i.e., no clock) to 40 MHz. At this speed,

ally require a response within milliseconds, or even several seconds.

On the other hand, a DSP's sole purpose in life is to rapidly process data. It executes sophisticated mathematical op-



How the DSP56800 processes a DSP instruction.

it consumes only 27 milliwatts. This power-consumption level makes the processor ideal for PC Cards and mobile devices.

### Combining the Odd Couple

It's hard to imagine merging two processors whose functions are so vastly different. A microcontroller, as its name indicates, controls devices. Microcontrollers normally don't need to be speed demons: The devices they manage usu-

erations—such as a voice-compression/decompression algorithm—repetitively so that it can process signals in real time. To accomplish this, a DSP has a repertoire consisting of fast math instructions and matrix operations.

Motorola designed the DSP56800 core from the ground up. First, the designers profiled the instruction usage of many DSP and microcontroller applications. Seldom-used DSP56000 instructions were

discarded first. Others instructions were eliminated if they complicated the processor architecture or weren't compact in size. The resulting instruction set offers a gamut of DSP capabilities, such as a fast multiply-accumulate (MAC) instruction and a fixed-point data type. For microcontrollers, there are instructions for bit manipulation and interrupt handling.

The end result was a streamlined instruction set that reduces a firmware program's size by one-third. According to Motorola, the DSP56800's code storage compares favorably to that of an 8-bit microcontroller, even though the core is a 16-bit processor. Due to the efficiencies of the instruction set and architecture, Motorola says the DSP56800 delivers 20 MIPS at 40 MHz.

### Processor Architecture

The DSP56800 core uses a Harvard architecture with separate address and data buses. The core is full of data and program buses that permit up to three simultaneous accesses to data and program memory; this expedites the movement of data and code throughout the processor. The core also has several concurrent execution units.

The data arithmetic logic unit (ALU) provides nonpipelined multiply and MAC operations. It also has a complement of arithmetic and logical operations; the latter help test the status of devices. A 16-bit bidirectional barrel shifter enables fast data-stream parsing (such as a network protocol stream), which reduces programming overhead.

The ALU also has two 36-bit accumulators and three 16-bit input registers. Arithmetic and bit results alike can be written back to any register, not just the accumulators; this simplifies programming and improves performance.

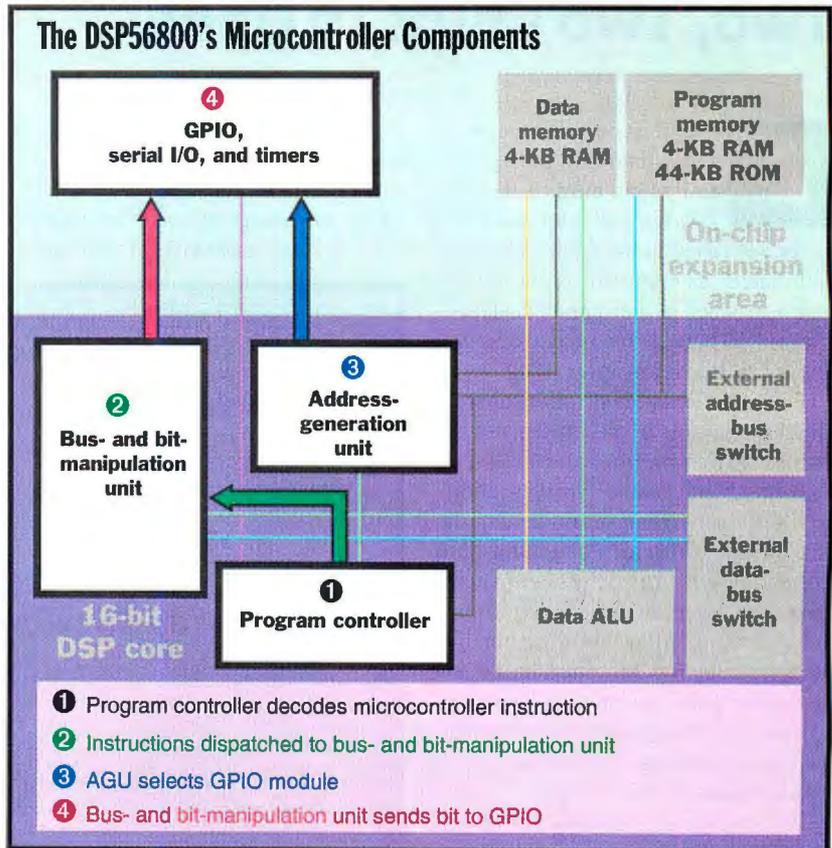
The bus- and bit-manipulation unit

handles many control activities, such as bit-manipulation operations and bit-test and bit-branch instructions. It complements some of the ALU's arithmetic and shifting operations.

As a separate unit, the address-generation unit (AGU) can pipeline instructions and compute the next address in advance. It can manage two data-memory accesses and two address updates in one instruc-

(GPIO) interface module. Certain modules, such as serial I/O, can be programmed to behave as GPIO modules.

Currently Motorola is sampling the DSP56800 core as two configurations with different resources in the expansion area. The first is the DSP56L811, which contains 2 KB of program RAM and 4 KB of data RAM; the second is the DSP56L812, which contains 44 KB of PROM, 4 KB of



### How the DSP56800 processes a microcontroller instruction.

tion. It has a modulo addressing mode that's effective at implementing circular buffers for DSP applications.

The program controller (PC) manages the overall operation of the core. It fetches and decodes instructions and routes them to the appropriate execution unit. The PC supports the hardware and software stacks. A two-level hardware stack implements hardware DO and REP loops—the staple of DSP algorithms—for performance. These hardware loops have zero overhead yet are interruptible, which reduces interrupt latency.

The DSP56800 core has an on-chip expansion area that sports additional on-chip memory and several types of integrated peripheral modules. There are two kinds of serial interface modules, a timer module, and a general-purpose I/O

data ROM, and 4 KB of data RAM.

Given its wealth of DSP and controller functions, the DSP56800 is well suited for a variety of applications. For example, a DSP56L812 could not only operate as a data pump for a low-cost V.22bis fax/data modem but also handle all the modem-control signals, such as on/off hook and carrier detect. A high-density disk drive could use the DSP56L812 not only to operate the servos that steer the head mechanism but also to read, process, and buffer the data. In addition, the DSP56800 has an advantage in projects where time to market is critical, because it can be programmed in C. **B**

*Tom Thompson is a BYTE senior technical editor at large. You can reach him at [tom\\_thompson@ix.com](mailto:tom_thompson@ix.com).*

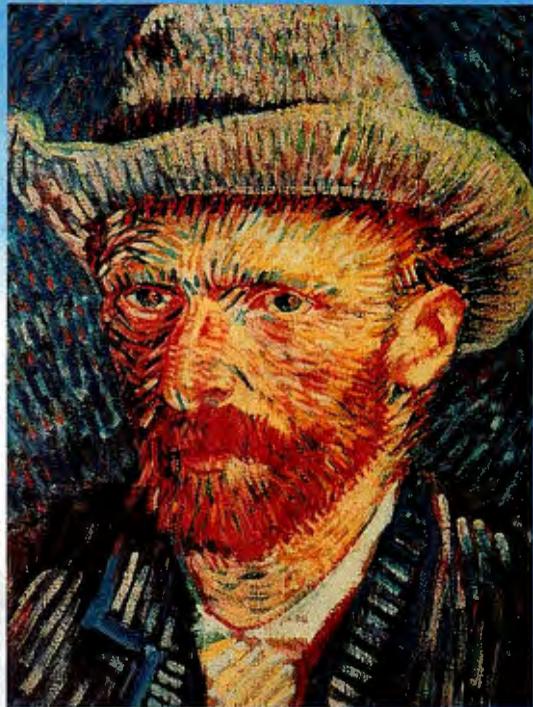
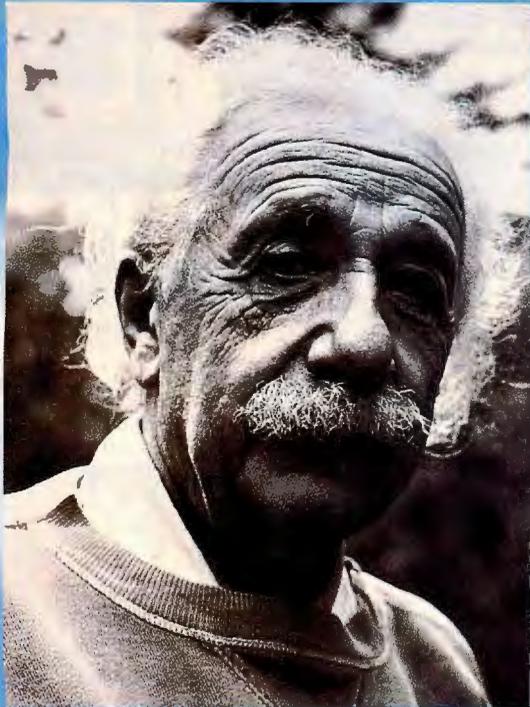
### Technical Specifications

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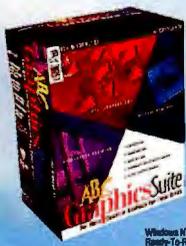
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#### Peripheral interface

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VxDs must now be two-faced, providing APIs for 32-bit as well as 16-bit Windows applications. **By Rick Grehan**

## VxDs In Windows 95

**V**xDs—virtual device drivers—are the hidden supports of Windows 3.x and 95. Like the small thieves in Terry Gilliam's *Time Bandits* who enjoyed access to the plumbings of the universe, VxDs simultaneously operate at the lowest and highest levels: Lowest in the sense that they directly access system hardware, and highest in that they run at the ring 0 privilege level.

Windows 95 has magnified the importance of VxDs, which are the means by which Microsoft extends the capabilities of the OS kernel. VxDs in Win 95 handle everything from file systems to sound cards to network systems.

Perhaps you haven't considered the fact that VxDs, though 32-bit in nature, were birthed in a 16-bit, nonthreaded, nonpreemptive OS. Now they're expected—required even—to participate in an OS that has all these characteristics. This is not a simple metamorphosis.

### The Grand Illusion

A virtual machine (VM) is an illusion. Specifically, the illusion is that a given process "thinks" it has exclusive access to all a computer's hardware. This includes memory, I/O ports, interrupts, and whatever other components the process chooses to manipulate. VxDs help to create this illusion.

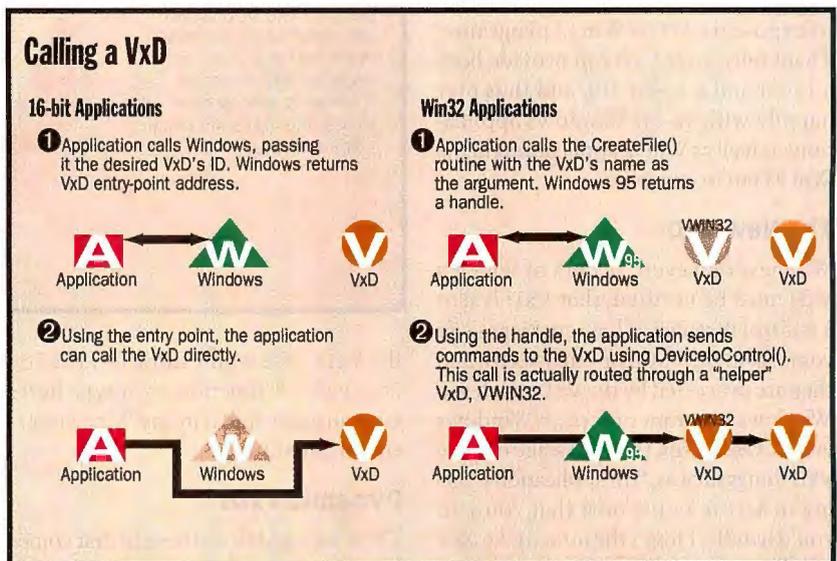
Two kinds of VMs existed in Windows 3.1: DOS boxes and the Windows VM itself. (The latter is called the "System VM"—within which runs all Windows applications.) A third software entity, the VM manager (VMM), though not a VM itself, acted as the chief supervisor for active VMs and VxDs. For example, the VMM had the job of handling the preemptive time-slicing among the executing VMs.

Additionally, any VxD that was to serve as the virtualizing mechanism for an I/O

device had to register itself with the VMM. So, if a VxD wanted to act as the handler for a particular I/O port, it had to ask the VMM to "hook" that port. Subsequently, whenever a Windows application attempted access on that port, an exception was sent to the VMM, which

turns out not to be the case. Each Win32 application runs as a member of the System VM, though with its own address space.

More important, a successful VxD in Win 95 had better be prepared to cooperate with old 16-bit Windows applica-



would pass the access request along to the appropriate VxD.

Under Win 95, life is much the same, but better in key ways. There's still one VM per DOS box and still one VM for all the Windows processes. But now some of the Windows processes are Win32 applications with more capabilities than the Win32s programs of Windows 3.x.

This produces a variety of new twists that VxD designers must be aware of. For example, Win32 applications in Win 95 can be multithreaded. No longer must a VxD be aware only of which VM requires service; there are occasions wherein a VxD must discover which thread within a particular VM needs help.

By the way, some readers might suspect that each Win32 application is its own VM in Win 95, as I first did. This

as well as with new 32-bit Win32 applications. And when it comes to VxDs, "cooperation" can mean a number of different things.

### The Old Way

Although VxDs can hook I/O ports and interrupts and perform other ring 0 feats to virtualize the hardware, this turns out to be only part of what VxDs do on behalf of applications. VxDs can also provide callable APIs so that an application can directly petition a VxD for services.

In Windows 3.x, it's possible to get at a VxD's API via interrupt 2Fh. I demonstrated how to do this in "The Software Stopwatch" (April 1995 BYTE), where I described how you can access the API of Windows' virtual timing device.

This mechanism still works in Win

95, provided you use it from a 16-bit application. In fact, Win 95 allows a variation: Rather than loading the device ID in the BX register, you set the BX register to zero and place a pointer in the ES:DI register pair. This pointer references an eight-character, blank-padded, uppercase string, which is the name of the VxD. As before, after your program issues an INT 2Fh instruction, the address of the VxD's API is returned in ES:DI.

Unfortunately, you can't use the INT 2Fh technique from a Win32 application. In fact, Win32 applications can't execute software interrupts, period; they'll crash if they try.

Does this mean that Win32 applications and VxDs live on opposite sides of an uncrossable digital chasm? A VxD can still do such things as virtualizing I/O ports on behalf of a 32-bit application, but what if you want to allow your VxD to expose its API to Win32 programs? Thankfully, your VxD can provide both a 16-bit and a 32-bit API, and thus play happily with 16-bit Windows applications as well as Win32 applications in the Win 95 environment.

## The New VxD

Whenever an event occurs of which a VxD must be notified, that VxD is sent a control message. These messages can come from the VMM or other VxDs, and they are processed by the VxD much as a Windows program processes Windows events. Ordinarily, these messages tell the VxD things such as, "An application is trying to access an I/O port that you said you'd handle. Here's the info...take care of it."

Win 95 adds a new message, W32\_DEVICEIOCONTROL. This message is sent to the VxD in response to a Win32 application's issuing a `DeviceIoControl()` to the VxD, and it's the mechanism whereby a Win32 application can call a VxD directly.

From the Win32 application's standpoint, it must first obtain a handle to the particular VxD by calling (oddly enough) the `CreateFile()` routine. Ordinarily, this function is used to create or open disk files. But if your program prefixes the filename with `\\.` when making the call, the system recognizes that the filename corresponds to a VxD name. (Of course, in C or C++, backslash characters appearing in a string must be prefixed with more backslash characters, so `\\.` becomes `\\\\.` Oh, well.)

The `CreateFile()` call returns a handle—in this case, it's a handle to the VxD. The application can then use this handle in subsequent calls to `DeviceIoControl()` to send messages to the VxD. (Calling `DeviceIoControl()` actually calls an "intermediary" VxD, VWIN32, which in turn calls the control-dispatch entry point of the VxD on behalf of the application.)

`DeviceIoControl()` provides parameters for informing the VxD of which function to perform, as well as input and output buffer pointers for transferring data between the application and

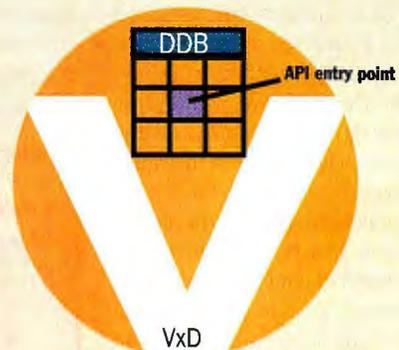
Once a VxD's handle count reaches zero, the system issues to the VxD the control message `SYS_DYNAMIC_DEVICE_EXIT`, telling it in essence: "You're about to be unloaded... please clean up before you leave." Once the VxD processes this message, the system unloads it.

## VxDs Forever

Of course, we haven't quite closed the loop here. For any of this to work, the VxD authors have to craft the additional handlers to process the `W32_DEVICEIOCONTROL` message. Although building a separate route into the VxD's API might

### How Does It Know?

How does Windows know where the VxD's entry point is? The DDB (device descriptor block) is stored in the VxD and examined when the VxD is loaded. It contains, among other things, the VxD's API entry-point address.



the VxD. (We won't show `DeviceIoControl()`'s function prototype here; you can easily find it in any Win32 reference manual.)

## Dynamic VxDs

There's an additional benefit that comes from using `DeviceIoControl()` to communicate with a VxD. If you step back into Windows 3.1 for a moment, you discover that VxDs are statically loaded. That is, all the VxDs a system will use are loaded when Windows starts up, and they hang around for the lifetime of Windows' execution.

Win 95 (and Windows for Workgroups 3.11) allows for dynamically loaded (and unloaded) VxDs. When an application issues a `CreateFile()` call to access a VxD, the system keeps track of how many handles are open on each VxD. When an application is terminating, it should issue a `CloseHandle()` call to release the VxD's handle, which causes the system to decrement the handle count. (It's important to note that the handles associated with a process are automatically called when the process exits.)

be something of a pain, it will likely be a well-trodden route as the number of Win32 programs multiplies.

Actually, this separate route is not really separate at all. A VxD will already have a control-dispatch handler in place to capture incoming messages sent to it by the VMM. Typically, this amounts to a jump table that pairs event codes with handler routines. Once the code to deal with `W32_DEVICEIOCONTROL` messages is written, it should be a simple matter to insert an additional entry into the jump table to complete the wiring.

With the `DeviceIoControl()` calling mechanism, there is no reason why Win32 applications have to be left out in the virtual cold. **B**

*Rick Grehan is a BYTE senior technical editor with an M.S. in mathematics/computer science. You can reach him by sending e-mail to [rick\\_g@bix.com](mailto:rick_g@bix.com).*

## Acknowledgment

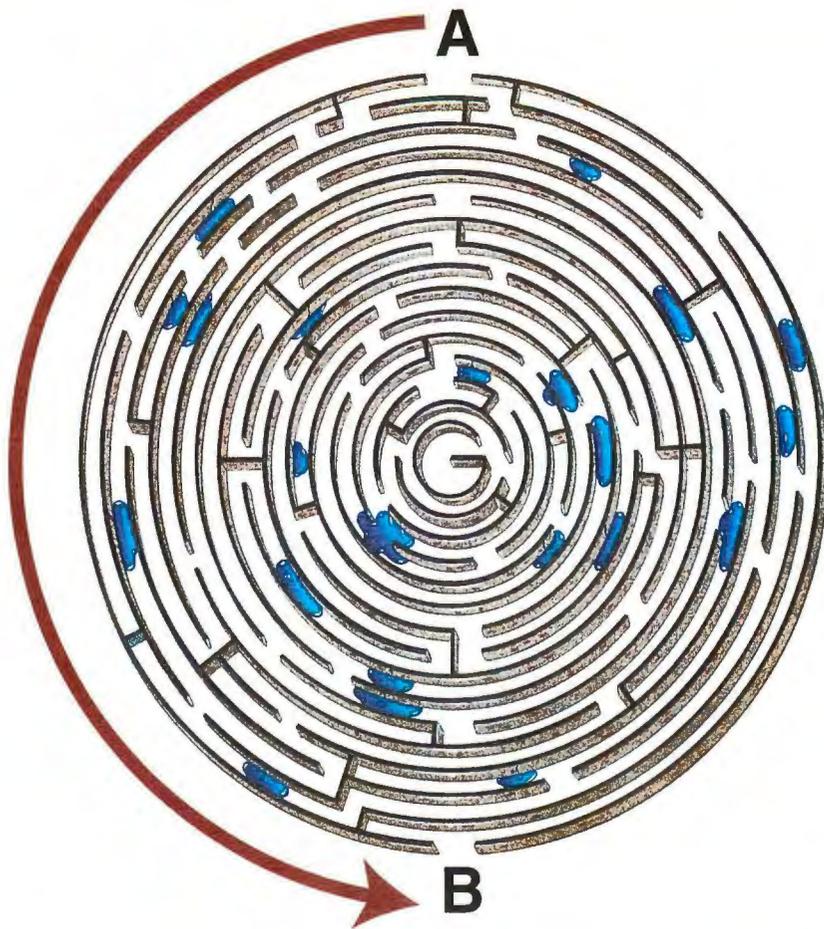
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TEAR HERE

Depending on your application, Polywell's 333-MHz Alpha workstation can raise Windows NT to new levels. **By Selinda Chiquoine**

## NT Flies at 333 MHz

**S**upporting the fastest CPU we've ever tested, Polywell's Poly 333P-A should make a great Windows NT workstation. With some NT applications, however, the Poly 333P-A fell behind a Pentium Pro machine running at much lower clock speeds.

Digital Equipment's 333-MHz 21164A Alpha CPU is a 0.35-micron version of the 0.5-micron 21164 with support for 8- and 16-bit loads and stores to improve x86 emulation performance. Later this year, Digital will introduce FX!32, an emulation/translation technology for 32-bit x86 applications, which should increase the number of NT applications you can use on the Alpha platform.

The Poly 333P-A's motherboard uses an L3 cache that holds 2 MB of synchronous static RAM (SRAM) on a 128-bit data path. This is besides the 21164A's built-in 96-KB three-way set-associative L2 cache and 16-KB L1 cache. The motherboard contains two 32-bit PCI slots, two 64-bit PCI slots, and three ISA slots (one shared).

Our system had 64 MB of 70-nano-second parity-checking RAM (Polywell offers up to 1 GB). The 4.3-GB SCSI-3 Quantum Grand Prix hard drive spins at 7200 rpm and connects with a 16-bit connection to QLogic's fast and wide



### Product Information

**Poly 333P-A**  
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controller (20-Mbps throughput). A 4-MB Diamond Multimedia Stealth 64 video card supported our test mode: 1024 by 768 pixels with 24-bit color.

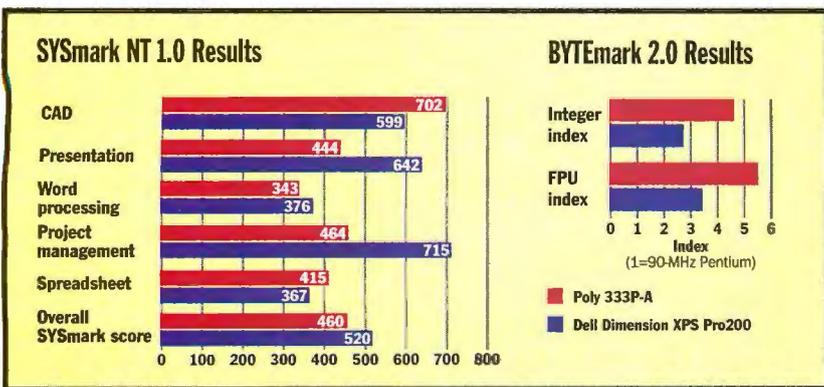
BYTEmark proves that the 333-MHz 21164A Alpha chip has plenty of raw speed. However, Bapco's SYSmark NT, an applications-based test suite, put the Poly 333P-A behind a 200-MHz Pentium

Pro Dell Dimension XPS Pro200 by 13 percent, on average. The 21164A's 96-KB L2 cache (compared to the Pentium Pro's 256-KB cache) may not be large enough

RATINGS				
TECHNOLOGY	★	★	★	★
IMPLEMENTATION	★	★	★	
PERFORMANCE	★	★	★	★

to handle the context switches caused by the Windows NT 3.51 API. (This problem should go away with NT 4.0.) The Poly 333P-A performed remarkably better only with the CAD test, where intense floating-point calculations come into play. Save the Poly 333P-A for 3-D modeling and CAD, or if you want to run OpenVMS or OS/F1, which Polywell also supports. **B**

*Selinda Chiquoine is a former BYTE technical editor. You can reach her on the Internet at selinda@bix.com.*



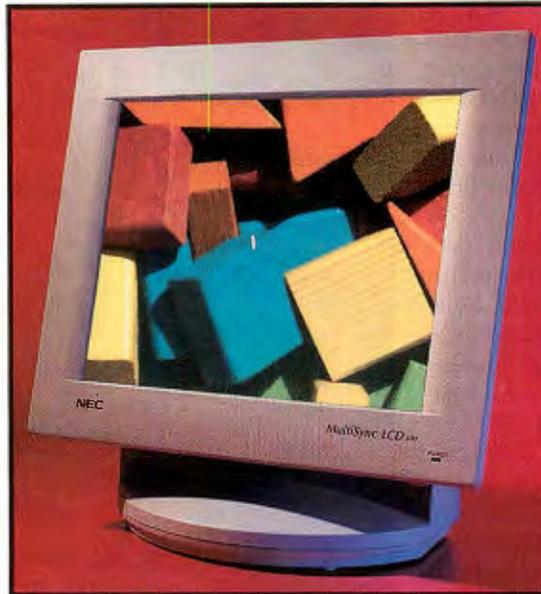
NEC's flat-panel LCD300 monitor offers a crisp color display while saving you desk space. *By Susan Colwell*

## Big Picture, Little Box

**T**he proverb "one picture is worth more than ten thousand words" applies to NEC Technologies' LCD300 monitor. You have to see it to believe it, so we can barely do justice to it here.

The 13-inch active-matrix LCD supports a resolution of 1280 by 1024 pixels with a true-color depth of 24 bits (16.7 million colors). With this high resolution, a refresh rate up to 72 Hz, and a dot pitch of only 0.20 millimeters, the images are sharp and clear. Besides color clarity, you get the added bonus of a small footprint; the monitor weighs in at only 8.8 pounds and has a depth of 6.7 inches, leaving you room to spare on your desktop. The monitor's only hefty feature is its \$5999 price tag.

Although the LCD300 costs half of what it used to, it's still well above the cost of a CRT monitor. In the past, the steep price was due to the complexity of the LCD technology and compatibility issues with graphics cards. Now the unit uses a standard analog signal, which means it can display unlimited colors simultaneously and works with any stan-



### Product Information

**LCD300**  
**\$5999**

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### NEC's 13-inch active-matrix LCD300 desktop monitor produces high-quality images at a resolution of 1280 by 1024 pixels.

dard Video Electronics Standards Association (VESA) graphics card.

Right from the start, we loved the LCD300's compactness. It's easy to handle and set up—you just have to connect its five color-coded BNC plugs. To test the monitor at its recommended 1280 by 1024 resolution, we used a 60-MHz Pentium Zeos Pantera running Windows 95 with an NEC-supplied Matrox MGA Millennium graphics card installed.

On start-up, we discovered that the LCD300 is not plug and play, which isn't a problem if you know the right video-mode settings for your graphics card. NEC's documentation wasn't up to date on the Matrox settings, but the company assured us that this data will be available on its FastFacts line ((800) 366-0476) and Web page.

Once the monitor was running at 1280 by 1024, the clarity of its flat, flickerless screen was impressive. The text

is sharp but small, and you have to sit fairly close to appreciate its clarity. With some applications, using larger fonts improves the readability.

To position and lock an on-screen image, you press the control buttons on

#### SCORES

<b>TECHNOLOGY</b>	★ ★ ★ ★ ★
<b>IMPLEMENTATION</b>	★ ★ ★ ★

the back of the monitor. We'd prefer to have them on the front. The mode settings are also on the back.

Overall, the LCD300 is ideal for those who work with complex graphics and high-color images. Its small size and sleek design give it a personal flair that commands your attention. The only drawback is its high price. **B**

*Susan Colwell is a BYTE technical editor. You can contact her by sending e-mail to [scolwell@bix.com](mailto:scolwell@bix.com).*

## TECH FOCUS

### An Analog LCD?

To work with PC graphics cards, the NEC LCD300 takes a standard analog signal (0 to 0.7 V). The continuous nature of this signal means the LCD300 can read an infinite number of colors. While it's unusual for an LCD panel to use an analog signal, the technologically hard part is designing a panel responsive enough to handle CRT refresh rates. The LCD300 must refresh all its pixels (1280 by 1024) 60 to 72 times per second; this means the LSI drivers that control the panel must handle a signal frequency of between 96 and 126 MHz, unusually high for an LCD.

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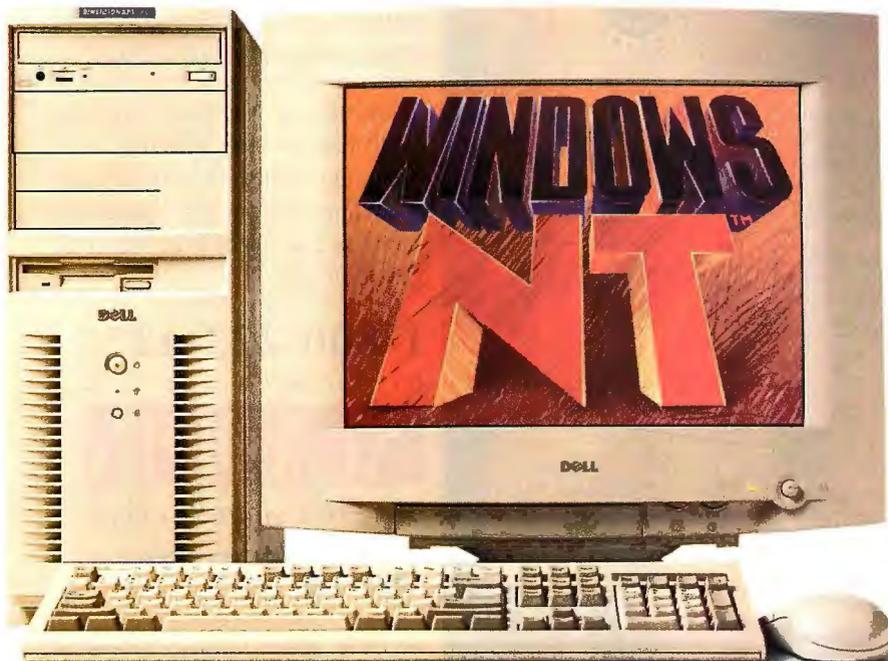
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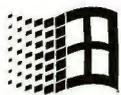
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Versatility/Features	10	8.7	8.8	8.6
Compatibility/Power Consumption	6.7	6.5	6.6	7.4
Speed of API Calls	0.9	1.2	10	4.1
<b>Final Score</b>	<b>8.5</b>	<b>6.5</b>	<b>7.5</b>	<b>6.6</b>

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Circle 78 on Inquiry Card (RESELLERS: 79).

*The promise is real-time video over the Internet; the reality is less exciting.  
By Stephen Satchell and H. B. J. Clifford*

# Internet Video: Small Isn't Beautiful

**D**on't sell your cable-TV stock just yet. Internet video broadcasts for your PC are in their infancy, waiting for better communications links.

VDOnet's VDOLive software promises over-the-Internet real-time playback of audio and video material on PCs and Macs. The company claims slow video and AM-quality sound over a 14.4-Kbps connection, up to 10 to 15 frames of video per second over a 28.8-Kbps link, and even better video and sound over faster hookups. Don't confuse this with video-conferencing products like CU-SeeMe (Cornell University/White Pine Software), which are designed for meetings where multiple participants contribute sound and video.

We downloaded version 1.0 of the VDOLive viewer for Windows 95 from the Web. When we went to view a clip on a computer lacking a sound card, VDOLive complained but showed us silent video. Although VDOLive's screen is tiny—only 160 by 120 pixels—you can



**Product Information**

**VDOLive**  
free via download

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Santa Clara, CA

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fax: (408) 654-9447  
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**Actual size! This is how a VDOLive image looks on a 15-inch monitor running at 800 by 600 pixels.**

double the size of the viewer window to ease the eyestrain. With Netscape 2.0, the VDOLive plug-in puts integrated video on a Web page.

When we ran VDOLive using an SVGA board at 256 colors, the picture was sometimes muddy and dark, and other times acceptably bright. The darkness was especially annoying with a network news feed shown on a bright-white surrounding, although with the stand-alone play-

With a 28.8-Kbps link on a 486DX2/66, the audio would occasionally break up and we experienced far fewer video frames than VDOnet claims—3 frames every 5 seconds was typical. This problem appeared to be mostly caused by our particular Internet link rather than by a flaw in either the server or the viewer.

Our experience indicates the Internet isn't ready for real-time audio and video without a faster-than-modem-speed connection. During a few near-perfect modem sessions, VDOLive delivered a few frames per second. However, a high-speed link is clearly crucial. ISDN users should see far better frame rates and audio quality. **B**

*Stephen Satchell is president of Satchell Evaluations (Incline Village, NV). You can reach him on the Internet at [satchell@accutek.com](mailto:satchell@accutek.com). H. B. J. Clifford is editor of the newsletter Sep-  
tel. You can reach her on BIX c/o "editors."*

## TECH FOCUS

### Working the Video Stream

To test whether our VDOLive problems resulted from a poor Internet link, we downloaded StreamWorks from Xing Technology (Arroyo Grande, CA) onto a MacIlex with 256-color video. Using the same Internet service provider (ISP), we got results similar to VDOLive's. The StreamWorks picture is about the same size as the VDOLive picture and displays the same murkiness; we also experienced audio breakup. These symptoms led us to believe that packets were being delayed, starving the player software of data. In addition, StreamWorks' diagnostics indicated we had network-throughput problems.

#### RATINGS

TECHNOLOGY	★ ★ ★ ★ ★
IMPLEMENTATION	★ ★ ★
PERFORMANCE	★ ★

er you can manipulate the desktop background for easier viewing. Sometimes the image quality was quite high with considerable detail, while at other times it was heavily pixelated and uninformative. Overall, VDOLive worked best with talking heads and bright scenes.

Equipped for the first time with a PowerPC chip, Apple's dockable Duo notebook can keep up with desktop Macs. *By G. Armour Van Horn*

## Apple's Desktop Replacement

**G**iven the price premium of a notebook/docking setup compared to an equivalent desktop PC, it's fair to ask how a docked notebook rates solely as a desktop system. In the case of Apple's PowerBook Duo 2300c/100 and its Duo Dock Plus docking station, the answer is "very well."

The 2300c/100 is Apple's PowerPC update to its 4.8-pound Duo notebook. It's built around a 100-MHz 603e, the low-power chip designed for portables.

Our test system came with a 1.1-GB hard disk and 20 MB of RAM, for around \$4600. (The standard is 8 MB of RAM and a 750-MB drive.) The 9.5-inch, 640- by 480-pixel, active-matrix color LCD is clear and bright, usable in most indoor environments and outside in the shade.

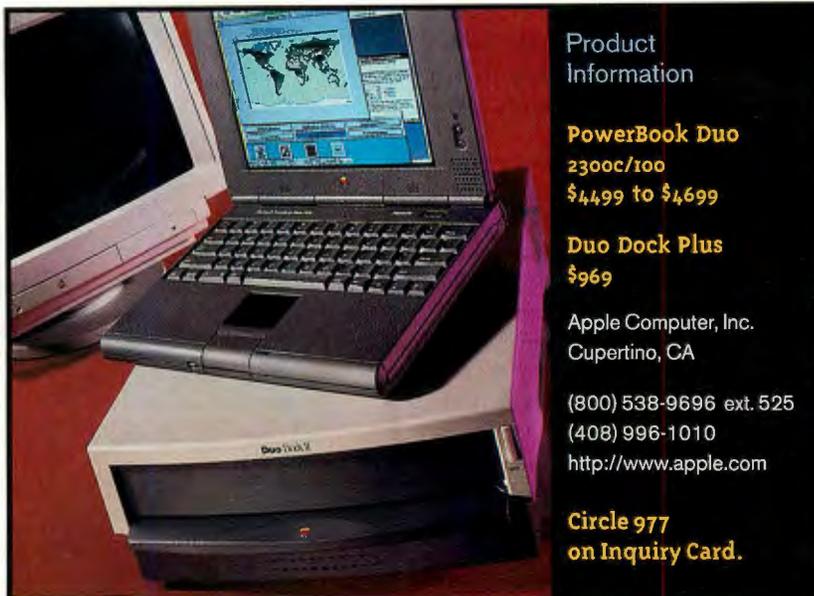
The Apple trackpad is smooth and accurate, once you learn to keep only one finger in contact with the pad. The PowerBook Duo 2300c/100 has no provision for PC Cards in any configuration, although Newer Technology (Wichita, KS, (800) 678-3726) has docking products that offer PC Card connections.

### TECH FOCUS

#### Cold Dock

Apple's 68K-based Duo notebook/Duo Dock was the first well-integrated docking system. But Intel-based notebooks have, in one sense, surpassed Apple's.

Running Windows 95 with its imperfect Plug and Play, many Intel-based docking systems allow warm and hot docking—docking in suspend and active mode, respectively. Its PowerPC 603e brings the Duo 2300c/100 up to date performance-wise, but it still supports only cold docking, which means you have to turn the notebook off first. Apple chose this route for backward compatibility.



#### Product Information

**PowerBook Duo 2300c/100**  
\$4,499 to \$4,699

**Duo Dock Plus**  
\$969

Apple Computer, Inc.  
Cupertino, CA

(800) 538-9696 ext. 525  
(408) 996-1010  
<http://www.apple.com>

**Circle 977**  
**on Inquiry Card.**

**Housed in the Duo Dock Pro, Apple's 4.8-pound PowerBook Duo 2300c/100 notebook becomes a credible desktop replacement.**

The Duo 2300's nickel-metal-hydride battery lasts two to four hours and recharges in as little as two hours.

The Duo Dock Plus completely encloses the 2300, so you add a standard Apple keyboard, the pointer of your choice, and a standard monitor. The dock's built-in floppy drive is on the side, and standard Macintosh ports are on the back. The Duo Dock Plus has two NuBus slots and can hold a single 1-inch-high, 3½-inch SCSI hard drive.

You must first shut down the Duo before docking it (a cold dock); docking in sleep mode prevents connection to storage and network resources. When you insert the closed Duo in the front of the dock, a motorized mechanism pulls it firmly into place. When you turn the notebook back on, it automatically recognizes and handles the attached peripherals—as any Mac user would expect. Pressing a front-panel button ejects the

notebook from the docking station, but only if you've properly shut down.

We ran the Duo 2300 with an Apple Multiscan 15 monitor, keyboard, mouse, CD-ROM drive, and an Apple auxiliary

#### RATINGS

TECHNOLOGY	★	★	★		
IMPLEMENTATION	★	★	★	★	

unit interface (AAUI) network connector; we had no problem accessing any resource on our local network.

Running the BYTEmark CPU test showed that the 100-MHz 603e gives roughly three-fourths the integer performance of a 100-MHz PowerPC 604. Now that the Duo runs the 603e chip, Apple's docking setup can keep pace with desktop Power Macs. **B**

*G. Armour Van Horn is a production artist and consultant in electronic imaging and prepress. You can reach him at [vanhorn@bix.com](mailto:vanhorn@bix.com).*

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# ELECTRIC MONEY

*Cash, checks, and coupons are all going digital. Here are the technical underpinnings of tomorrow's legal tender.*

**By Udo Flohr**

**A** microbit saved is a microbit earned. Machine time is money. Bit wise and byte foolish. If Ben Franklin were alive today, Poor Richard's Almanac—the CD-ROM version—might brim with homey advice about electric money. But don't think the differences between traditional currency and the coming electronic versions are as superficial as updating our economic lexicon. The changes under way in our monetary system will fundamentally alter how consumers interact with businesses and how businesses interact with one another.

What will be the most sweeping change brought on by an electronic economy? Money may no longer be controlled exclusively by central authorities—like the U.S. Treasury—that are tied to individual political systems. In its place will be digital currency “minted” by companies responsible for keeping it secure and valuable (see the text box “How to Make a Million Dollars” on page 76). If this sounds farfetched, check out DigiCash bv, an Amsterdam company that already implements this vision. Mark Twain Bank of St. Louis, among others, licenses DigiCash technology and has been circulating its own E-cash since last fall.

So if electric money is already legal tender, why did the U.S. Treasury just issue a new \$100 bill instead of shutting down the printing presses? We need to resolve four technology issues before consumers and merchants anoint electric money with the same real and perceived value as our tangible bills and coins. The key areas are:

- **Security:** For on-line transactions, transferring funds, and minting electric currency.
- **Authentication:** So buyers and sellers can verify that the electric currency they receive is real.

**T**ransactions between consumers and retailers represent only a small section of the electric-money infrastructure. Peel away this layer and you'll find interconnected public and private networks that extend to banks, financial-service companies, Electronic Data Interchange (EDI) networks, manufacturers, and distributors.

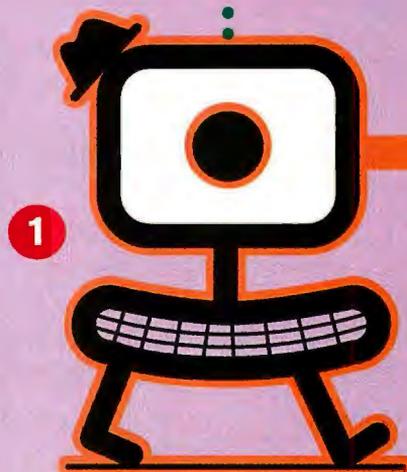
**1. Consumer:** The catalyst for electronic commerce. Mouse-clicks by a home shopper can send orders that energize companies at all ends of our domestic and international economies.

**2. Retailer:** The point of contact for consumers, banks and financial organizations, distributors, manufacturers, and suppliers.

**3. Credit-card companies:** They help merchants verify credit cards at the point of sale and collect reimbursements later. This is usually done over dedicated networks, which can handle almost any currency and work with a variety of banks across the globe.

**4. Banks/financial-services companies:** An interbank clearinghouse coordinates financial transfers between banks. U.S. banks use the Automated Clearing House (ACH). Local banks register payments in a database,

Store



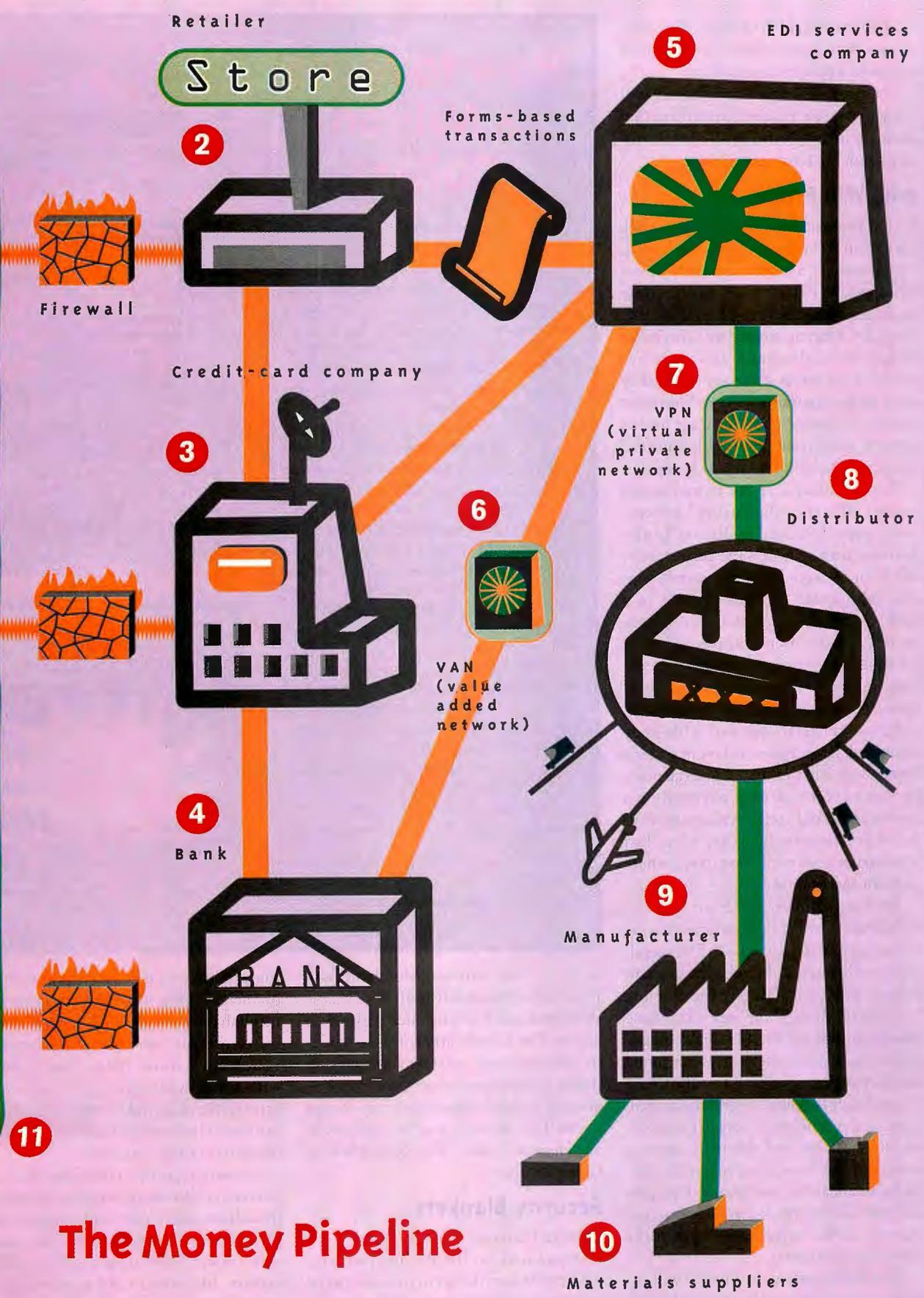
which are then exchanged overnight.

**5. EDI service companies:** Most EDI transactions still use dedicated lines or value-added networks (VANs) run by commercial services. However, EDI also could work over the Internet.

**6. VANs:** Special-purpose networks for electronic commerce using EDI or credit-card transactions. VANs might connect with Virtual Private Networks (VPNs) across the Internet.

**7. VPNs:** For transactions among parties in the same organization or with companies that have continuous relationships, such as distributors (8), manufacturers (9), and materials suppliers (10). VPNs can be direct private links among divisions and companies, or you can create one via a special Internet connection with an encryption tunnel. Network administrators sometimes build these tunnels by integrating encryption schemes into bridging, routing, or modem hardware.

**11. Internet:** The common denominator for electric-money transactions among consumers, retailers, and suppliers.



# The Money Pipeline

- **Anonymity:** To assure that consumers, merchants, and the transactions themselves remain confidential.

- **Divisibility:** So electric money will come in cent or less denominations that can make high-volume, small-value transactions on the Internet practical.

## Who Will Profit?

Both consumers and merchants could see a windfall if these problems are solved. For merchants, a secure and easily divisible supply of electric money will motivate more Internet surfers to become on-line shoppers. Electric money will also make it easier for smaller businesses to achieve a level of automation already enjoyed by many large corporations whose Electronic Data Interchange (EDI) heritage means streams of electronic bits now flow instead of cash in back-end financial processes.

For consumers, electric money means greater efficiency than using hard currency, paper bills, and traditional banks. Automation also brings the convenience of 24-hour, seven-day banking and shopping with home PCs tied directly to a bank's (or other financial service's) computers. Electric money also could offer greater security than a paper-and-coin system. Imagine being able to make a back-up copy of your funds: If you lose your E-cash, you can get it back with a file-copy command. If someone steals your electric money, you can invalidate the serial number just as you now stop payment on a paper check. And you never have to wonder where this month's salary went: Just reconstruct your e-mail log to see where you sent each digital cent.

Because so many different types of individuals—from home shoppers to corporate purchasing agents—will be spending electric money, digital currency will come in many formats (see the text box "Colors of Money" on page 78). These manifestations will be only small components of a larger monetary system tuned for electronic transactions (see the figure "The Money Pipeline"). For it to succeed, the underlying financial network needs to be open, scalable, and able to interweave consumers with retailers, materials suppliers, and financial institutions. This quilt will extend over the Internet and across private LANs, value-added networks (VANs), and intranets.

Within this system, consumers will use dedicated payment software and hardware or general-purpose client software,

# How to Make a Million Dollars

Digital coupons and vouchers can be important ways to generate sales for your company in the years ahead. For example, you might create your own currency for promotions or to supply services without using money to regulate the exchange. It's not the same as printing a million dollars, but used effectively, private money could help you grow your business.

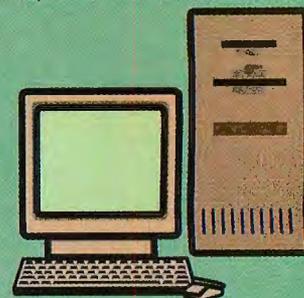
Minting electric money is surprisingly simple. Coupons and vouchers are nothing more than promises to do something in the future. These IOUs have no value unless consumer and merchant both trust the notes. That means customers must be able to verify that the note is authentic. Merchants must be able to determine that no one counterfeited the coupon. Authentication is relatively easy: Encryption technology, such as the freely distributed PGP, is fast and accurate.

Constructing a simple coupon is straightforward, in part because it's just a block of text endorsed with the company's digital signature. The block contains a description of what the coupon buys you as well as an identifying serial number. Anyone can cut and paste this block of text in a word processor, e-mail editor, or Web form to pass it around.

—Peter Wayner

*Peter Wayner is a BYTE consulting editor in Baltimore. You can reach him on the Internet at [pcw@access.digex.net](mailto:pcw@access.digex.net).*

**1** Perhaps you want to use digital coupons to launch a sales promotion. First, set up a server. In most cases, you'll need a 486/66 or better PC or a PowerPC-based Macintosh (with 8 MB of RAM and a 500-MB hard drive) and an Internet connection.



**5** Issue coupons. You can do this by sending the coupon file via e-mail to customers that buy a particular product you're promoting or any other criteria you choose. Anyone can trade or exchange the coupons via the Web or e-mail through clipping, cutting, or pasting the text.



such as a Web browser. Merchants will process payments with software that is either dedicated or integrated with a Web server. The servers carry software to verify transactions, perform accounting duties, guarantee payments, and even create digital money. Merchants may choose to run their own server or become part of an "electronic mall" like eShop Plaza or CommerceNet.

## Security Blankets

Without the messy matter of security, on-line commerce is simple: You just send your credit-card details to your electronic merchant, and your credit-card organization will process the transaction. Too bad

this process could be hazardous to your financial health. As your message passes through multiple network hubs along the way, criminals can scan messages to steal your information. True, it can happen with any conventional credit-card transaction, but in digital commerce, thieves can sweep thousands of credit-card numbers from a single database.

Commercial R&D departments and university labs are developing measures to address security for both Internet and private-network transactions. The venerable answer to securing sensitive information, like credit-card numbers, is to encrypt the data before you send it out. MIT's Kerberos, which is named after the

**2** Publish a public key. Standard encryption software, such as PGP, will let you do this using easy menu selections.

Pick your RSA key size:

512 bits- Low commercial grade, fast but less secure

768 bits- High commercial grade, medium speed, good security

1024 bits- Military grade, very slow, highest security

Pick your own size (between 384 and 2048 bits):

Number of bits in encryption exponent:

User ID for your public key. Desired form is name followed by E-mail address in angle brackets. Eg: John Q. Smith <12345.6789@compuserve.com>

**3** Create coupons. Encryption software can also help here. A coupon consists of a short text message with essential details, like the issuing company's name, the value of the coupon, and a unique serial number to guard against someone trying to redeem a coupon more than once. If you're using PGP, the coupons will look like this:

```
-----BEGIN PGP SIGNED MESSAGE-----
Serial Num:      03A43BB
Issuer:         Larry's Limericks
Value:          One Verse
Redemption URL: http://www.limerick.com/
Expiration Date: 01/01/1998
```

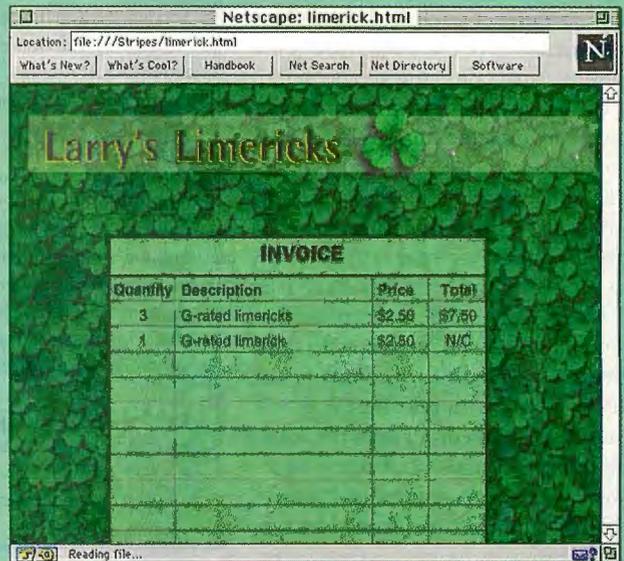
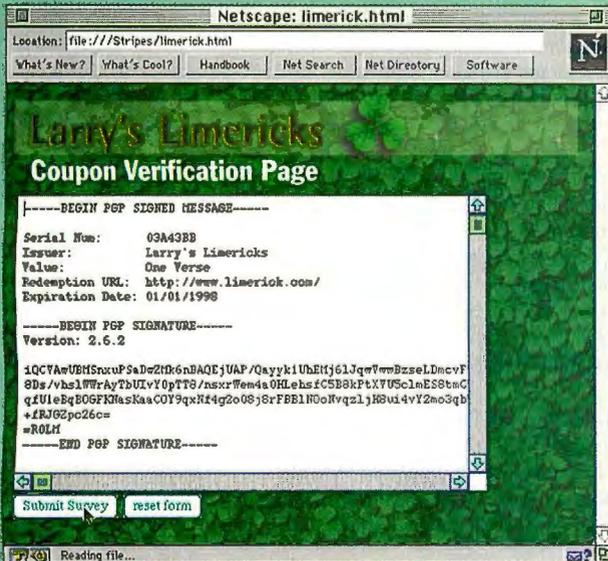
**4** Sign the coupon with a digital signature, which can also be automatically generated by encryption software.

```
-----BEGIN PGP SIGNATURE-----
Version: 2.6.2

iQCVAwUBMSnxuPSaDwZMk6nBAQeJUAP/
Qayyk1UhEMj61JqVvwBzseLDmcfTq6
8Ds/vhs1WwAyTbUIvY0pTT8/nsxrWem
4a0HLehsfC5B8kPtXVU5c1mES8tmCTMS
qfU1eBqBOGfKNasKaaCOY9qxNf4g2o08
j8rFBB1N0oNvqz1jH8ui4vY2mo3qbTKU
+FRJGZpc26c=
=ROLM
-----END PGP SIGNATURE-----
```

**6** Consumers verify the coupon's validity by checking the digital signature of the note. Web servers can also verify that a particular serial number hasn't been redeemed. Consumers redeem a coupon by pasting it into a Web form or mailing it to an e-mail processor.

**7** Redeem the coupon. Note on the coupon database that this particular serial number is no longer valid and send one free limerick to the consumer.



three-headed watchdog of Greek mythology, is one of the best-known private-key encryption technologies. It creates an encrypted data packet, called a ticket, which securely identifies the user. To make a purchase, you generate the ticket during a series of coded messages you exchange with a Kerberos server, which sits between your computer system and the one you're communicating with. The latter two systems share a secret key with the Kerberos server to protect information from prying eyes and to assure that your data has not been altered during the transmission. But this technology has a potentially weak link: Breach the server, and the watchdog rolls over and plays dead.

NetCheque, developed at the Information Sciences Institute of the University of Southern California, uses Kerberos to authenticate signatures on electronic checks that Internet users have registered with an accounting server. A NetCheque is a special Kerberos ticket: A merchant's digital signature creates one ticket—a check—which the payee's digital endorsement transforms into another ticket—an order to a bank computer to transfer funds. The merchant can send NetCheques via e-mail or through network protocols. NetCheque is appealing because it's scalable: As demand grows, companies can add multiple accounting servers.

However, private-key encryption has

some fundamental drawbacks for electric money. Most notable is that transactions aren't anonymous. These types of encryption systems accumulate buyer, seller, and transaction data, which makes it possible to create spending profiles on consumers and threaten their privacy.

An alternative to private-key cryptography is a public-key system that directly connects consumers and merchants. Businesses need two keys in public-key encryption: one to encrypt, the other to decrypt the message. Everyone who expects to receive messages publishes a key. To send digital cash to someone, you look up the public key and use the algorithm to encrypt the payment. The recipient then uses

the private half of the key pair for decryption. One of the better-known public-key systems is MIT's RSA encryption standard (which is named for its creators: Rivest, Shamir, and Adleman).

A commercial version of RSA technology, from RSA Data Security (Redwood City, California), helped settle the security-standards feud between two major credit-card companies earlier this year. The warriors—Visa and MasterCard—agreed to support Secure Electronic Transactions (SET) as the nonproprietary security protocol for Internet transactions, and it appears that their technology partners—Microsoft and Netscape Communications, respectively—also support the agreement. The standard will include pieces of separate proposals supported by the two camps, with the RSA encryption technology providing the glue that binds the pieces together. As we go to press, the groups haven't yet published the technical specifications of the standard, but the two credit-card companies expected to have code ready for testing by now, with commercial implementations before the end of the year.

IBM's Internet Keyed Payments (iKP), a family of secure payment protocols, combines public- and private-key concepts for use on the Internet. IBM based iKP's architecture on the assumption that buyers and sellers will interact with third parties, such as credit-card companies or banks, to complete transactions. With iKP, consumers place an order over the Internet, but the system uses a secure private network for the payment transactions.

Will the most effective blend of encryption systems solve all our electric-money problems? No such luck. Encryption fortifies our electronic transactions against thieves, but there's a cost: The processing overhead of encryption/decryption makes high-volume, low-value payments prohibitively expensive. Processing time for a reasonably safe digital signature conspires against keeping costs per transaction low. Depending on key length, an average machine can sign between 20 and 50 messages per second. Decryption is faster. Still, if a server receives one cent per transaction, this would generate only about \$500,000 per year.

One way to factor out the overhead is to use a trustee organization, one that collects batches of small transactions before passing them on to the credit-card organization for processing. First Virtual, an

## Colors of Money

### E-Cash

Digital cash consists of a token that you can authenticate independently of the issuer. You can withdraw digital currency from an Internet bank account and store it on your computer's hard drive or on Smart Cards the size of credit cards. E-cash uses digital signatures, usually called "coins," which represent a fixed value. The coins establish their own authenticity by a complex software algorithm or through tamper-proof hardware. DigiCash, a Dutch company, holds a patent for E-cash.

### Digital Checks

A digital check uses a paper-check model. You can't validate digital checks without involving the issuer. You sign and endorse the checks using digital signatures. Digital certificates establish the payer's identity and bank information. Authentication is achieved using the public-key system. The payer digitally signs a form containing a description of the transaction, payer and payee information, the amount, and a time stamp. The payee, who may receive the signed form via public e-mail or various other forms of electronic communication, can validate the check using a public key and deposit it to collect payment.

Digital checks integrate with automatic ordering and billing systems. They also tie in well with existing interbank clearinghouses.

### Digital Bank Checks

Guaranteed by a bank, these checks function similarly to digital cash, minus the anonymity. You use it when the payee requires a bank certificate that sufficient funds are available and will be paid out. Users buy the checks from a bank, which redeems each serial number only once. Digital bearer bonds with interest coupons are a special flavor of a digital check. The bearer periodically sends in a coupon to the issuer to collect interest at a specified rate.

### Smart Cards

Smart Cards usually use a debit system; The prepaid card stores value that the holder can spend. Merchants receive payments through the card organization. Particularly in Europe, old-style Smart Cards—simple memory cards that are not too smart—are popular for pay phones, vending machines, road tolls, photocopiers, and other pedestrian uses. Some companies are introducing newer, more sophisticated cards that contain embedded micro-processors. The cards are much more tamper-resistant than their predecessors, thanks to challenge-response authentication. In some implementations, users combine the cards with electronic wallets that can read the data on the card and exchange value with other users.

### Electronic Coupons and Tokens

Electronic coupons, the electronic equivalent of the supermarket coupon, are functionally similar to cashier's checks, but they can be redeemed only at the issuing organization. They usually pay for some specified service and can't be redeemed for cash.

Internet-based banking organization, relies on this approach. Consumers register their credit cards with First Virtual (registration happens over the phone to eliminate security risks). From then on, they use personal identification numbers (PINs) to make purchases.

### Real-World Authentication

Encryption may help make electric money more secure, but we also need guarantees that no one alters the data—most notably the denomination of the currency—at either end of the transaction. One form of verification is secure hash algorithms, which represent a large file of multiple megabytes with a relatively short number consisting of a few hundred bits. We use the surrogate file—whose smaller size

saves computing time—to verify the integrity of a larger block of data. Hash algorithms work similarly to the checksums used in communications protocols: The sender adds up all the bytes in a data packet and appends the sum to the packet. The recipient performs the same calculation and compares the two sums to make sure everything arrived correctly.

One possible implementation of secure hash functions is in a zero-knowledge-proof system, which relies on challenge/response protocols. The server poses a question, and the system seeking access offers an answer. If the answer checks out, access is granted. In practice, developers could incorporate the common knowledge into software or a hardware encryption device, and the challenge could then

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## Europe Bucks Conventions

Want to get an advanced look at tomorrow's electric money? Technical, financial, and political forces are now coalescing to make Europe the place to turn to see the future of electronic commerce.

Europe is in the unique situation of inventing a new monetary system. Before the turn of the millennium, the 20 or so currencies used by individual European states will be replaced by one currency, called the Euro. This should do away with exchange-rate speculation on international money markets, help money flow more smoothly across borders, boost the pan-European marketplace, and bootstrap a state-of-the-art electronic commerce environment.

This sweeping change is happening in an already progressive monetary environment. Many Europeans now find clogging up the payment channels with paper checks—sent from payer to payee to the bank and back—about as quaint as the 12-hour clock. If they want to pay a bill, they don't send a check. They send a payment request and the relevant account numbers to the bank, which transfers money from the customer's account to the merchant's. About 15 years ago, banks introduced a phone- or modem-based version of this service.

These systems continue to evolve. Much of Europe's research on electric money focuses on Smart Cards. Many countries are running field tests with cards that use automated teller machines (ATMs) or pay phones. You generally use these cards off-line (payments don't require you to connect to a bank or card processor) for low-volume transactions. For larger, point-of-sale transactions, regular ATM and credit cards remain ubiquitous. A calculator-size electronic wallet, with a slot for the card, allows transactions practically anywhere.

In Austria, 2.5 million consumers already carry a card that has the standard ATM magnetic stripe as well as the embedded Smart-Card chip. In the British town of Swindon, some parents even dole out their

Europe's Conditional Access for Europe (CAFE) project uses several types of electronic wallets with infrared transceivers to secure electric-money transactions.



children's allowance with the Mondex Smart Card. British Telecom and two major British banks, National Westminster and Midland, jointly developed Mondex. The card can store the local equivalent of about \$250. Hitachi has developed a prototype modem that would allow you to use Mondex on the Internet.

Conditional Access for Europe (CAFE), a project in the European Community's ESPRIT research program, is developing a secure electronic payment system based on Smart Cards and several types of electronic wallets with infrared transceivers. You can run the protocols using standard PDAs. Thirteen partners from several countries, including the Netherlands, Denmark, Britain, France, and Germany, are involved. CAFE is now in field trial.

consist of a random-number string. The device might, for example, submit the number to a secure hash function to generate the response.

### Ties That Bind

Companies don't have to tackle security and authentication on a piecemeal basis: Two protocols already exist that join a variety of measures for Internet-based electronic commerce. Netscape Communications champions Secure Sockets Layer (SSL) as the best protocol for data encryption, server authentication, message integrity, and optional client authentication for TCP/IP connections. SSL sits between the raw Internet protocol (TCP/IP) and application protocols; it encrypts and decrypts on the fly any communication between client and server, including the uniform resource locator (URL), document contents, and perhaps credit-card numbers. To access documents with SSL, you simply type `https://`.

The second security candidate is a simple HTTP extension called S-HTTP, from Enterprise Integration Technologies. It adds message-based security to the HTTP protocol and lets you sign, encrypt, and authenticate interprocess communications (IPC). If desired, businesses can layer S-

HTTP atop SSL to use the two together.

In the end, some observers don't fret about security at all. They believe the technical issues will be resolved if only because they have to be if anyone is to capitalize on all the potential profits electric money promises. "It's like asking, what do you think of oxygen? It's vital that it be there, but you don't think about it," says Scott Cook, chairman of Intuit (see the text box "E-Commerce: Safe Today?" on page 84).

### First-Class Privacy

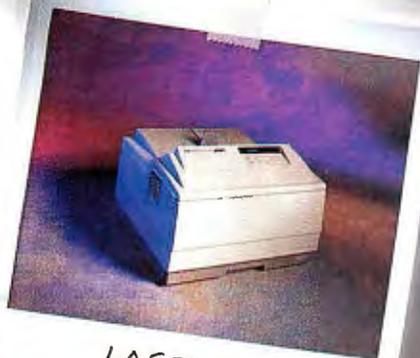
The third component of the electronic-currency infrastructure is anonymity—the ability to buy and sell as we please without threatening our fundamental freedom of privacy. What's the danger? If unchecked, all our transactions, as well as analyses of our spending habits, could eventually reside on the corporate databases of individual companies or in central clearinghouses, like those that now track our credit histories.

Serial numbers offer the greatest opportunity for broadcasting our spending habits to the outside world. Today's paper money floats so freely throughout the economy that serial numbers reveal nothing about our spending habits. But a company that mints an electric dollar

could keep a database of serial numbers that records who spent the currency and what the dollars purchased. How do we build a degree of anonymity into electric money? Blind signatures are one answer. Devised by DigiCash's David Chaum, it lets consumers scramble serial numbers. When a consumer makes an E-cash withdrawal, the PC calculates the number of digital coins needed and generates random serial numbers for the coins. The PC specifies a blinding factor, a random number that it uses to multiply the coin serial numbers. A bank encodes the blinded numbers using its own secret key and debits the consumer's account. The bank then sends the authenticated coins back to the consumer, who removes the blinding factor. The consumer can spend bank-validated coins, but the bank itself has no record of how the coins were spent.

### Dialing for Microcents

The fourth technical component in the evolution of electric money is flexibility. Everything may work fine if transactions use nice round dollar amounts, but that changes when a company sells information for a few cents or even fractions of cents per page—a business model that's evolving on the Internet. Electric-money



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## Oscard Makes Phones Pay

Smart Cards may be the rage in Europe, but in the U.S., a new approach, using remote-value devices, could be like putting automated teller machines (ATMs) in your pocket. Unlike Smart Cards, which hold digital representations of currency in their internal memory, remote-value devices store balance information for cash reserves that reside at a bank or other central location.

One of the first implementations of this strategy is the optical-scanner card called Oscard, from Brilliant Color Cards (San Rafael, California). Oscard is an evolution of the phone card, and in its initial implementation, it will be limited to purchasing phone services. But in the future, the device could be issued by any type of commercial business, according to founder Larry Brilliant, who developed Oscard with Shelly Howard, a security expert.

Oscard includes a DTMF tone reader and decoder that convert telephone tones to digital information that resides in the card's memory. To conduct a transaction, the consumer simply dials an 800 number and uses DTMF tones generated by Oscard to tell the bank to transfer a payment to the merchant. Personal identification numbers (PINs) provide security against unauthorized purchases. The DTMF signals also can relay account balance information to the device.

An OCR scanner, which sits within a slit at one end of the device, reads proprietary OS code—a close relative to bar code—which you can swipe in from a printed check or, potentially, view from an ATM screen. The company uses proprietary OCR software. The next-generation Oscard, due commercially in September, will have an LCD screen for displaying account information.

Oscard takes advantage of relatively low phone service costs in the U.S. This keeps transaction expenses low even though an Oscard

transaction requires two telephone calls (the first to a local telephone point of presence—or POP—using the 800 number, the second to the merchant, a toll call). Second, Oscard uses standard telephone equipment, so there are no added expenses for Smart Card readers. "There are 200 million phones in the U.S., and these are the best entry points for digital money," says Brilliant, who estimates the cards will sell for



Unlike Smart Cards, which store value internally, Oscard and its portable reader manage digital currency stored at a central location.

about \$20. "This system isn't dependent on new standards or changes in the infrastructure."

Brilliant developed Oscard in part because he doesn't see the U.S. market embracing Smart Cards because of their expense and unresolved standards. In the meantime, Oscard blends established technologies like DTMF with the evolving need for electric money.

—Alan Joch

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systems must be able to handle high volume at a marginal cost per transaction.

Millicent, from a division of Digital Equipment, may achieve this goal. Millicent uses a variation on the digital-check model with decentralized validation at the vendor's server. Millicent relies on third-party organizations that take care of account management, billing, and other administrative duties.

Millicent transactions use scrip, digital money that is valid only for Millicent. Scrip consists of a digital signature, a serial number, and a stated value (typically a cent or less). To authenticate transactions, Millicent uses a variation of the zero-knowledge-proof system. Consumers receive a secret code when they obtain a scrip. This proves ownership of the currency when it's being spent. The vendor that issues the scrip value uses a master-customer secret to verify the consumer's secret.

The system hasn't yet been launched commercially, but Digital says internal tests of transactions across TCP/IP networks indicate the system can validate approximately 1000 requests per second, with TCP connection handling taking up

most of the processing time. Digital sees the system as a way for companies to charge for information that Internet users obtain from Web sites.

Another micropayment scheme is NetBill, from Carnegie Mellon University. NetBill includes a business model, protocols, and software that lets Internet users pay for information at a transaction cost of about 1 cent for each 10 cents of purchase price. The proposal also strives for a high degree of anonymity. Consumers in NetBill transactions use a "checkbook," while merchants use a "till." A single transaction-oriented protocol handles communications between these two entities and with NetBill. Other communications between client and server remain unchanged, allowing NetBill to work with diverse channels including the Web, FTP servers, SQL queries, or MPEG-2 streams.

### Game Plan

Security, authentication, anonymity, and divisibility all have developers working to produce the collective answers that may open the floodgates to electronic commerce in the next 12 to 24 months. But where does all this leave you if you need

to make strategic decisions right now about how and when to bank on electric money? There are essentially two strategies you can use.

The first strategy is active: Look to pioneering turnkey systems. Using this approach, you establish or grow a network composed of the Internet, intranets, and Virtual Private Networks (VPNs) to cement business-to-business ties. This segment, an evolution of the established EDI market, already sees a number of large companies offering systems to energize digital commerce. One example is Sterling Software's Electronic Commerce Gateway, which extends the reach of EDI VANs to the Internet. Its Dataguard client/server product is based on EDI X12, which—along with EDIFACT—defines digital versions of business documents (such as purchase orders and invoices) used in EDI transactions. X12 is an ANSI standard; the United Nations supports EDIFACT. Sterling also offers commercial businesses Vector: Connexion, which links merchants to the VisaNet credit-card network.

Similarly, Computer Associates and Microsoft have jointly announced they will Internet-enable a cobranded product

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for Windows NT servers. CA's CA-Uni-center/ICE (Internet Commerce Enabled) provides security as well as network and systems management for the Internet. Microsoft distributes for free its Internet Information Server for Windows NT. The package comes with Merchant Workbench, a set of tools for launching a variety of services, including on-line payments.

Harbinger, a VAN services provider, added Internet capabilities to its EDI-based electronic-commerce software. Relational database vendors, including Oracle, Sybase, and IBM, have announced Web support for Harbinger's PC and Unix products. This will allow businesses to establish live links from inventory systems to Web servers without reformatting their database. Users can launch SQL queries directly from their Web browsers.

SBT Internet Systems has a multipart E-commerce suite. WebTrader, Internet in a box for business, lets you capture critical customer information such as sales orders and product registration—all protected by RSA encryption. WebPay, a Windows-based payroll application, lets accounting departments manage their direct deposits.

The R/3 system, from German-based SAP, is a framework for corporate information processing. The company joined forces with Sun Microsystems, Netscape, Microsoft, and others to support EDI as well as standard Internet transactions.

#### WHERE TO FIND

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## E-Commerce: Safe Today?

Intuit, publisher of Quicken and TurboTax, is working to make its personal financial software the interface between consumers and financial institutions across the electric money pipeline. In the following interview, Intuit chairman Scott Cook discusses his vision of electronic commerce and the role he expects Intuit to play in its evolution.

**BYTE:** Will we ever see a secure and reliable remote-payment system for the Internet?

**Cook:** Right now, there is a remote-payment system that's quite well established. It's called a credit card. With slight adjustments it will work on the Internet.

**BYTE:** What adjustments?

**Cook:** Frankly, not much because you can type in a credit-card number and send it over the Net [today]. And it's probably as secure if not more secure than using a credit card to buy dinner in a restaurant. Because when the waiter disappears with your credit card, you don't how many charge slips he's running off, what notes he's making, or what happens to the trash. All sorts of bad things can happen, but the credit-card companies cover your butt, and you don't worry about it. On-line, there's no waiter going anywhere. Especially if you put any kind of modest security on it, it's going to have an equal or better chance of not being tampered with than in the restaurant example. What needs to happen? The banks need to cover your butt the way they do with credit-card users. I think you'll get better security on the Net than you will in a restaurant. VISA and MasterCard are coming out with a security standard [see the section, "Security Blankets" in the main story].

**BYTE:** What do you think about that?

**Cook:** Whatever they do is fine. In two years, no one will think about it.

**BYTE:** Will Intuit ever get into the transaction-processing business?

**Cook:** No. We believe the payment system should be run by banks. And that groups of banks should run intracountry transactions. So we're in essence unrelated to DigiCash and CyberCash. One, we don't do payment transactions. Second, we don't do retail-to-consumer work at all. We're building electronic-commerce software that helps financial institutions (banks, insurance companies) sell to and serve their customers.

The financial institutions are already tremendously automated at the back end. There's no physical delivery: Wealth is exchanged by exchanging electronic bits. Our goal is to get an end-to-end digital link [for consumers].



Intuit's Scott Cook: The Net will be safer than waiters with your credit card.

IXOS Software will provide users a real-time "live link" between an R/3 database and a Netscape browser.

## No Going Back

Of course, there's a second strategy: Check back at the millennium. This skeptical approach takes the somewhat cynical view that electric money's technical problems will see only moderately successful answers to our security questions, and that the sophistication of thieves will grow at the same pace as that of security experts. Transactions will become more secure but never enough to gain our full confidence. In the meantime, traditional currencies will prevail.

This attitude recognizes the technical

hurdles that have yet to be overcome, but it doesn't acknowledge the fact that the electric-money genie is already out of the bottle. The market will demand electric money because of the accompanying new efficiencies that will shave costs in both consumer and supplier transactions. Consumers everywhere will want the bounty of a global marketplace, not one that's tied to bankers' hours. These efficiencies will push developers to overcome today's technical hurdles, allowing bits to replace paper as our most trusted medium of exchange. **B**

Udo Flohr is a BYTE contributing editor based in Hannover, Germany. You can reach him on the Internet at flohr@dfn.de.

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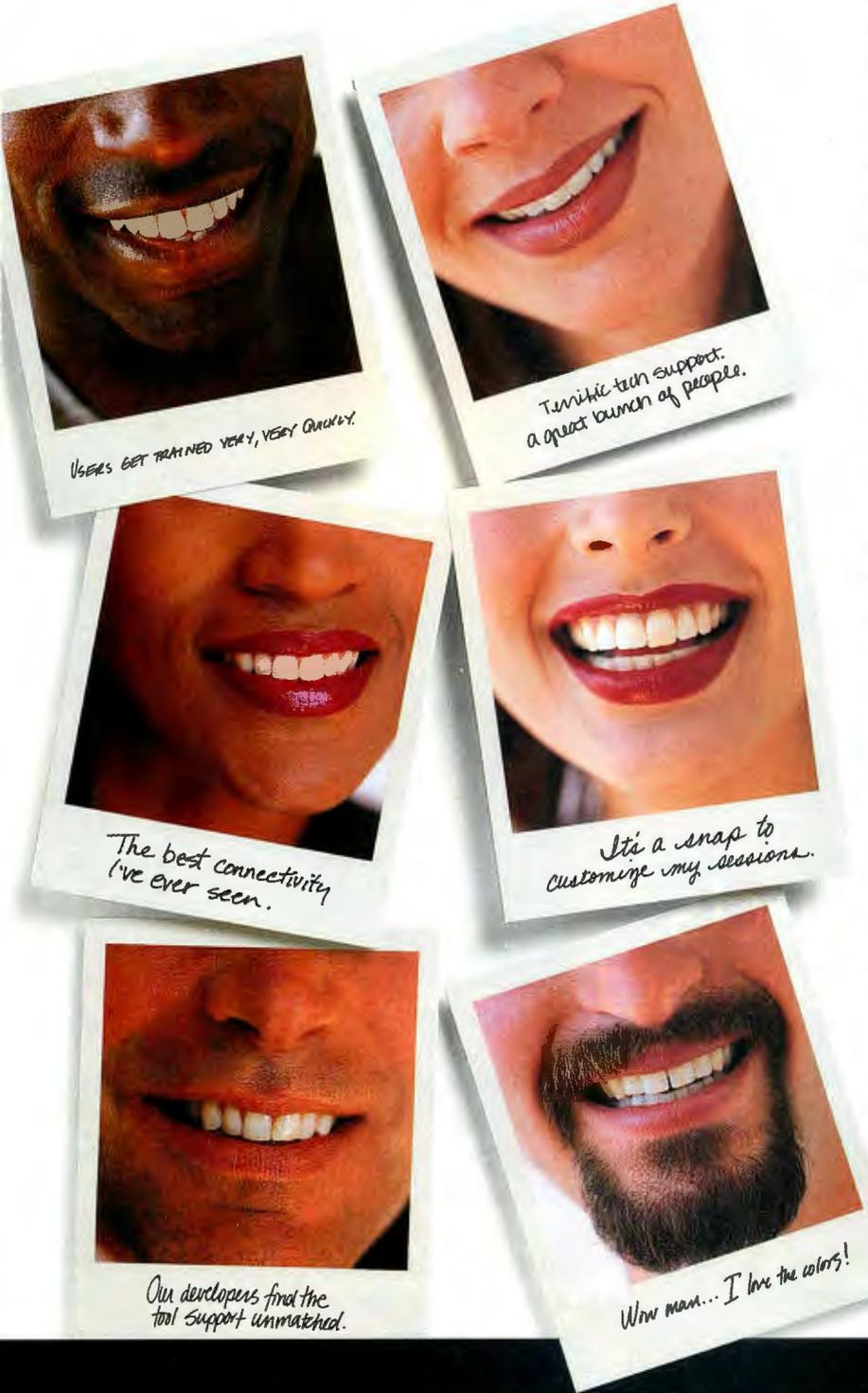
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## A Place for Everything

Data-storage pioneers continue to push technology to the limits.

**D**ata storage is the most exciting technology on the planet—and the dullest. Face it: Most users could not care less about the type of storage their computer uses, as long as they can get their programs and information when they want them—fast. Yet, the technology users most want to ignore is constantly pushing the bounds of the possible.

Pundits have long been predicting the demise of those slow electromechanical dinosaurs-to-be—hard drives. But hard drives continue rocketing to faster speed, higher capacity, better reliability, and—astonishingly—lower prices. Designers are ransacking diverse regions of science and technology. To perform their magic, today's hard drives depend on mind-bending combinations of aerodynamics, signal-processing algorithms, and quantum mechanics.

Also magical is the notion that silicon chips can store data indefinitely, without electrical power. Yet, that is exactly what solid-state storage using flash memory does. This technology remains too pricey to dethrone hard drives in the desktop-storage realm, but it continues to boost storage density and lower prices. As flash memory keeps conquering more noncomputer fields, such as digital cameras and answering machines, this challenger may someday take the desktop throne, too.

Another surprise you may find on your desktop: CD-ROM recording equipment. There was a time when recording your own CDs seemed about as practical as recording your own record albums. Yet, today, under-\$1000 CD Recordable (CD-R) units can record—and read—CDs in the same-size bay as an ordinary CD-ROM drive. Many organizations, such as NASA, are seizing on CD-R as the answer to an archivist's prayer: cheap, easy—and bulletproof—long-term storage.

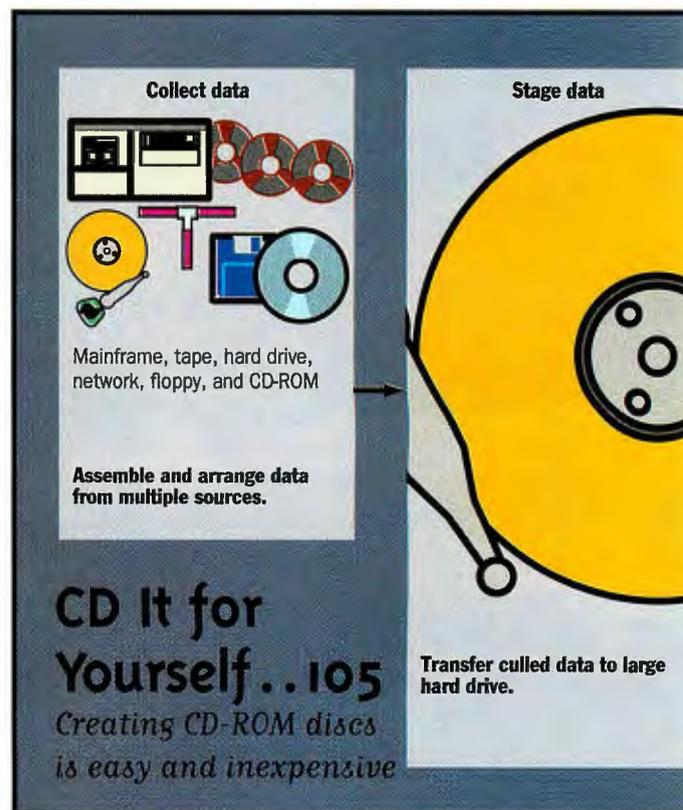
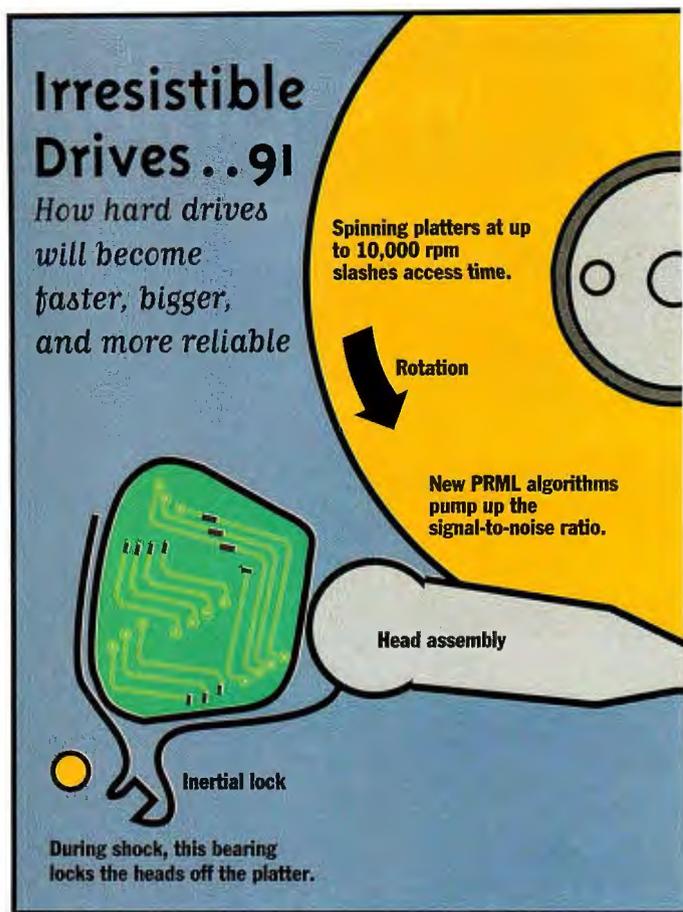
All these advances in storage may radically alter the future of “everyday” computing. Larger and faster hard drives already support RAID storage and will permit ever-larger database operations—without bothering the network unduly. Some users even “mirror” slower CDs on their hard drive for faster access. Flash memory could quietly back up your live work environment, reducing any problems should the system crash.

So, just what's going on with storage? More, faster, easier, cheaper. Sounds pretty exciting. **B**

—By Edmund X. DeJesus

### Irresistible Drives...91

How hard drives will become faster, bigger, and more reliable



Magneto-resistive heads are replacing inductive heads, boosting areal density.

Fresh from IBM labs, spin valve heads have crashed the 10-Gb-per-square-inch milestone.

Dynamic head loading. Until the platters spin up, the heads rest on a ramp off the platter surface.

# The Way of All Flash...99

Nonvolatile storage finds creative applications

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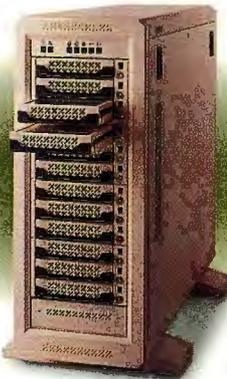
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Quantum mechanics meets aerodynamics in hard drives: the next generation. **By Edmund X. DeJesus**

## Irresistible Drives

**H**ard drives can't stand still. Sure, the colossal 40-MB drives of yesteryear also had magnetic platters rotating *swiftly* under hovering read-write heads. But the similarities with today's multi-gigabyte wonders stop there. The hard drives of today—and especially tomorrow—range deep into new territories including quantum mechanics, aerodynamics, and dizzying spin speeds.

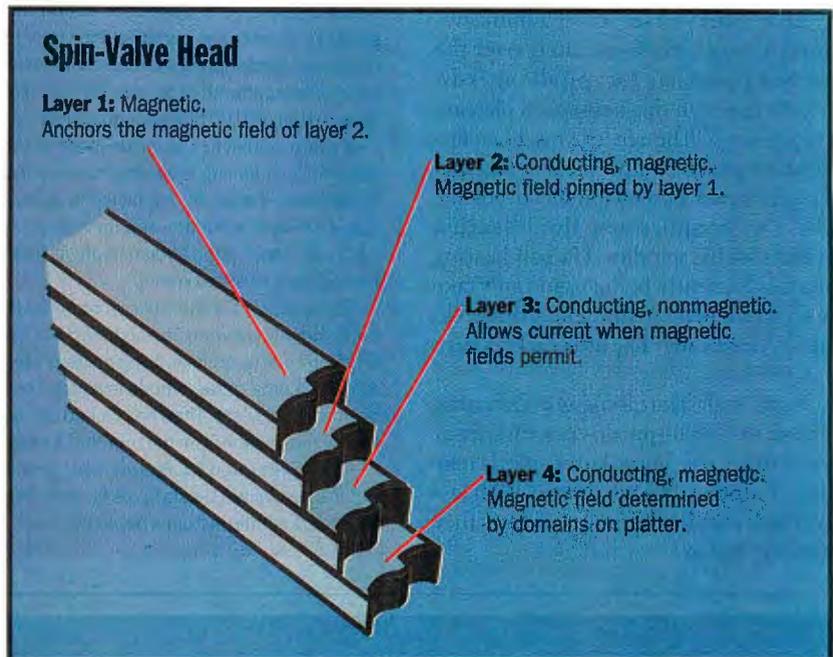
As a result of such technologies, capacities are compounding at 60 percent each year—a tenfold increase in capacity every five years. Analysts expect this rate to continue into the next century.

The gray hairs of hard-drive designers are due largely to the mutually interacting relationships of drive components. Want to increase the capacity? Simple: Move the heads closer to the surface of the disk. The heads can write and read smaller magnetic domains, and the smaller the domain, the more data each platter can hold. Of course, the closer the heads, the more you have to worry about the heads hitting the platter and completely shaving off the magnetic domains.

So coat the platters with protective materials. You might want to redesign the aerodynamic properties of those heads, too. With more data flowing past each head, you'll need better electronics, maybe even a bigger on-board cache, to handle the increased throughput. Probably a good idea to change the algorithm for detecting each magnetic domain, too. Don't forget to check that the smaller domains are still stable at the usual operating temperatures. Most likely you'll shorten up the spindle length also, and design a new housing to hold the whole thing, and reposition all the mounting gear on the outside. All at a competitive price, of course. You get the picture.

### Spin Doctoring

*Access time* is the most widely used indication of the speed of a hard drive. Access time is the sum of the *average seek*



Current flows through layer 3 based on magnetic fields of layers 2 and 4. Layer 4's magnetic field derives from domains on the platter.

*time*—how long on average it takes the head to move to the correct track—and the *latency*—how long on average it takes the desired data on the correct track to move under the head. (Advertisements often, deliberately or accidentally, confuse access time with seek time. They also usually quote the lower—faster—read-seek time rather than the higher—slower—write-seek time.)

The seek time depends on the size of the drive (e.g., 3½ inch), the number of tracks per inch (tpi, which itself depends on such things as the size of the magnetic domains), and the speed and precision of the head actuators. The latency depends upon the spin rate: the rotational speed of the disk. Latency is half the time it takes for a complete rotation of the disk. The actual throughput also depends on the layout of the magnetic domains: You can pack more sectors in the tracks near the outer edge than on tracks nearer the center. This approach

is referred to as *zone-bit recording*.

One way to improve the access time is to reduce this latency by speeding up the rotation of the disk (the spindle speed). Faster spin rates generally mean better performance. In the olden days (a few years ago), all desktop spindle speeds were the same: 3600 rpm. The resulting latency (time for half a rotation) was 8.3 milliseconds.

Top-speed hard drives for desktop PCs these days rotate at 5400 rpm, 50 percent faster, for a latency of 5.6 ms. Some current hard drives rotate at 4500 rpm, for a latency of 6.7 ms. Many hard drives for portable computers still use a rotation speed of 3600 rpm in order to consume less power.

Current hard drives for servers rotate at an even zippier 7200 rpm, twice as fast as the old brand. Their latency is 4.17 ms, half the old latency. This is especially significant for transaction-oriented servers, points out James Porter, president of

Disk/Trend (Mountain View, CA), a company that monitors drive business and technology. Server administrators typically strive to put data that belongs together in the same area on a hard drive to reduce the effective seek times of drive access. Thus, their access time is especially sensitive to changes in latency: Reduce the latency significantly and you have a happy server administrator.

That's why you see server administrators turning cartwheels lately over the newest prospects for spindle speeds: 10,000 rpm. On this new speed plateau, the latency will be a mere 3 ms. Heat dissipation gets to be a problem at this spin rate, however. Zoomy spindle speeds like these will require new fluid-bearing motors for the spindles. The ball-bearing motors currently being used can't take such speeds without shortening drive reliability drastically: The little suckers burn out too fast.

Some analysts are looking even further ahead, to 14,000-rpm drives with latency rates of 2.1 ms. These latter speeds may appear first in 2½-inch drives: With less platter matter for the motors to turn, they can turn faster.

## Atomic Bits

Nestled in the hills of south San Jose, California, next to a county park, lies the intellectual birthplace of the disk drive. IBM's Almaden Research Center is home to some of the most creative and brilliant people you'll ever meet. Recently, these experts gathered to discuss the future of storage systems.

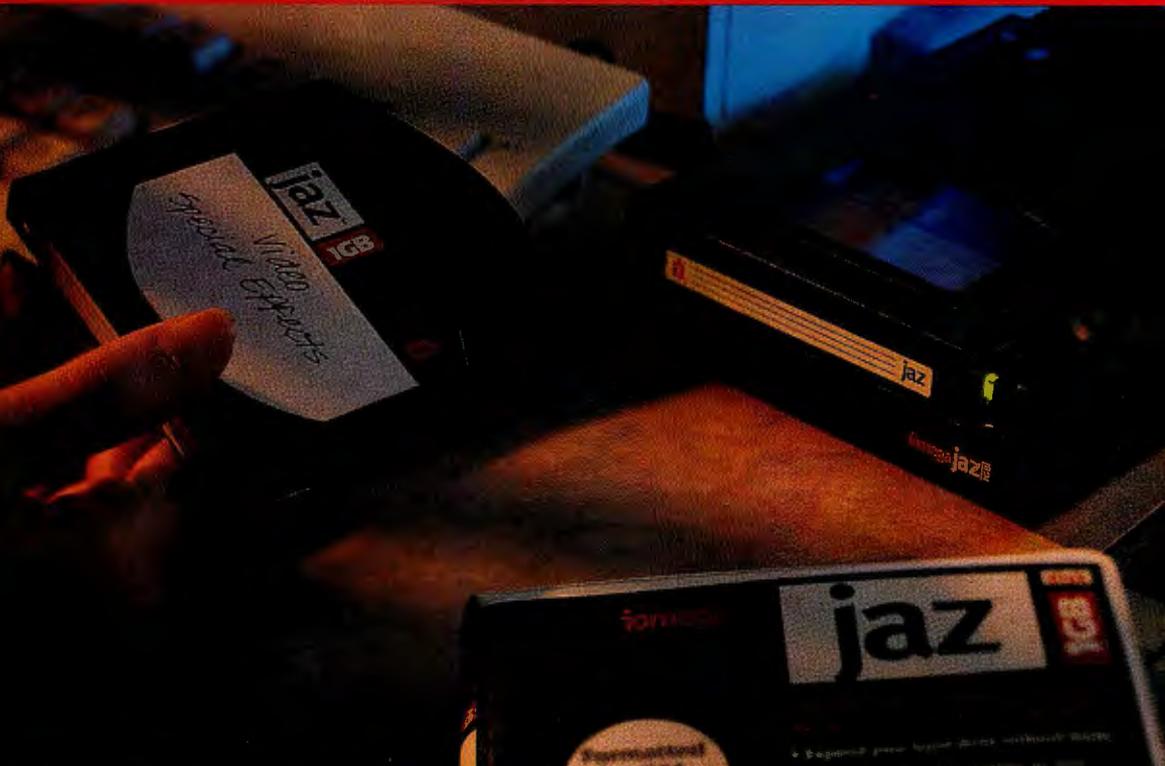
There was the expected talk about cobalt, chrome, and platinum underlayers with magnesium-oxide or nickel-aluminum coatings, and of inductive write heads made of various metallic nitrides. David Thompson, IBM Fellow and director of the Advanced Magnetic Recording Lab, discussed the superparamagnetic limit (which basically says that the smaller you make the particles, the sooner they forget what you tell them); described optical storage and supersphere solid immersion lenses; talked a bit about the incredible potential of holographic storage (see "What's Next?," April BYTE); and mentioned the theoretical density limit of  $10^{15}$  bits per square inch (the size of an atom).

It was a lead-in to a surprise speaker: Don Eigler, another IBM Fellow. Eigler works with Almaden's scanning tunneling microscope (an IBM invention that won two scientists the 1986 Nobel Prize). He explained how the microscope works—basically it senses the distance between a surface and the microscope's head—and gave some examples of what it can "see." Most of the audience got its first look at what a single atom looks like (a gray tennis ball, if you want to know).

Eigler brought up the massive screen at the front of the auditorium and flipped a few switches. Suddenly we were seeing a live feed from the STM at the other end of the building. The STM isn't just good for looking at atoms, Eigler explained; it can move them, one by one. He donned a data glove (whose inventor, Tom Zimmerman, recently joined IBM at Almaden). The room fell silent. Then he "picked up" a xenon atom and moved it. The silence was broken by the ovation from the roomful of seasoned skeptics.

The experts aren't quite sure what scanning tunneling microscopy will do for disk drives, but the results will be about as far from the 305 RAMAC (IBM's first disk drive system) as the space shuttle is from a paper airplane.

DRIVEN BY CREATIVITY.



## Heads: You Win

The technology of the hard-drive heads, which read and write the data magnetically, primarily determines the size of the magnetic domains (which influences the capacity of a platter) and part of the seek time. Traditional technology uses *inductive heads*: The moving magnetic domains on the platter induce a tiny electric current in the head. The drive electronics then translate the variations in the induced current into bits. Usually the same physical head does both the reading and the writing.

IBM has been the leader in developing the newer *magneto-resistive* (MR) technology, and all of IBM's hard drives now use MR heads. MR technology uses the property of some materials that change their electrical resistance in the presence of a magnetic field. First used in drives in 1991, MR heads have sense current constantly flowing through them. The magnetic domains on the platter alter the resistance of the MR heads—changing the electrical current, which electronics then translate into those handy ones and zeroes that define digital life. In a typical MR drive, different physical heads per-

form the reading and the writing tasks.

MR heads offer better signal-to-noise ratios than inductive heads. Part of that improvement comes from the separation of read and write heads. Also, the MR effect depends on the size of the magnetic field itself, in contrast to induction, which depends on the rate of change of the magnetic field.

MR heads can handle much smaller magnetic domains, increasing the number of tracks per inch and the number of bits per inch (bpi). Together, tpi and bpi yield the *areal density* (bits per unit area) of a hard-drive platter. The larger the areal density, the greater the overall capacity of each platter. Current tpi can top 6000, and bpi can exceed 100,000. Areal density using MR heads—up to 1000 megabits per square inch so far—can be nearly double what you can get using inductive heads.

Also, the speed of the magnetic domains does not affect MR heads. This property is in contrast to inductive heads, where the speed of the magnetic domains directly affects the size of the induced current. Mainly drives with smaller form factor have this problem: They may be so

small that the velocity of the magnetic domains (proportional to the radius and the rotation rate) is insufficient to induce a current in inductive heads.

One drawback to MR technology is price: MR heads cost more than inductive heads, and the cost doesn't necessarily scale with the benefit. An MR head costing twice as much as an inductive head probably won't yield double the areal density. As always, prices will fall. But the drive business is price-sensitive, and saving a few bucks a head is important. When buyers compare two drives with similar capacities and access times, the deciding factor is not going to be which drive has MR heads.

Another drawback is that it's more difficult to manufacture MR heads in a production environment than it is to make the comparatively simpler inductive heads. MR heads are exquisitely sensitive to stray electrical charges that can throw a subatomic monkey wrench into the works. Positioning MR heads also requires extreme precision.

Variations on MR technology can boost performance even further. Hewlett-Packard is using a dual-stripe MR design,

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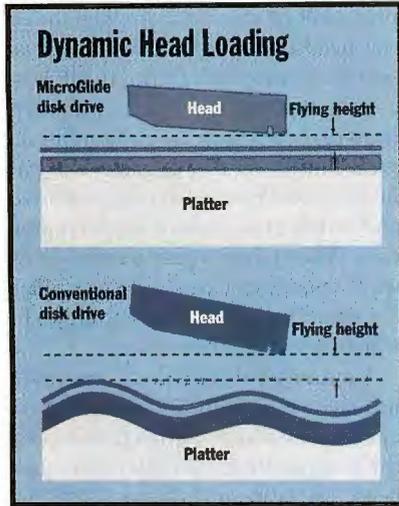
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developed with EMC Corp., that connects two MR elements and works on the difference in response of the two elements. This technique automatically can-



### Integral Peripherals' technology means lower-flying heads.

cels some noise sources, simplifying the analysis of the resulting signal and improving signal-to-noise ratios further.

That means higher areal densities than with MR alone.

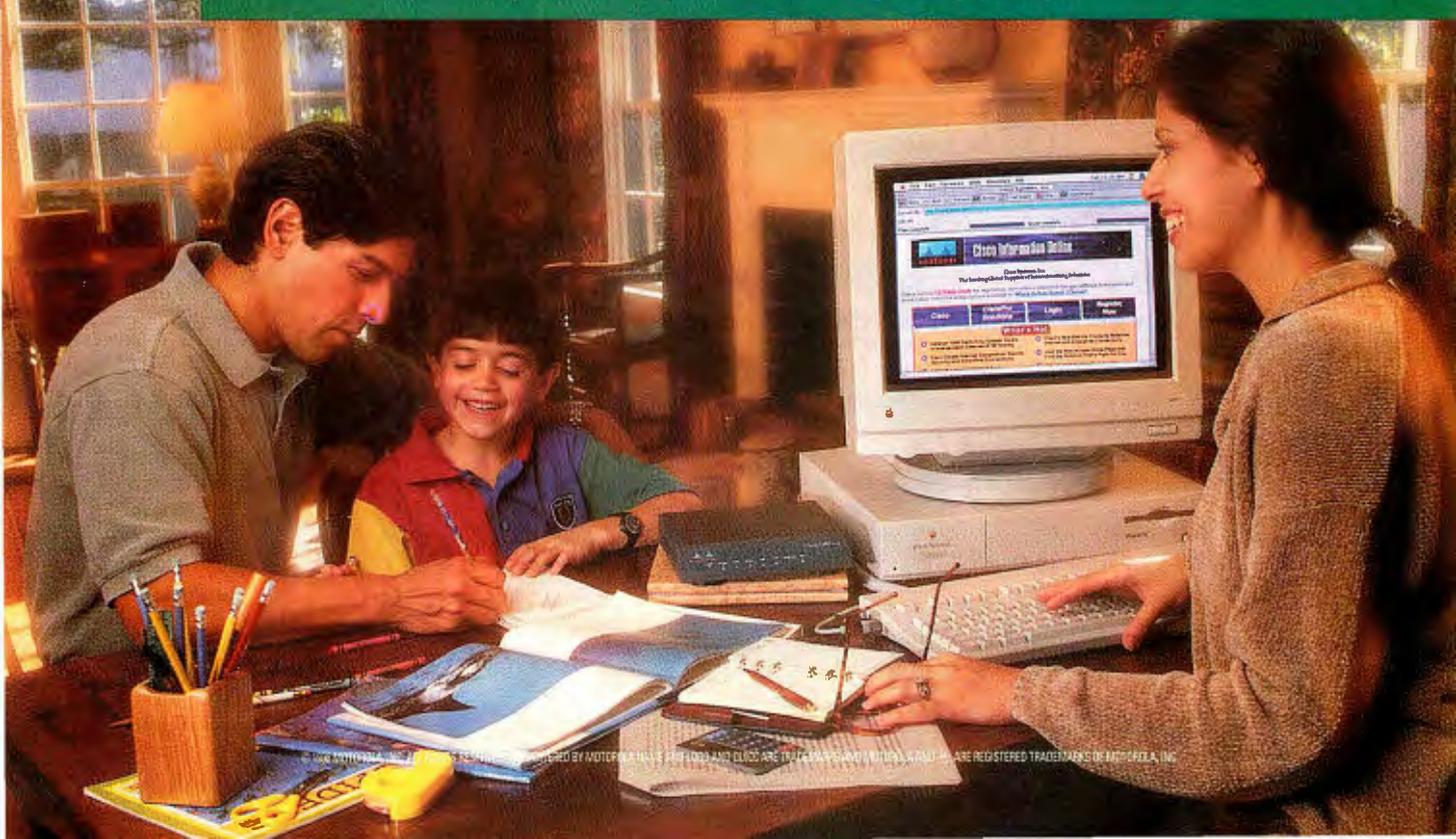
As impressive as MR technology is, IBM, HP, and other researchers are already looking beyond to advanced technologies like *giant MR* (GMR). GMR uses the quantum mechanical effect of electron tunneling. Electrons have wave-like properties that allow them to "tunnel" through potential barriers that would stop unwave-like particles. The scanning tunneling electron microscope works using the same effect (see "Atomic Bits" on page 92). The resistance to electron tunneling between two layers of special conducting magnetic material depends on the magnetization of one layer compared with the other. Thus, the presence of magnetic domains affects the tunneling rate. It turns out that this rather esoteric effect detects magnetic domains several times better than ordinary MR. GMR will permit even higher areal densities than MR technology does.

A further refinement of GMR is *spin valve* technology (see the figure on page 91). Fasten your seat belts. Two magnetic and conducting layers have a non-magnetic but conducting layer between

them. The top magnetic layer has its magnetic orientation anchored by yet another layer above it. Electron flow through this contrivance varies depending on the magnetic orientation of the bottom magnetic layer, making it very sensitive to the presence of magnetic domains. Some estimates suggest that spin-valve technology will increase areal density by ten- to twentyfold (which would mean 10,000 to 20,000 megabits per square inch). But first they'll have to pry the devices out of the laboratory and put them into the real world, where economical manufacturing and reliable operation are paramount.

Manufacturers aren't throwing out inductive technology just yet, however. Inductive heads are still cheaper. Vendors have a natural bias toward known, proven, and thrifty technology. Besides, increasing spindle speeds, decreasing the distance from the head to the platter, and improving detection algorithms and electronics all help inductive heads compete successfully against MR. But the long-term money is still on MR. In three years, all drives will be using MR heads, predicts Disk/Trend's Porter.

## INTERACTION BY INTERNET.



## Close to the Edge

In the race to boost hard-drive performance, one seemingly risky strategy is moving the heads closer to the platter surface. (This keeps less-expensive inductive heads in the game while allowing higher areal densities.) *Glide height*, or *flying height*, is measured in microinches (millionths of an inch). In the rules of this insane world, a glide height of 3 to 4 microinches is considered somewhat conservative these days. (Perspective: A human hair is about 4000 microinches in diameter.) More daring are heads that zip down to within 1 microinch or even—gasp!—touch the surface of the platter.

The danger here is that the head will plunge Icarus-like into the surface of the platter, plowing what used to be your company's database into a drift of semi-magnetic slag. What the designers want to ensure is that these close encounters don't cause any damage, and they do this in several ways.

Preparing the surface of the platter to resist or withstand head contact is one strategy. Carbon-based coatings give the platter a nonstick surface. Platters are usually not perfectly smooth but have tiny

ridges that present less area to which an errant head can adhere.

*Proximity-recording*, *tri-pad* (the head consists of three parts), and *virtual-contact* heads all do what was formerly unthinkable: make occasional contact with the platter surface. It takes considerable aerodynamic savvy to design a smoothly gliding component. Outriggers on the head may ride on an *air bearing* that keeps a minimal distance between head and platter. The lighter the head, the easier it is to maneuver, and the less damage to the platter if contact occurs. Covering the head with nonstick lubricating materials helps preserve the platter's surface, while tough coatings protect the head itself.

Integral Peripherals' *dynamic head loading* technique ensures that heads cannot contact the surface at all. The heads park on "loading ramps" until platters achieve a speed that can support a safe air bearing between head and platter. If the platter spins down, or the drive gets a bump, inertial locks automatically secure the heads to the ramps. With concern for possible contact out of the way, Integral can fly heads very close to the platters,

increasing areal density. Special preparation of the platter's surface to reduce contact damage is no longer necessary.

## PRML Screams

Many techniques for increasing drive speed and capacity require a new method for turning magnetism into bits. For years that method was *peak detection*, which works with no a priori knowledge of where the data might actually be. Analog peak detection for finding magnetic domains is like realizing that you might have just climbed over a mountain: You had been going uphill and now you're going downhill. Peak detection thinks, "Hey, what's this coming toward me? Hard to tell. Well, it's gone now. Must have been a magnetic domain. And it was a 'one' if I'm not mistaken. Hey, what's this coming toward me?"

One problem with peak detection is that it can misinterpret noise as a magnetic domain. Peak detection can also confuse two domains as one.

The method called *partial response maximum likelihood* (PRML) is largely replacing peak detection in the read channel, especially to interpret MR head data.

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Digital PRML knows when to expect magnetic domains to appear, looks for them, and then compares the incoming signal with what a signal should look like. This is more like finding a mountain by checking a map of the area, looking in the right direction, and comparing the outline observed with the known shape. PRML thinks, "The next magnetic domain should be coming along right about now. Yup, thar she blows. Looks like a 'one.' The next magnetic domain should be coming along right about now."

PRML also has its difficulties. It costs

more than peak detection. And it consumes more power. This means it is less likely to be used in low-power notebooks. It also means potential heat-dissipation problems that affect drive reliability. Analog PRML designs, however, decrease power consumption and chip size without major impact on performance.

Using PRML to sift the data wheat from the noise chaff improves the signal-to-noise ratio because PRML doesn't even look at noise in an area where it's not expecting a signal. This permits higher areal densities, and faster data rates, even

with older head technologies and spindle speeds. Data rates with PRML currently reach above 150 Mbps, which is decidedly better than the below-80 Mbps common just two years ago.

### The Hundred-Year Drive

It wasn't long ago that the life of a hard drive was brutish and short. Sure, the mean time between failure (MTBF) was in years, but not many of them. The inevitable crash would occur with no warning, leaving you thinking about all the backups you had meant to do. With all their fancy head gadgetry, faster spindle speeds, and daredevil platter-buzzing antics, you'd think that the new bigger and faster hard drives would be less reliable than their simpler counterparts.

Au contraire. Hard-drive MTBF is starting to hit the million-hour mark. That's 114 years, folks. Your new hard drive may very well last longer than you. Besides the longevity bonus, the industry standard *self-monitoring analysis and reporting technology* (SMART) lets some hard drives perform checkups on themselves. They then let the user know if they're ready for duty or if it's time to issue the hard-drive equivalent of "Hull breach imminent!"

All this good news in the hard drive biz means bad news for all the technologies whose developers hope will replace hard drives. For example, solid-state storage—which many predicted would replace clunky old hard disks with uncrashable chips—is chasing a moving target. Out-running hard drives' booming storage capacities and diving prices is a tough business plan to accomplish. Don't expect to do it anytime soon. CD-ROMs, whose 650-MB capacity once seemed immense, are now like floppy disks compared to today's multigigabyte hard drive hulks. Indeed, many users are finding a performance boost by copying the contents of their most-used CD-ROMs onto a spare hard drive.

In this best of all possible storage worlds, we now have the prospect of faster, more voluminous, more accurate, and more trustworthy hard drives that we can bequeath to our grandchildren. And that 1 GB of drive space might just be enough to hold Windows 2110. **E**

*Edmund X. DeJesus is a senior technical editor at BYTE. You can send him e-mail at 76443.1723@compuserve.com.*

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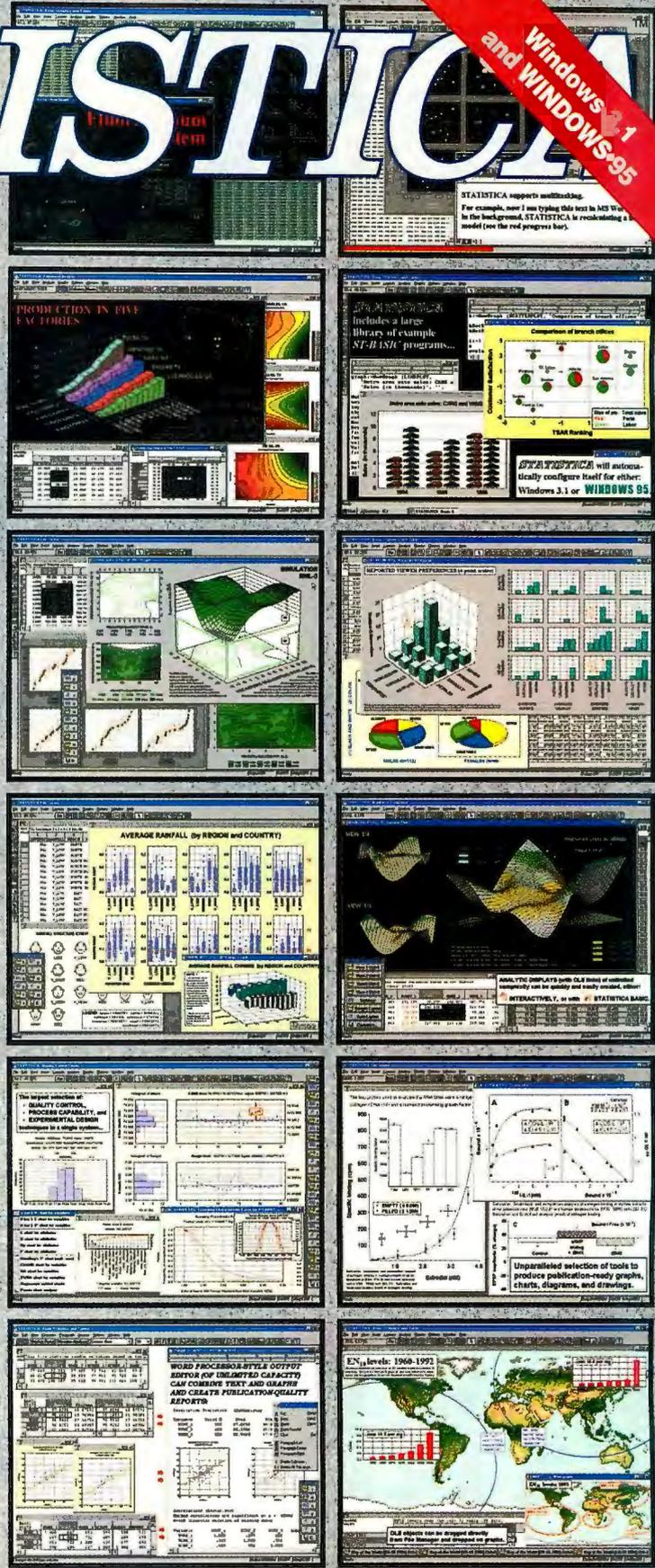
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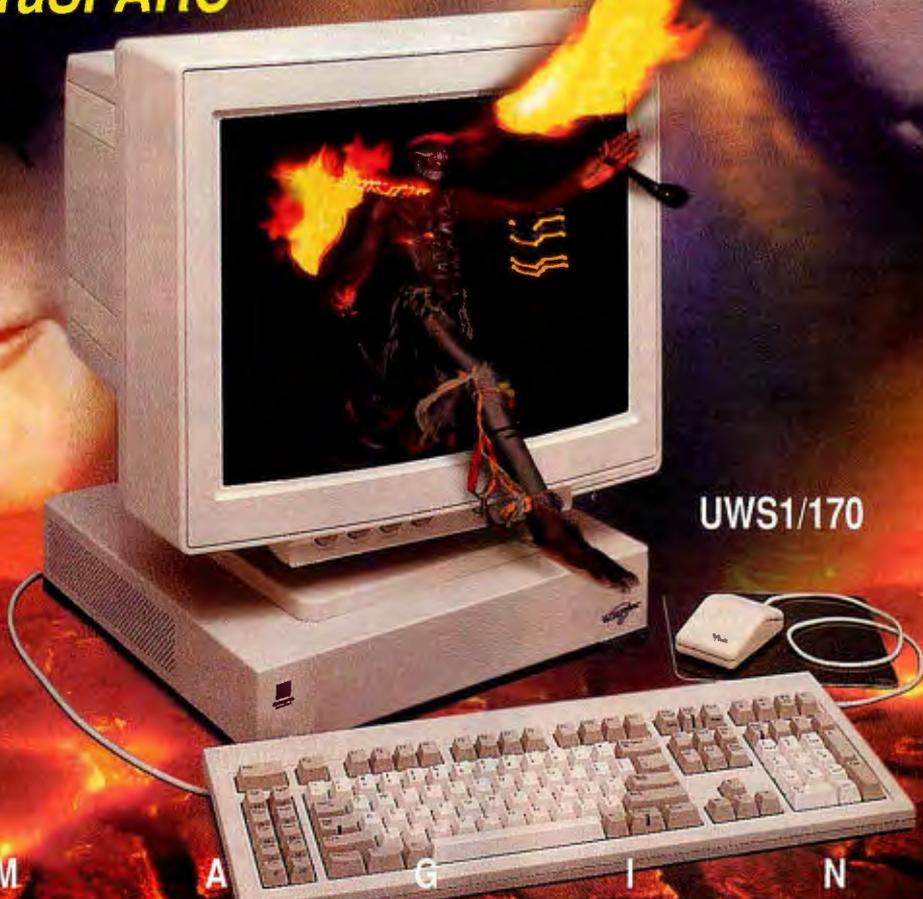
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Circle 88 on Inquiry Card.

Flash memory keeps chasing hard drives—while becoming more important in other ways. *By Rick Cook*

## The Way of All Flash

**R**emember when flash memory was going to replace hard drives? It seemed to make sense: Nonvolatile, invulnerable solid-state storage would replace expensive, bulky, and delicate hard drives.

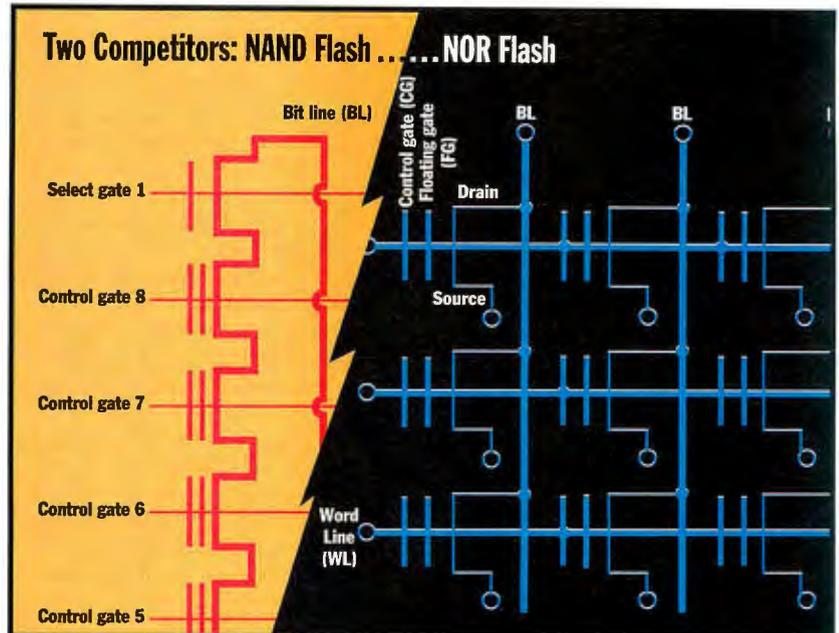
The revolution never happened. Hard drive prices fell, capacities increased, and voilà—gigabyte hard drives are showing up on new desktops, far outpacing 40- and 80-MB flash-memory cards.

Under the covers, though, flash memory has become big in products that need a small amount of nonvolatile storage for programs and data. According to In-Stat, a Scottsdale, Arizona, market research firm, only about 25 percent of flash-memory products went into computers in 1995, making computers the number-two users, behind communications products. Even in computers, however, most flash-memory applications today are replacements for EPROMs and EEPROMs (code storage) rather than mass storage (data storage).

Flash memory may stay as the holder of your BIOS, but the big push for data-storage flash memories probably won't come from computers. Consumer items, such as digital cameras and voice recorders, will play that role, says Alan Niebel, a senior analyst for In-Stat. Luckily for flash-memory makers, demand has outstripped supply, and manufacturers have found a market no matter what their technology. However, Niebel warns, this will start changing later this year, as supplies increase and growth in the computer market slows down. Vendors will feel more pressure in price and technologies. This works for the big companies with advanced technologies, and against both big companies with less advanced technologies and smaller companies that may lack marketing muscle.

### New Flash Cards

The prospect of high-volume consumer products, such as digital cameras and



NAND memory connects cells serially, for higher densities.

NOR cells are in parallel, for faster access.

voice recorders, is producing yet another form-factor war in the flash-memory industry. The PC Card is too bulky for these applications, so flash-memory makers, camera companies, and other interested parties are touting three new "standards" for tiny solid-state storage. All three of these new cards are about the size of your thumbnail, and all rely on flash memory.

The current leader in the miniature-card race is probably SanDisk, with a scaled-down version of its current memory-card technology, called Compact Flash. Since its announcement, about 60 companies have joined the Compact Flash Association (CFA), a consortium backing the SanDisk technology. Among its members are camera companies, such as Polaroid and Eastman Kodak, computer companies, such as Hewlett-Packard, and semiconductor firms, such as Motorola and NEC.

Like a PC Card, Compact Flash in-

cludes an AT-attachment (ATA) controller and memory in the card itself. CFA's competitors call this a drawback, because it increases the cost of the card. CFA's backers call it a feature, because it makes the cards compatible with any computer or other device that uses the ATA disk standard, including most PCs.

Intel is pushing a rather different solution, using an elastomeric connector called Miniature Card (née Mini-Card, but changed for trademark reasons). It is slightly larger than the Compact Flash card. The elastomeric connector has 40 pins (pads, actually) embedded in a rubberized connector, which makes the connector more forgiving at very small sizes than the normal pin-and-socket design. Franklin has been using them for years on its electronic books.

The Miniature Card's strong point is price. Intel and other members of the Miniature Card consortium (including AMD, Fujitsu, and Sharp) point out that

# How Flash Memory Works

That a flash-memory card could appear as a hard drive to the user is a tribute to the ingenuity of flash-system designers, rather than any inherent similarity in the technologies. At the bit level, flash has very different requirements and considerations.

Flash-memory cells can wear out after a number of write cycles, typically between 100,000 and 1 million, depending on the design of the cell and the precision of manufacturing. The main injury mechanism is cumulative damage to the cell's floating gate from the effects of repeated high voltages used to erase the cell. Either the oxide layer breaks down or electrons build up in the floating gate. Flash-memory makers allow for this by providing extra cells on the chip to replace failed ones. In addition, most flash-memory systems for data storage use a technique called leveling, which amounts to moving the data around on the chip to "wear" each cell as equally as possible.

Another consideration is that erasing a cell of flash memory takes much longer than erasing a bit of data on a hard drive. Like hard drives, flash-memory systems typically erase files by erasing entries in the memory table rather than erasing all the data. Inevitably, however, they will need that space again, and they must write over the data in those sectors. This is a more time-consuming process than it is with a hard drive.

## Anatomy of a Flash

A flash-memory cell is like a conventional transistor with an extra gate. (The scheme shown in the figure "Two Competitors: NAND Flash... NOR Flash" is Intel's ETOX IV NOR flash, but most of the others are similar.) Between the source and drain and the control gate, there is a second gate,

called a floating gate, that serves as a charge storage mechanism (see the figure below). Thin layers of oxide isolate the floating gate from everything else.

When a sufficiently large voltage goes across the source (at ground potential; see "Source n+" in the figure) and the control gate (at programming voltage), electrons (depicted by "-" in the figure) tunnel through the oxide layer and accumulate in the floating gate. This process is called *channel hot electron injection*. The extra negative charge (electrons) in the floating gate raises the cell's turn-on threshold by increasing the negative potential opposing voltage. That writes a zero in the cell, instead of the one of the erased (uncharged) cell.

Erasing the cell reverses the process. Grounding the control gate, and bringing the source to programming voltage, removes electrons from the floating gate and reducing the turn-on threshold. That turns the cell back to a one.

Oddly, erasing does not happen "as quick as a flash": It takes a long time. The reason is that the relatively high voltage involved (at least 10 V in most schemes) entails a good deal of current. Since there are limits to how much current chips can handle, there are limits to the number of cells that can erase at once, too. That's why erasing occurs one group of cells at a time.

The basic technology lends itself to flashy variations. Most of them involve a floating gate. For example, AMD uses a variation that erases by putting a positive voltage on the source and applying a negative voltage to the drain. National Semiconductor's technology erases by floating the source and drain, holding the control gate at 0 V, and applying a 20-V potential to the substrate.

## Pressing the Flash

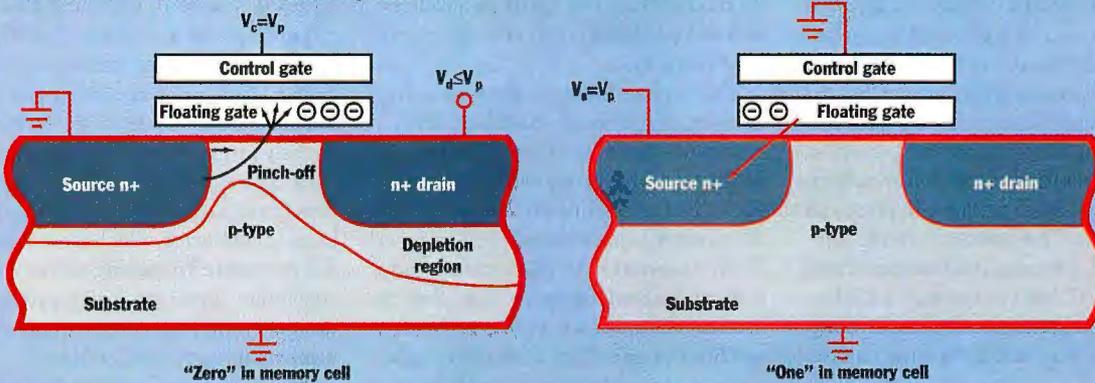
Flash memory is still new enough that there is no one way to make it. Manufacturers take about a dozen different approaches to making and organizing flash-memory cells on a slab of silicon. Some are better for data storage and some for code storage (storing the BIOS on a motherboard, or firmware on disk drives and modems).

Ironically, the common method of referring to flash technologies—by the logic scheme they use—is mostly not a function of the technology at all, but the way the manufacturer chooses to arrange the cells. You're not absolutely free to substitute cell arrangements using different cell technologies, but pretty much so.

NOR (see the figure "Two Competitors: NAND Flash... NOR Flash") is the leading technology today, and Intel is the major manufacturer. It organizes the memory cells in parallel fashion, with each cell's drain connected to a bit line, and many bit lines are grouped to make up an I/O group. The select line connects the control gates of a row of cells, one on each bit line. With this layout, it can access several cells, such as a byte or a word, in parallel. NOR provides faster random access, but its parallel structure reduces memory density.

NAND (see the figure "Two Competitors: NAND Flash... NOR Flash") is a technology used by National Semiconductor, Samsung, and others. It connects the cells serially, with a select gate for every few control gates (usually, one select gate per byte or word) and serial connections to the control gates in that group of gates. NAND has slower random access, but it allows higher densities due to its smaller-size cells.

## Zeros and Ones in Flash-Memory Cells



Left: Electrons accumulate in the floating gate: a zero. Right: Electrons leave the floating gate: a one.



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HAWK 2XL	5T32155	2.147 GB	Ultra SCSI 8/16 bit	up to 40 MB/sec	5411	9/10.5
HAWK 2XL	5T31055	1.050 GB	Ultra SCSI 8/16 bit	up to 40 MB/sec	5411	9/10.5

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the Miniature Cards are cheaper; they contain nothing but flash memory, rather than including a controller chip in each card. Backers of the other approaches point out that this makes them incompatible with PCs and other equipment without special drivers.

Finally, Toshiba is assembling its own group around a technology dubbed the Solid-State Floppy Disk Card (SSFDC). This is a kind of hybrid. The SSFDC can mount in an adapter that fits in a conventional PC Card slot. The adapter contains an ATA controller so that the card-and-adapter combination looks like an ATA hard drive to the computer. However, unlike SanDisk's Compact Flash card, the SSFDC does not need a separate controller chip for each memory card.

At this time, it is far too early to tell which of these three standards is going to succeed. All have important supporters and good technology. Still, it's a good bet that one of them will be very successful indeed.

## Flash and Blood

So, with all this support and all these alternatives, why hasn't flash memory toppled the hard drive yet? Price. Flash memory is still 10 to 30 times as expensive as hard drive storage. Flash memory's backers point out this differential is much less than it was a couple of years ago. Still, even the most optimistic say it will take perhaps a decade for flash memory to fall to hard drive prices. The less optimistic don't expect that flash memory will ever be as cheap as hard drive storage.

Besides, hard drives are a moving target. Progress in hard drives has been relentless, driving speed and capacity up and costs down.

What about notebooks? Mobile computing seems the ideal market for mass storage not affected by bumps and jolts. But gone are the days when 40 MB was generous for a notebook. Today, the tendency is to load full-featured applications, like Microsoft Word, on note-

books as well as desktop computers. Niebel points out that although 80 MB is an ideal size for a flash-memory "disk drive," effectively no market exists for 80-MB hard drives in PCs, notebooks, or workstations.

PDAs, like Apple's Newton, are also an ideal application for flash memory. The problem is that they have not taken off yet—and maybe never will. So flash

sonalities on code storage (cameras and answering machines) and data storage (hard drive replacement). They pragmatically recognize where the dough is today and that they need to serve that market to make some.

However, they are also fixated on flash memory's potential for mass storage, and they yearn to sell tens or hundreds of megabytes into a single piece of equip-



Flash-memory cards from Toshiba, National Semiconductor, Intel, or SanDisk can give up to 85 MB of solid-state storage—at \$20 per MB.

memory isn't getting the boost from them that its backers had hoped.

Choosing which type of memory is best in a real-world application depends very much on the application (see the text box "How Flash Memory Works"). The ideal of high memory density and rapid random access is as elusive in flash memory as anywhere else. In applications where memory density is most important, slower access may be worth the sacrifice. However, in time-intensive applications, the speed of access may outweigh all other considerations. Consumer applications are typically forgiving on the speed issue, while computer applications usually demand speeds comparable to or faster than a hard drive.

## Pressing On to the Goal

Despite the current market reality, most flash-memory companies have split per-

ment, rather than a megabit here and a megabit there for code storage. That is why, to capitalize on the coming market, most flash companies are actively promoting mass-storage applications by doing everything from selling PC Card memories to developing new technologies that better fit flash memory to the needs of computer systems.

Flash memory's future is bright, as it continues to move into new market areas. Vendors are making money and developing new technologies. And there's still a flash of hope for competing with hard drives. **B**

*Rick Cook is a freelance writer living in Phoenix, Arizona, who specializes in computers and technology. He is also the author of several fantasy novels that are full of bad computer jokes. You can contact him on the Internet at [rcook@bix.com](mailto:rcook@bix.com).*

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Circle 109 on Inquiry Card.

Recording CD-ROMs is easy, inexpensive, and perfect for archival storage. *By Jason J. Hyon and Michael D. Martin*

## CD It for Yourself

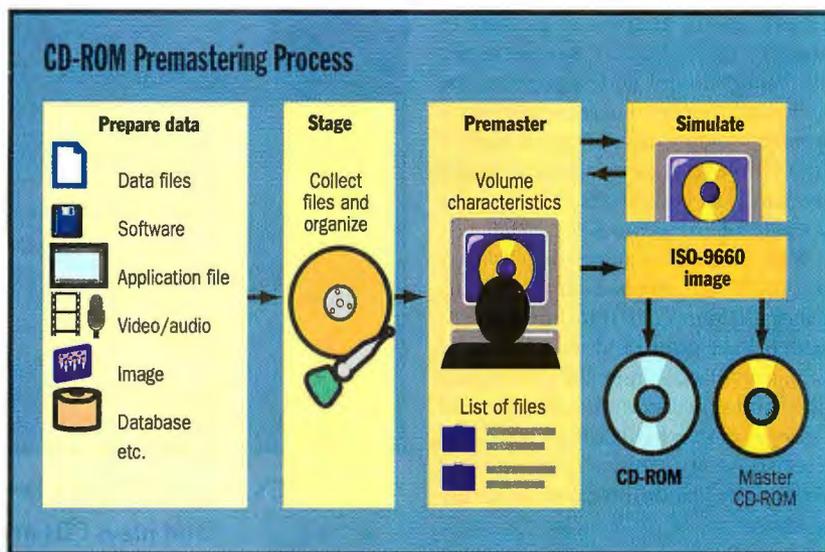
**T**he name says it all: CD-ROM is *read-only memory*. No writing your own CD-ROMs, unless you're ready to invest in some big, complex, and expensive equipment, right? Right. Until now. With CD Recordable (CD-R) drive prices dropping below the \$1000 level, the only questions now for many organizations looking for efficient archival storage are how and when.

What's the attraction of CD-ROM technology? Mainly, it's the 650 MB that can fit on a thin, nearly weightless, polycarbonate (as in bulletproof glass) disc. If you have tried backing up 1-GB hard drives or moving multimegabyte graphics files using floppy disks, that 650 MB looks appealing. NASA is among those burning its own CD-ROMs to manage the vast quantities of images and data from its many missions.

A major advantage of CD-ROM, especially in distribution or archival applications, is freedom from errors. NASA's Planetary Data System has shipped 100,000 CD-ROMs without having a single substantiated read error. CD-R discs have similar characteristics, and at \$7 per disc, they are the archivist's dream come true. The attributes of low cost, random access, and long life (100 years) make it the perfect archival medium (see the text box "CD-R Solves NASA's Space Race" on page 108).

### It's the Pits

Audio CD (defined by the Red Book and developed by Philips and Sony) uses a stream of 2352-byte blocks to store digitally sampled sound. A cross-interleaved Reed-Solomon code (CIRC) provides for error detection and correction by—among other activities—spreading data over several physical sectors. CD-ROM (defined by the Yellow Book) adds 280 bytes of layered error correction to each of the above blocks. This error correction kicks in if any errors get by the first layer.



Premastering transforms raw input files into an image of the eventual CD. Some software allows simulation of the CD.

Manufacturing plants produce audio CD and CD-ROM discs under clean-room conditions, for about \$1000 per master and \$1 per replica. The first step is to etch user data onto a master disc. Pits (indentations) distinguish data from lands (flat areas). When a laser hits a land, the laser reflects; when the laser hits a pit, the laser light scatters. Like a record album (remember them?), the tracks on a CD-ROM go in a spiral.

The next step sees the replication of the master disc on stamping masters. The stamper for CD-ROM is a plate with hills where the pits will be. Then the stamping masters create replicas by injection molding using polycarbonate resin. Finally, each polycarbonate disc gets an aluminum reflective layer and a coat of lacquer.

The advantage of this process is that you can mass-produce many copies of a master disc inexpensively (per disc). However, you realize that low cost only when producing hundreds or thousands of discs. What if you want only a single disc, of your hard drive or whatever?

Clearly, what you want is a one-step—cheaper—version of what the manufacturing plants do.

The problem is that you do not want the inconvenience of an injection-molding facility on your desktop just to produce pits and lands. That's why CD-ROM recorders simulate pits and lands optically instead of physically. CD-R (defined by the Orange Book) is essentially a CD-ROM with layers of gold overlaid with dye replacing the aluminum reflective layer. The dye is translucent, allowing the gold to reflect laser light (like a land). Burning tiny spots in the dye layer reduces the reflectivity at that spot, simulating a pit. The stamper for CD-R has a long spiral ridge that forms a pregroove in the molded CD-R disc. The pregroove wobbles to allow tracking during the recording process.

CD-R discs come in two lengths, 63 minutes (540 MB) and 74 minutes (650 MB). Because there is almost no price difference between the two capacities, it is likely that 63-minute discs will eventually disappear. *continued*

## CD-R ABCs

The figure "CD-ROM Premastering Process" shows the steps to produce a CD-R disc. This is a deliberate activity, as opposed to the typical ad hoc file storage on a hard disk or other medium. You generally try to fill a disc completely, because it is unlikely that you will use it again. The capability to add sessions to an already-used CD-R disc exists (it's called multisession), but the intersession gaps are so large that this procedure is undesirable. CD readers do not widely support the multisession effort. There are also some problems finding driver support to view the multiple sessions on a disc, although new hardware and drivers will recognize multiple logical volumes.

When you are designing your CD's layout, you'll have to consider the performance attributes of CD technology. CD readers have poor random-access performance (10 to 20 times slower than hard disks) and slower transfer rates (several times slower than hard disks). These characteristics may require redesigning a retrieval application, for example, for use on CD-R.

After designing the volume, you usually must stage the data files to local storage devices. A good network infrastructure—one with lots of space on your server—will simplify this process. An external hard drive is the second-best alternative for transferring large quantities of data between machines. The use

of ZIP drives, Bernoulli or Syquest cartridges, quarter-inch cartridges (QICs), digital audiotape (DAT), or Exabyte tape introduces additional complications.

The next step is premastering. It includes selecting a volume structure for the disc, selecting the directories and files

tering software will scan the source directories and report any inconsistencies. These inconsistencies usually relate to file naming or missing or damaged files.

The premastering software then reads the data files and writes an image file, which is essentially a copy of the entire



**JVC's Personal RomMaker internal CD-R drive records and plays CDs at speeds of up to 4X.**

to include (generally a point-and-click operation with modern premastering software), and specifying certain attributes for files (hidden files, use of ISO-9660-compliant filenames, and the positioning files on the output volume). After specifying this information, the premas-

ter recording system must sustain the transfer rate (150 KBps for 1X, 300 KBps for 2X, 600 KBps for 4X, or 900 KBps for 6X) for the entire recording session. This requirement arises because the CIRC error correction spreads adjacent data across blocks recorded on the CD, so there is no way to pause and resume a session. Thermal recalibration in older hard disk models has been the source of many CD-R recording failures. Unfortunately, SCSI device contention can also slow the throughput below the minimum. Most premastering packages can test the throughput rate and warn of problems or automatically cycle to a lower recording rate if necessary.

The final step in the production process is cutting the disc. This step places the greatest demand on the host computer. The recording system must sustain the transfer rate (150 KBps for 1X, 300 KBps for 2X, 600 KBps for 4X, or 900 KBps for 6X) for the entire recording session. This requirement arises because the CIRC error correction spreads adjacent data across blocks recorded on the CD, so there is no way to pause and resume a session. Thermal recalibration in older hard disk models has been the source of many CD-R recording failures. Unfortunately, SCSI device contention can also slow the throughput below the minimum. Most premastering packages can test the throughput rate and warn of problems or automatically cycle to a lower recording rate if necessary.

The post-final step is testing the resulting CD-R. You must have a test plan in place to verify CD-R contents routinely. Test methods include a checksum scheme on the data files, performing a byte-by-byte comparison of the source data to the

## Remarkable Reliability

**H**ow good are CD Recordable (CD-R) discs—with their pseudo-pits—compared with genuine injection-molded CD-ROMs? NASA's Planetary Data System at the Jet Propulsion Laboratory conducted a major government evaluation of CD-R in 1993 to determine its characteristics as an archival medium. This involved recording 300 pieces of media from nine vendors on different recorders at different recording speeds. Three government agencies tested these discs on different test devices. The results proved that CD-R is a robust medium. Every byte on every disc was recoverable, despite some discs having extremely high error rates due to an incompatibility between recorders and medium types.

This incompatibility involves the use of two dyes in the industry (cyanine and phthalocyanine). Cyanine is more sensitive to light and records better under marginal recording situations. Phthalocyanine is less sensitive and requires a higher-power laser to record properly. Because higher recording speeds require higher power, the medium's dye type must match the recording speed. Newer recorders can use different recording power to handle either cyanine or phthalocyanine media.

There are still some mysteries about the interactions between CD-R and CD readers, but at least two issues are involved. CD-R generally has a lower reflectivity (signal strength) than CD-ROM, and the push-pull (a measure of the tracking signal) is near or above the upper limit specified for CD-ROM discs. Thus, the CD reader has a weaker signal and more difficult tracking requirements when reading CD-R discs. A marginal CD reader will encounter errors on marginally recorded CD-R media.

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CD-R, or using a commercially available testing program.

Several test devices will perform detailed evaluations of the physical parameters of a CD-R or CD-ROM. These include the CD-CATs SA-3 (Audio Development), the CD-Analyzer (CD Associates), and the Clover Systems tester. These devices are expensive (\$5000 to \$120,000) and require complicated calibration procedures to work effectively. NASA's Planetary Data System has had only moderate success in using these devices to evaluate CD-R quality.

### CD-ROM Recording Studio

That's the process. Now to get your equipment. The first critical decision in setting up a CD recording system is determining the host computer. If you need special disc types (e.g., hybrid Mac or Unix-compatible Rock Ridge discs), you'll want a recording system for that platform. Otherwise, premastering software on any platform will produce fully compatible ISO-9660 discs.

The second issue is how portable you want your recording setup to be. Will you do all your recording on a dedicated machine, or will you move the recorder to different machines? In the latter case, a combined unit like the JVC Personal RomMaker (which includes a power supply, hard drive, and recorder) will work best. (The Data Distribution Lab at the Jet Propulsion Laboratory uses five or six Macs for developing multimedia presentations, and the single JVC Personal RomMaker moves between systems as needed.) Unfortunately, this portability does not work across OSes.

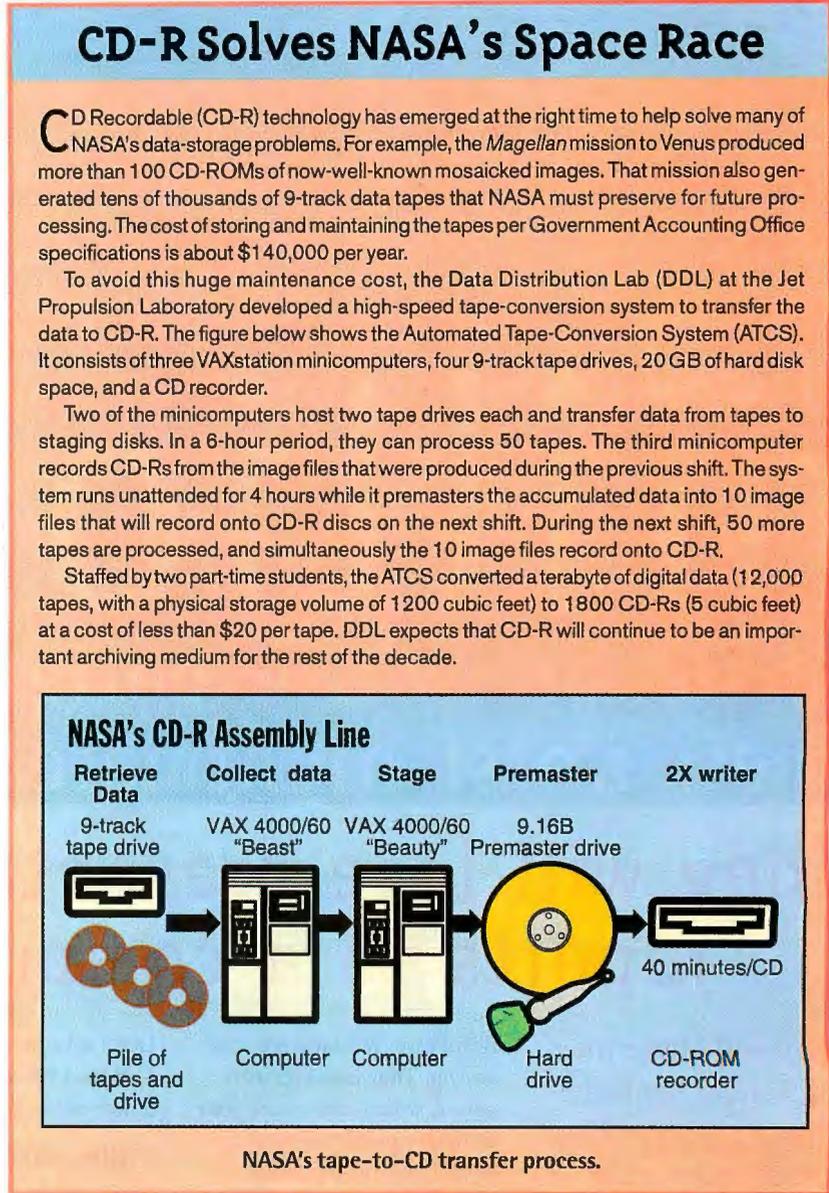
If your choice is to dedicate a machine to the task, that machine will need at least a 25-MHz 486 CPU, 8 MB (or more) of RAM, and a dedicated (or limited-use) SCSI connection. It should have at least two hard drives. One drive will need to be at least 1 GB, and the other at least 650 MB. The first drive (collection disk) will contain the system software, applications, and 650 MB of free space for collecting data files. The second drive will store the CD-R image file before recording the image file on the CD-R disc.

The first drive may not be necessary if other peripherals (e.g., ZIP drives, DAT drives, or network devices) will hold all the input files. Most premastering software will let you select files from any input device, but the premastering pro-

cess itself is then subject to many more uncertainties. Similarly, you can forgo the second drive if the premastering software can write to the CD recorder directly without producing an image file. Again, this architecture introduces many more pitfalls and requires high-performance hardware on the host.

if you will routinely need multiple copies of each volume, a 4X or 6X recorder will pay for itself in a short time. In short, it is usually worth it to get a fast system to premaster your discs.

Dozens of recorders are on the market. At the low end, 1X or 2X consumer recorders from Pinnacle Micro and



Be aware that the host computer's performance may limit your selection of a recorder. A slower machine may support a 1X or 2X recorder, but nothing faster.

The volume of discs to produce is also an issue. If producing individual discs is the norm, the recording rate is not an issue, because the setup and premastering overhead will consume most of the time for producing each disc. However,

Hewlett-Packard sell for street prices of less than \$1000. In the middle are Sony and Philips, with 2X recorders at around \$2000. At the high end are Yamaha, Pioneer, and Eastman Kodak, with 4X and 6X recorders starting at \$4000. For automated recording, Eastman Kodak sells a Disc Transporter that automatically loads up to 75 discs. Pioneer and NSM jukeboxes support internal recorders, but at

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a substantial cost (\$20,000 to \$40,000).

Premastering programs are available from a number of vendors. Meridian Data, Corel, Incat Systems, and Pinnacle Micro provide software for PCs. JVC Information Products and Optical Media International provide software for Macs and PCs. Young Minds, Creative Digital Research, Smart Storage, and Soliton Computing provide software for Unix workstations and PCs. Elektrotron's GEAR is available on many platforms and claims to support all recorders and formats. Most recorders sold today bundle ade-

quate premastering software, or you can buy the software separately for several hundred dollars. *CD-ROM Professional* magazine is a good resource for determining the capabilities of packages.

### New Discs, Old Readers?

The next logical extension to CD-R is CD Erasable (CD-E). It will use a phase-change technology for overwriting. Whereas CD-R mainly targets file exchange and archiving, CD-E will compete head-on with hard disk and magneto-optical (MO) systems. Furthermore,

CD-E drives will support existing CD-ROMs, read and write CD-Rs, and write, read, and rewrite CD-Es.

Industry negotiations over the new digital videodisc (DVD) format have generated a great deal of publicity. The agreed-on standard format will provide both video distribution and digital storage. The video format will use the MPEG-2 video-encoding scheme with digital surround sound. The disc will have the same physical characteristics as CD-ROM and CD-R, with a diameter of 120 mm, Constant Linear Velocity (CLV) sector layout, and Reed-Solomon error correction. Higher laser power will allow a shorter

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## CD-R's Multiple Personalities

There are many schemes for extending CD Recordable (CD-R). Sony CDRFS treats CD-R like a floppy disk for formatting and operations; thus, it allows fast access, addition and update, multi-tasking, and fixed-packet recording. The packet size is smaller than the buffer capacity of the CD-R drive, so there is no chance of a buffer underrun error that produces a ruined disc.

Incat Systems' FlexCD supports variable-packet recording, compatibility with ISO-9660, and efficient access and recording. HP/Philips supports Universal Data Format (UDF), a subset of ISO-13346: a volume and file structure of write-once and rewritable media using nonsequential recording for information interchange. Kodak Photo CD supports only multisession and basically requires writing multiple ISO-9660 structures, where the last-written structure contains the updated file system for all sessions on the disc.

The industry is working through the Optical Storage Technology Association (OSTA) to come up with a single standard from the competing specifications. The goal is a single standard that supports features of information interchange from ISO-13490 and easy migration to CD Erasable (CD-E) by the end of the year. That standard will provide increased performance through packet recording and an indexed directory tree, and reducing buffer underrun. Users may wish to avoid vendor-specific implementations of multi-session and packet-recording solutions, or face nonsupported disc formats in coming years.

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pit length and track pitch (0.74 micron). Four configurations will provide from 4.7 to 17 GB capacity, using multiple layers and double-sided discs.

These new discs will require new readers. However, the new readers will be backward-compatible with CD-ROMs. There is still some question about compatibility with CD-R media. Plans also include a Super Density Recordable (SD-R) disc that will store 3.8 GB single-

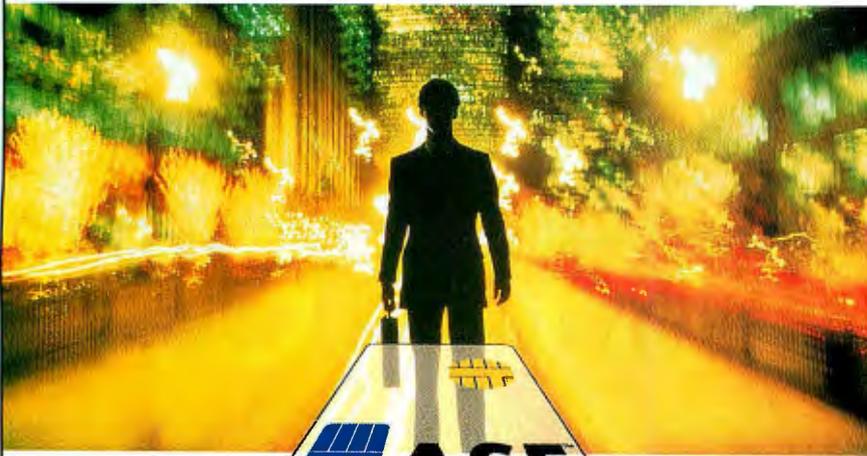
sided and 7.6 GB on a double-sided disc.

While these new technologies promise enormous savings in storage cost and a new generation of high-quality multimedia products, they are still a few years away from the consumer market. Meanwhile, market projections show the cost of CD-R recorders dropping to \$300, and the cost of CD-R media to \$2 per disc, by 1998. This will allow the technology to compete with magnetic tape systems as

a primary backup device. The boom in CD-ROM reader sales and increased competition in the CD-R recorder industry are bringing prices to a level where a small organization or even an individual can take advantage of the benefits of, yes, recording CD-ROMs. **B**

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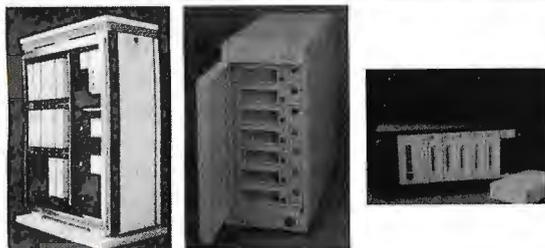
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Choose from among the dozen ink-jets we tested for affordable, high-quality output.

By Jim Kane and Dorothy Hudson

## 12 Ink-Jet Printers for Quality Color

**I**nk-jet technology has come a long way since its prehistoric era of ho-hum, low-cost black-text printing. A new crop of color ink-jet printers has sprung up that are still affordable enough that everyone can produce high-quality documents. We tested 12 color ink-jet printers from the market leaders—Apple, Canon, Epson, Hewlett-Packard, Lexmark, and Okidata—that can color your world without breaking your bank.

For this roundup, we compare ink-jets that are a microcosm of the small office/home office (SOHO) market and break down our analysis to three categories—best overall, high quality, and low cost—to help find the printer that's best for your needs. We have lower-cost ink-jets that range in price from \$300 to \$400 and higher-priced ones from \$600 on up that provide vivid color output.

A whole new animal in the ink-jet market is our best-overall winner, the Hewlett-Packard DeskJet 1600CM (\$2479 as tested). It has laser-like performance, and you can network this big ink-jet to give workgroups access to color printing. The Epson Stylus Pro (\$799) wins in our print-output quality tests because of its high-definition 720-by-720-dots per inch (dpi) output. And the Canon BJC-4100 and Lexmark Color JetPrinter 2070 tie in the low-cost category.

To evaluate these printers, we ran performance tests that measure how each model prints different kinds of documents—some filled with basic ASCII text and others with complex bit-mapped images. We realize that performance isn't as high a priority when printing graph-

ics-filled pages and color documents, so we included output quality as part of our tests. We also considered how easy it is to set up and use the printers and checked that they all have the features you'll need.

### Stiff Competition

The first ink-jets on the market were monochrome-only printers designed to be affordable but low-end devices for home use only. Since then, faster print speeds and near-typeset-quality output have made ink-jets more competitive with laser printers as office machines.

**BYTE BEST**  
INK - JET PRINTERS

**Hewlett-Packard's  
DeskJet 1600CM**  
offers laser-like performance and  
quality color output that's hard to beat.

The one edge that ink-jets have over lasers is they make color printing affordable. The first color ink-jets, however, were a hassle to use because you had to swap the black cartridge with a color cartridge to print color documents. Most of today's color ink-jets have dual-cartridge configurations, and they can automatically switch to black ink or color cartridges to fit the requested print job. One caveat: The single multicolor cartridges can run out of ink fast, and they cost about \$35 a pop to replace. On average, it costs between 3 and 5 cents per page to print monochrome text, and color pages

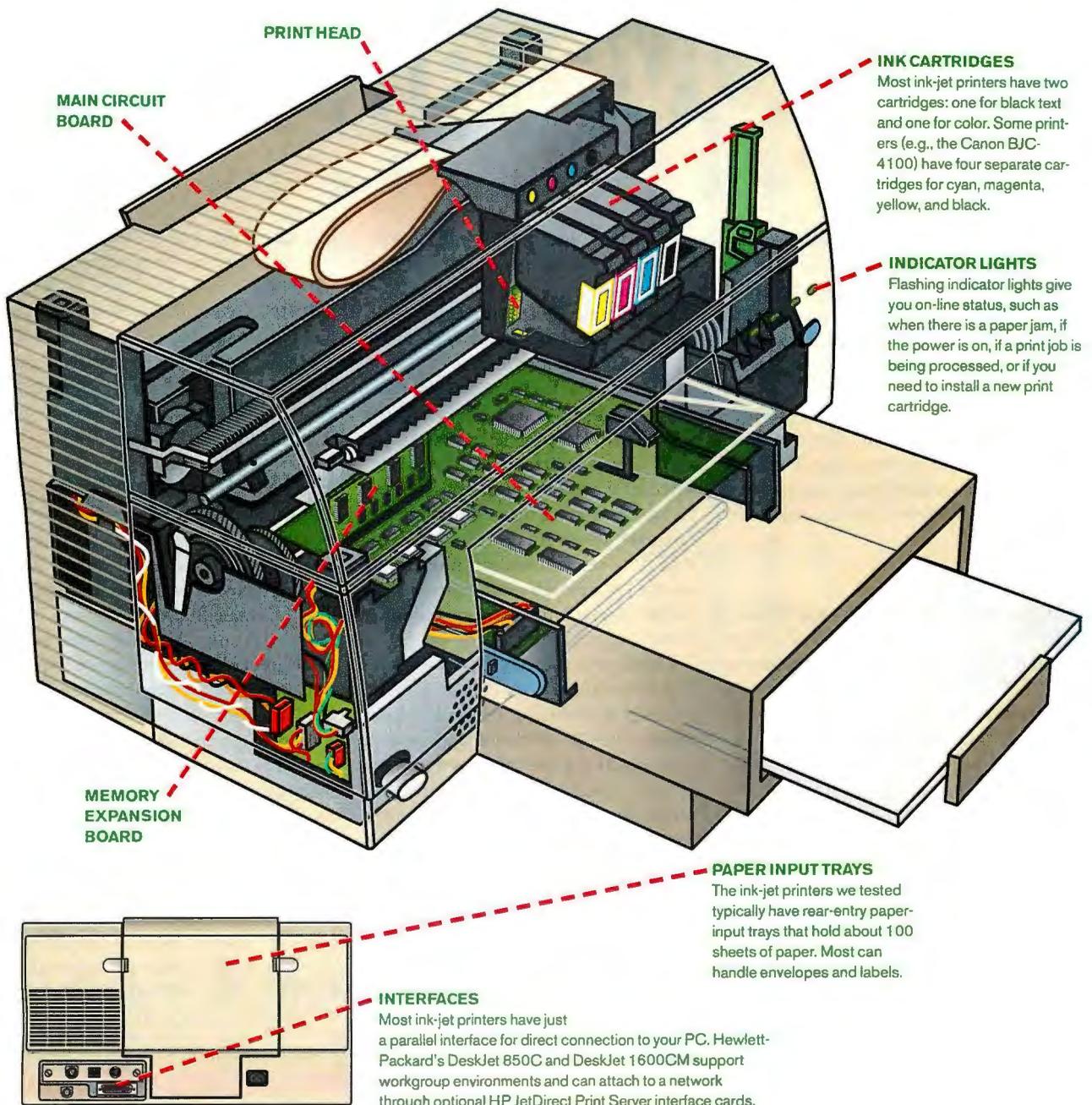
can cost between 10 and 40 cents a page.

Even though affordable color-printing capability is the strong suit of ink-jets, speed has always been their Achilles' heel. Lasers are faster, and the ink-jet printers we tested have vendor-specified print speeds of 3 to 10 pages per minute in black-text mode. We discovered that the PC-based printers have an average combined print speed of 1.9 ppm at their standard-resolution setting when processing the ASCII text, bit-mapped images, and various fonts in our test pages. At 4.9 ppm, the HP DeskJet 1600CM is in a class by itself. Color printing, however, generally takes much longer, depending on how many colors are being applied to the print job.

### High on Quality

Not everyone is concerned with print speed. If you spend hours in a desktop-publishing application, you want to make sure your output is right on the mark. We find that the printers with the highest print resolutions are best for black-only text. The maximum monochrome resolutions range from 600 by 300 dpi to 720 by 720 dpi (see the features chart on page 122). In reality, it is hard to tell the difference between resolutions when looking at text on a piece of paper. You should save high-resolution settings for when you're producing newsletters and other documents that have graphics or art.

Printers with the best color quality, like Epson's Stylus Pro, HP's DeskJet 1600CM, Lexmark's Color JetPrinter 2070 (\$399), and Apple's StyleWriter 2500 (\$379), come closest to producing the realism of a photograph. Color quality



**INK CARTRIDGES**  
Most ink-jet printers have two cartridges: one for black text and one for color. Some printers (e.g., the Canon BJC-4100) have four separate cartridges for cyan, magenta, yellow, and black.

**INDICATOR LIGHTS**  
Flashing indicator lights give you on-line status, such as when there is a paper jam, if the power is on, if a print job is being processed, or if you need to install a new print cartridge.

**PAPER INPUT TRAYS**  
The ink-jet printers we tested typically have rear-entry paper-input trays that hold about 100 sheets of paper. Most can handle envelopes and labels.

**INTERFACES**  
Most ink-jet printers have just a parallel interface for direct connection to your PC. Hewlett-Packard's DeskJet 850C and DeskJet 1600CM support workgroup environments and can attach to a network through optional HP JetDirect Print Server interface cards.

ILLUSTRATION: SANDERS/TIKKANEN DESIGN & ILLUSTRATION © 1996

doesn't rely on high resolutions as much as it does on the printer drivers and the color management programs provided with the printers.

We tested the printers on vendor-supplied glossy paper; the quality is much better than on plain paper but not up to grade with that of more expensive dye-sublimation printers. The output results of our subjective color-quality test range from tight colors to washed-out colors with banding. If you want deeply saturated colors, we recommend that you buy only those printers that have scored highest in our quality ratings.

## Two Printers to Go

Canon's BJC-70 (\$399) and Apple's StyleWriter 2200 (\$419) are portable units. They weigh only about 3 pounds each, but their portability doesn't hinder their performance and quality when compared to some of the bigger desktop units. The BJC-70 offers 720- by 360-dpi high-resolution printing. Its performance is adequate with its vendor-specified 3-ppm print engine when outputting black text in draft mode. You can even print T-shirt transfers on this tiny printer. Apple's Mac-based StyleWriter 2200 has a faster

print engine (5 ppm) than that of the BJC-70, and it actually does better than Apple's StyleWriter 2500 (\$379) desktop printer in our black-text performance benchmarks. The performance of the StyleWriter 2200, however, flip-flops with that of the StyleWriter 2500 when it comes to high-resolution printing.

### Contributors

- Jim Kane, Project Manager/NSTL
- Dorothy Hudson, Project Manager/NSTL
- John McDonough, Technical Writer/NSTL
- Maggi Bender, Technical Analyst/NSTL
- Susan Colwell, Technical Editor/BYTE

# Best Overall

## INK - J E T P R I N T E R S

**P**icking the right color ink-jet printer depends on the person who's picking the printer. If you want quick speeds and feeds, then the Hewlett-Packard printers with faster engines and big memory buffers are your ticket. If you require exquisite image quality, then the 720-dpi printers and the ink-jets with lush color output are the way to go. There are also some excellent lower-cost printers for thrifty SOHO users and several printers for Apple users.

### Best Overall

We awarded the best-overall printer laurels to Hewlett-Packard's DeskJet 1600CM (\$2479) because it is by far the fastest ink-jet at pushing paper into the output tray (see the lab results on page 117). HP's DeskJet 850C is second best in performance. At \$618, the DeskJet 850C is much easier on the wallet than the network-ready DeskJet 1600CM; it is more of a traditional ink-jet than its big brother because it has just a parallel port for direct connection to a desktop system. The 850C has 1 MB of buffer memory. Black-text print speed is 6 ppm, and color print speed is 1 ppm at its highest (600-dpi) resolution, according to vendor specifications. HP provides an excellent

user's manual with the 850C, and its software-based control panel makes printer management easy. The two HP ink-jets also performed better than the others when hooked up to Apple's Quadra 640 AV for our Macintosh tests.

The Epson Stylus Pro (\$799) is number one in our black-text and color-quality tests. It provides excellent overall value and has good performance (1.8 ppm) when set at its lowest print density of 180 by 180 dpi. You see the performance hit, however, when going from the Stylus Pro's low-resolution draft mode to its intense 720-dpi high-resolution mode. At the higher resolution, you get output at only 0.3 ppm.

The Canon BJC-610 (\$599) also deserves mention. This 720- by 720-dpi printer puts out sharp, high-quality documents. The BJC-610 has decent performance, and our test team preferred the control panel located on the printer rather than the software-based control panel that most of the ink-jet devices use.

### High Quality

Epson's Stylus Pro is our top pick for producing high-quality brochures and professional-looking reports. It also has the highest usability rating of all the printers due to its easy-to-understand status

indicators, its easy-to-install ink cartridges, and its above-average user's manual. Not far behind is Canon's BJC-610 and HP's two high-performance ink-jets—the 1600CM and DeskJet 850C. They both offer excellent speed and quality output. Apple's StyleWriter 2500 (\$379) had the fifth-best rating in our subjective color test.

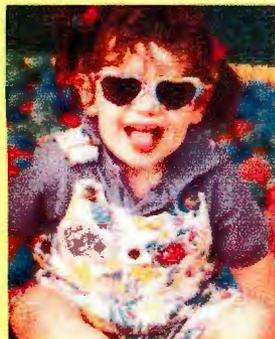
### Low Cost

One of the best features about ink-jets is that they are inexpensive. Of the 12 printers we tested, five cost less than \$400, making them affordable for most people. The Lexmark Color JetPrinter 2070 (\$399) has one of the best scores in our subjective color tests, where we compare documents that contain complex graphics. The Canon BJC-4100 and the portable BJC-70 scrape the \$400 limbo pole at \$399 each. The Canon printers have excellent software utilities, and among the low-cost models we tested, they are the easiest ones to set up and use.

At about \$282, Lexmark's Color JetPrinter 1020 is the lowest-priced unit we tested. Its specifications are typical of low-cost ink-jets: 600- by 300-dpi edge sharpness and 3-ppm print speed for black text. The Lexmark is a good mate for a student's home system.

#### BEST OVERALL

Hewlett-Packard's  
DeskJet 1600CM



#### HIGH QUALITY

Epson Stylus Pro



#### LOW COST

Lexmark Color  
JetPrinter 2070



Canon BJC-4100



These output samples are part of a series of complex graphics that we use to subjectively judge color quality.

# LAB RESULTS

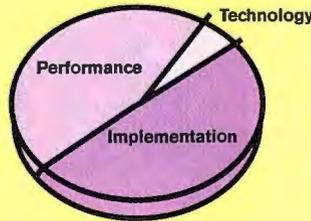
I N K - J E T P R I N T E R R A T I N G S

## BEST OVERALL

### Hewlett-Packard DeskJet 1600CM

A network-ready printer primed for small workgroups, the HP DeskJet is blazingly fast in our performance benchmarks. It offers 6 MB of memory (with support for up to 70 MB of RAM), has a vendor-specified 9-ppm print engine, and support for DOS, Windows, and Mac environments. To justify its \$2479 price tag, it's best wired to an Ethernet or LocalTalk network with HP's JetDirect Print Server card.

### WEIGHTING



	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	QUALITY	USABILITY	FEATURES	OVERALL VALUE
HP DeskJet 1600CM	\$2479	★★★★★	★★★★	★★★★★	★★★	★★★★	★★★★	★★★★
Epson Stylus Pro	\$799	★★★★	★★★★	★★★	★★★★★	★★★★	★★★★	★★★★
HP DeskJet 850C	\$618	★★★	★★★★	★★★	★★★★	★★★★	★★★★	★★★
Canon BJC-610	\$599	★★★	★★★★	★★★	★★★★	★★★★	★★★★	★★★

## HIGH QUALITY

### Epson Stylus Pro

At 720-by-720-dpi, the Epson Stylus Pro (\$799) scores highest in our subjective color-quality tests with its near-photographic images. With quality this good, it's easy to ignore its sloth-like high-resolution printing performance. In 180-dpi black-text draft mode, however, its performance is decent. It also has the best usability rating due to its easy-to-install ink cartridges and user-friendly manual and control panel.

### WEIGHTING



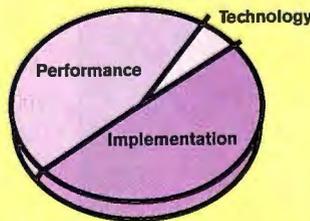
	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	QUALITY	USABILITY	FEATURES	OVERALL VALUE
Epson Stylus Pro	\$799	★★★★	★★★★	★★★	★★★★★	★★★★	★★★★	★★★★
HP DeskJet 1600CM	\$2479	★★★★★	★★★★	★★★★★	★★★	★★★★	★★★★	★★★★
HP DeskJet 850C	\$618	★★★	★★★★	★★★	★★★★	★★★★	★★★★	★★★
Canon BJC-610	\$599	★★★	★★★★	★★★	★★★★	★★★★	★★★★	★★★
Lexmark Color JetPrinter 2070	\$399	★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★

## LOW COST

### Lexmark Color JetPrinter 2070 and Canon BJC-4100

At \$399 each, the Lexmark Color JetPrinter 2070 and the Canon BJC-4100 take two different routes to affordable excellence. In draft mode, the JetPrinter scored an impressive 3-ppm performance in our tests. The 720-by-360-dpi Canon BJC-4100 is a four-cartridge printer that excels in usability and features.

### WEIGHTING



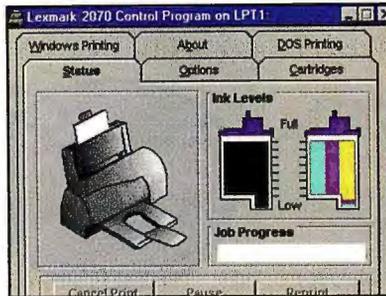
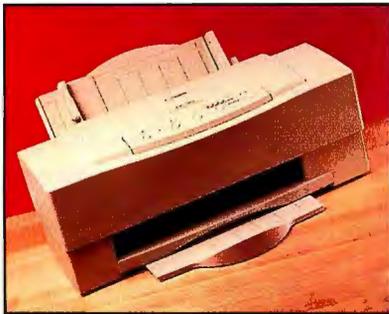
	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	QUALITY	USABILITY	FEATURES	OVERALL VALUE
Lexmark Color JetPrinter 2070	\$399	★★★	★★★★	★★★★	★★★★	★★★	★★★★	★★★
Canon BJC-4100	\$399	★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★
Canon BJC-70	\$399	★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★
Lexmark Color JetPrinter 1020	\$282	★★★	★★★★	★★	★★★	★★★	★★★★	★★★
Lexmark WinWriter 150C	\$349	★★★	★★★	★★★	★★★	★★★	★★★★	★★★

★★★★★ Outstanding    ★★★★ Very Good    ★★★ Good    ★★ Fair    ★ Poor

# Details

## Talk to Me

If you can deal with your car telling you your "door is ajar," then you'll love Canon's talking BJC-610. The printer uses Microsoft's Windows Printing System to let you know via 11 different WAV audio files that you should "add paper to printer" or "replace ink cartridge." The utility also worked with the Lexmark and Okidata printers we tested.



## On-Line Printer Status

The software printer management utilities for Lexmark's Color JetPrinter 1020 and 2070, as well as Okidata's OkiJet 2010, pops up and lets you know exactly what's happening when a print job is in progress. The window displays how much ink is in each cartridge, lets you know what page is printing (i.e., two of five), and how long it will take to print. You can also cancel, pause, or reprint the file from within the status window.

## A Whole Lotta Shakin'

You'd better have a sturdy table to support HP's DeskJet 1600CM. During testing, it shook the banquet-size table it was on so much that our testers had to move to a different table to jot down notes. At 25 pounds, the DeskJet 1600CM weighs twice as much as most of the printers, and the force with which its print heads whip back and forth may have something to do with its outstanding performance numbers.



## HP's CopyJet Does It All

Hewlett-Packard ((408) 246-4300; (800) 752-0900) had an idea: Why not combine its wealth of experience in color ink-jet printing and digital scanning into one product. HP's brainchild is the CopyJet (\$2949), a two-in-one ink-jet printer and legal-size color copier for small workgroups. We find that the CopyJet handles both jobs well enough so that you won't have to shell out the bucks for an expensive color copier and a color ink-jet.

A 66-pound giant compared to the smaller desktop models, the CopyJet falls in between HP's DeskJet 1600CM and the DeskJet 850C (second overall) in our performance benchmarks. As for copying speed, the CopyJet pumps out 4 copies per minute (cpm) in black-

text mode and 1 cpm in color mode, according to HP. You can buy a network-ready version (the HP CopyJet M) with a JetDirect card so that workgroups can share the device. The printer has a 180-sheet, front-loading paper-input tray.

The CopyJet uses the same print engine for both printing and copying. As a printer, the CopyJet receives text, graphics, and images as digital objects to be placed on paper. As a copier, the device uses its 8½-by-14-inch flatbed scanner to digitize the original into a single raster image. You just raise the cover and insert a document on the scanner bed to make a copy. The machine has several print options on the front panel: photograph, black only, high quality, and emphasize light color. There are also color controls, and document scaling ranges from 50 percent up to 400 percent.

HP's two-headed device makes 300-by-300-dpi copies and prints 600-by-300-dpi text documents. Fifth-best among the ink-jets in our print-quality tests, the CopyJet does a good job of copying color documents. We inserted several CD art covers on the scanner, and the reproduction on plain paper was almost flawless, if not a little too dark. An internal heater dries the ink while printing to help prevent smudges.

Color copying and printing isn't cheap with the CopyJet. It has four print cartridges (cyan, yellow, magenta, and black) that cost a bundle to replace: \$135 in retail outlets. You may want to consider using color sparingly in your documents. It costs only 7 cents a page for a document with 15 percent color, while it costs 42 cents a page with 100 percent color, according to HP.

Circle 1092 on Inquiry Card.



A two-in-one printer, the Hewlett-Packard CopyJet lets you print and copy documents.



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# Test Specs

**O**ur test suite lets us evaluate a printer's performance, quality of printed output, usability, and features. We tested and scored each element separately and then computed an overall score by assigning a weight to each element (see page 117).

We ran the PC-based tests on a Compaq Deskpro 66M running MS-DOS 6.22 and Windows 95. Printers with Mac ports were tested with a Quadra 640 AV, running System 7.5. We used the print drivers the vendors supplied, and we disabled print servers, spoolers, and buffers during performance testing.

Our performance tests measure the speed at which a printer can produce six different elements: dense text, sparse text, bit-mapped images,

monochrome graphics, color graphics, and a minimum of two fonts. We tested each model in two different output modes: the next-to-lowest and the highest PCL resolutions (except for the Mac platform) that each printer supports.

We judged printers for the quality of their monochrome output and also tested how well they could print two color pages. The first color page is judged using objective criteria, such as the output's range of hues and the absence of smearing on fine lines. A group of technicians subjectively judges the second color page, which contains a series of complex graphics.

Usability scores are based on such aspects as the ease of installing the ink media, the intuitiveness of the control panel, the ease of driver installation,

and the clarity and usefulness of the provided manuals. For features, we weight and score the important characteristics that we believe a color ink-jet printer should have.

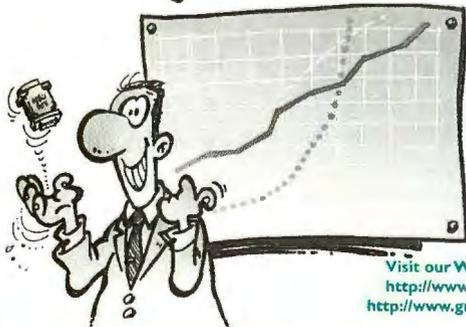
These Quality, Usability, Features, and Value scores form the basis for the Implementation score. A separate Technology rating scores each printer according to the newness and importance of its technology. We then combine the Technology, Implementation, and Performance ratings to come up with an Overall rating.



Two of the samples used in our quality tests.

*Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of NSTL's monthly PC Digest. To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of The McGraw-Hill Companies.*

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Circle 80 on Inquiry Card (RESELLERS: 81).

# INK-JET PRINTERS

# FEATURES

	Apple Computer Color StyleWriter 2200	Apple Computer Color StyleWriter 2500	Canon Computer Systems BJC-70	Canon Computer Systems BJC-610	Canon Computer Systems BJC-4100 <small>BYTE BEST</small>
Price as tested	\$419	\$379	\$399	\$599	\$399
Overall value	★★★	★★★	★★★	★★★	★★★
Pages per minute (standard/max. resolution)	2.3/0.6	2.0/1.3	1.1/0.4	0.9/0.4	1.1/0.8
Installed memory	512 KB	512 KB	35 KB	60 KB	64 KB
Memory as tested	512 KB	512 KB	35 KB	60 KB	64 KB
Standard memory/maximum	512 KB	512 KB	35 KB/35 KB	60 KB/60 KB	64 KB/64 KB
<b>COLOR</b>					
Output in high-quality/draft mode (millions)	16.7/4	16.7/16.7	16.7/16.7	16.7/16.7	16.7/16.7
Resolution in high-quality mode	360 x 360	720 x 360	720 x 360	720 x 720	720 x 360
Resolution in draft mode	180 x 180	180 x 180	180 x 180	360 x 360	180 x 180
Maximum resolution (dpi)	720 x 360	720 x 360	720 x 360	720 x 720	720 x 360
PostScript standard		Optional			
<b>PRINTER SPEED</b>					
Engine manufacturer	Canon	Canon	Canon	Canon	Canon
Monochrome/color (rated ppm)	5/0.33	5/0.66	3/0.8	3/1.3	5/0.8
Monthly duty cycle (pages)	500	1000	Not available	Not available	Not available
Controller manufacturer	Canon/Apple	Toshiba	Canon	Canon	Canon
Processor clock speed (MHz)	20	20	16	16	20
<b>STANDARD INTERFACES</b>					
Centronics parallel			✓	✓	✓
RS-232C					
RS-422A	✓	✓			
Other					
Auto-switching					
<b>STANDARD DRIVERS</b>					
Windows 3.1			✓	✓	✓
Macintosh	✓	✓			
Windows 95			✓	✓	✓
Windows NT					
<b>PHYSICAL CHARACTERISTICS</b>					
Number of jets (color/black)	64/128	72/64	136/128	192/64	136/128
Number of print heads	2	1	2	1	2
Dimensions in inches (W x D x H)	11.6 x 6.2 x 2.2	14.4 x 9.2 x 8.3	11.8 x 2.2 x 6.2	16.1 x 7.2 x 10	14.4 x 7.8 x 8.8
Weight (lbs.)	3.1	6.9	3.1	9.9	7.1
Voltage	110	120	120	120	120
MTBF (hours)	250	250	Not available	Not available	N/A
Energy Star-compliant	✓	✓	✓	✓	✓
<b>SUPPORTED PAPER SIZES</b>					
Letter (8.5 x 11 in.)	✓	✓	✓	✓	✓
Legal (8.5 x 14 in.)	✓	✓	✓	✓	✓
A4 (8.26 x 11.69 in.)	✓	✓	✓	✓	✓
B5 (7.17 x 10.12 in.)					
Tabloid (11 x 17 in.)					
Executive (7.25 x 10.5 in.)	✓	✓	✓	✓	✓
Envelope	✓	✓	✓	✓	✓
OHP film	✓	✓	✓	✓	✓
Adhesive-backed labels	✓	✓	✓	✓	✓
<b>TRAYS</b>					
Input/output tray capacity (sheets)	30/30	100/100	30/30	100/100	100/100
Maximum number of input trays	1	1	1	1	1
Standard feed mechanisms	Automatic	Automatic	Automatic	Friction	Friction
<b>FONTS</b>					
Number of resident fonts	64	64	7	7	7
Downloadable font support		✓	✓	✓	✓
<b>EMULATIONS</b>					
Auto-sensing					
PostScript Level I/Level II					
HP PCL4/PCL5/PCL5C					
HPGL					
Epson LQ/FX			✓	✓	✓
IBM Proprinter			✓	✓	✓
Other					
Warranty (years)/coverage	1/P, L, F, R	1/P, L, F, R	2/P, L, F, R	2/P, L, F, R	2/P, L, F, R
Phone	(408) 996-1010	(408) 996-1010	(714) 438-3000	(714) 438-3000	(714) 438-3000
Toll-free phone	(800) 538-9696	(800) 538-9696	(800) 848-4123	(800) 848-4123	(800) 848-4123
On-line address	http://www.apple.com	http://www.apple.com	http://www.usa.canon.com	http://www.usa.canon.com	http://www.usa.canon.com
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**BYTE BEST** = BYTE Best

✓ = yes

**Warranty:** P = parts; L = labor; F = freight to repair center; R = return to customer.  
 ★★★★★ Outstanding    ★★★★★ Very Good    ★★★ Good    ★★ Fair    ★ Poor

Epson America Stylus Pro	BYTE BEST	Hewlett-Packard DeskJet 850C	Hewlett-Packard DeskJet 1600CM	BYTE BEST	Lexmark International Color JetPrinter 1020	Lexmark International Color JetPrinter 2070	BYTE BEST	Lexmark International WinWriter 150C	Okidata OkJet 2010		
\$799	★★★★	\$618	\$2479	★★★★	\$281.95	\$399	★★★	\$349	★★★	\$499	★★★
1.8/0.3		2.6/1.9	4.9/4.6		0.6/0.2	3.0/0.4		1.2/0.3		1.2/0.3	
64 KB		1 MB	6 MB		29 KB	29 KB		29 KB		29 KB	None
64 KB		1 MB	6 MB		29 KB	29 KB		29 KB		29 KB	None
64 KB/64 KB		1 MB/1 MB	6 MB/70 MB		29 KB/29 KB	29 KB/29 KB		29 KB/29 KB		29 KB/29 KB	None
16.7/16.7		16.7/16.7	16.7/16.7		16.7/16.7	16.7/16.7		16.7/16.7		16.7/16.7	
720×720		600×600	300×300-color/ 600×600-black		600×300	600×600		600×300		600×300	
180×180		300×300	300×300		300×150	300×150		300×150		300×150	
720×720		600×600	600×600		600×300	600×600		600×300		600×300	
Optional			✓								
Epson 3/1		Proprietary 6/2	Hewlett-Packard 9/4		Lexmark 3/25 to .5	Lexmark 7/1 to 2		Hewlett-Packard 3/25 to .5		Lexmark 3/25 to .5	
Not available		160-C/1000-B	12,000		500	1500		1000		1000	
Epson 50 to 60		Proprietary 16	Intel i80960 20		Motorola 10	Motorola 10		Motorola 10		Motorola 10	
✓		✓			✓	✓		✓		✓	
✓			HP Bitronics parallel		High-speed bidirectional parallel	High-speed bidirectional parallel		High-speed bidirectional parallel		High-speed bidirectional parallel	
✓			✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
48/64		64/300	104/300		48/52	96/104		48/52		48/56	
2		2	4; 1 per cartridge		1	2		2		2	
19×20.9×7.2		17.5×15.6×8.9	20×17×11		14.2×8.2×7.8	17.2×10.6×11.7		17.2×10.6×11.7		17.2×10.6×11.3	
16.5		14.3	25		9	17		9.75		9.75	
120		100 to 240	110 to 240		90 to 137	90 to 259		90 to 259		90	
4000		20,000	20,000		10,000	25,000		25,000		25,000	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
✓		✓	✓		✓	✓		✓		✓	
100/30		150/50	180/100		100/25	150/75		150/75		150/150	
1		2	2		1	1		1		1	
Friction		Automatic	Manual and automatic		Automatic	Automatic		Automatic		Manual and automatic	
9		8 built-in/ 14 TrueType	35 with PostScript; 10 TrueType; 35 Intellifonts		All Windows fonts	All Windows fonts		All Windows fonts		All Windows fonts	5
✓			✓		✓ (CorelDraw 3)	✓ (CorelDraw 3)		✓ (CorelDraw 3)		✓ (CorelDraw 3)	
PS Level II			✓ PS Level II PCL5/PCL5C								
Epson ESC/P2 2/P, L, F, R		HP PCL3 1/P, L	1/P, L, R		2/P, L, F, R	2/P, L, F, R		2/P, L, F, R		2/P, L, F, R	GDI, PCL3 for DOS
(310) 782-0770		Contact HP dealer	Contact HP dealer		(606) 232-2000	(606) 232-2000		(606) 232-2000		(609) 235-2600	
(800) 289-3776		(800) 752-0900	(800) 752-0900		(800) 358-5835	(800) 358-5835		(800) 358-5835		(800) 654-3282	
http://www.epson.com		http://www.hp.com	http://www.hp.com		http://www.lexmark.com	http://www.lexmark.com		http://www.lexmark.com		http://www.okidata.com	
1085		1086	1087		1088	1089		1090		1091	

## New Leaders of the Client/Server Migration

**B**efore the client/server "revolution," most companies' data resided in old flat-file databases on legacy mainframes. Today, companies face the challenge of tracking and efficiently using the data as it migrates to network servers and users' local hard disks. Spreadsheet programs, desktop DBMSes, or specialized query tools can help, but they're not easily tied together into integrated applications.

The best answer lies in software that helps you build mechanisms for users to enter, sort, filter, and report on your organization's data. With such client/server development packages, you can create custom programs that incorporate your business policies, procedures, and data operations into stand-alone applications.

We tested four leading packages for Windows: Borland International's Delphi Client/Server Suite 2.0, Microsoft's Visual Basic 4.0 Enterprise Edition, Powersoft's PowerBuilder Enterprise 4.0, and Gupta's SQLWindows 5.0.

### How We Tested

NSTL tested the products for performance, versatility, and usability. We used each product to develop a standard database of books, authors, and customer orders for an order-entry system. Our test applications allow users to browse a database of 50,000 existing orders in various ways, and to enter new orders. Test users also run two reports: one detailing order status for customers within a user-specified range of zip code values, and the other covering all orders within a range of order numbers. This latter report can

be achieved using either a five-table join or a three-level nested report.

We tested nondatabase functions with a string-parsing test that's based on an actual data collection mechanism NSTL uses. This is a significant performance indicator because database access speed often depends largely on the back-end server, not on the application.

### BYTE BEST C/S DEVELOPMENT TOOLS

#### Borland's Delphi Client/Server Suite

is the fastest, most versatile, and easiest to use of the client/server development tools that NSTL evaluated. It offers superior performance across the board and provides many useful data access features.

### Delphi Client/Server Suite

We tested an advanced beta version of Borland's Delphi; the final code release for version 2.0 wasn't available at press time, but the product is now shipping. In BYTE's experience, the performance of prerelease versions is often inferior to that of final products, but in our tests Delphi was head and shoulders above all its competitors. And this wasn't in just one area; Delphi was superior across the board: in database and nondatabase operations, browsing entire database tables, executing queries, and searching for data.

Delphi's navigation control allows scrolling, adding, updating, deleting, or canceling changes to records with a sin-

*"Upstarts" Delphi 2.0 and Visual Basic 4.0 offer the fastest ways of building client/server applications for Windows users.*

*By Mark Hettler*

gle button click and no programming. A field editor allows quick placement of fields on forms and easy specification of calculated and lookup fields. Once a developer has specified a table or query object, he can select multiple fields and drag them onto the form. Delphi also includes Database Explorer, a powerful database administration tool.

The program offers a unique data control grid, which is essentially a grid of miniforms. Developers can place multiple fields, labels, and other objects in the upper left cell of the grid in any arrangement they desire, just as they would on a form. Each cell of the grid then displays a different record.

Delphi has unique facilities for synchronizing master/detail display—displaying a single record from one table and multiple related records from another. For example, our order-browsing form displays the matching entry records for the current order record. With most other products, you have to program a procedure that executes each time the user moves to a new master record, to query the detail section. With Delphi, however, you link fields in the master and detail tables. As the user scrolls through the master records, the form automatically maintains synchronization based on the specified link fields.

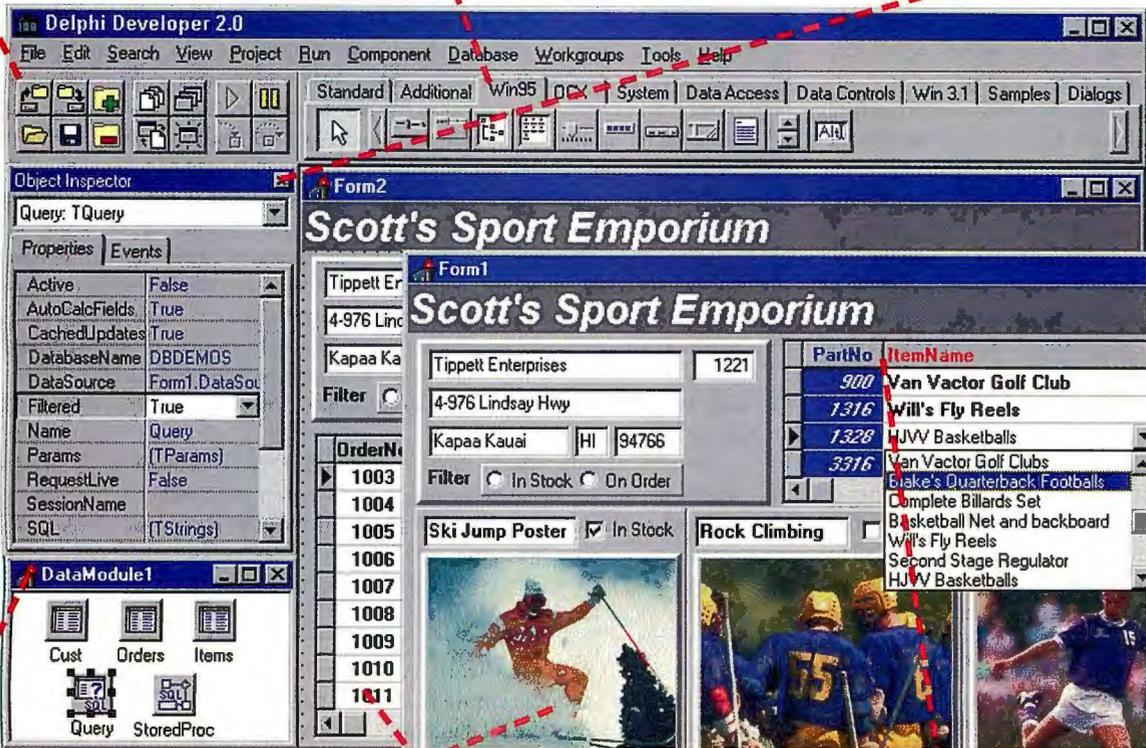
Delphi is the only product in this group that cannot execute an event procedure each time the user moves to a new record. However, it allows a program to search for a specific value in any indexed field.

Delphi comes with two separate report-writing facilities. QuickReports

**1. Frequent Filers** File-based operations are common, and this compact group of icons makes them readily accessible.

**2. Creating Objects.** This Windows 95-inspired 10-tabbed toolbar makes it easy to pick from the many types of operators and on-screen devices available, with a different toolbar just a click away.

**3. That's Not Quite What I Meant.** Once you've placed an object on a form or in a data module, the Object Inspector allows you to examine and set its properties and any associated events.



**4. Dat's My Data.** With Delphi, you can group all the components of an application into related modules. This example window shows three data tables, a query (which can include multiple forms), and a stored procedure.

**5. Good Form.** Delphi's form designer lets you place almost any type of data object, operator, or function. Form1 shows how graphics can be brought into a query screen.

**6. Easy Pickings.** Pull-down pick lists are just one of many interactive tools at the application designer's disposal that simplify the work of the eventual user.

uses Delphi forms and controls to tightly integrate reports with applications, but designing reports is confusing and cumbersome. ReportSmith has better facilities for designing reports, but applications must launch the ReportSmith run-time program in order to run the reports. The Delphi package includes a component repository that developers can store in a client/server database. All in all, an outstanding product.

## PowerBuilder Enterprise

Powersoft's PowerBuilder Enterprise 4.0 uses two main interfaces, the Window Painter for designing forms and the DataWindow Painter for defining visual

interfaces to databases. Windows can contain embedded DataWindows. PowerBuilder's interfaces are the most intuitive and user-friendly of this group, but it's inconvenient to move between the two painters and awkward to manipulate embedded DataWindows.

With PowerBuilder you can implement standard SQL cursors, where the program executes a SQL statement and can step forward (and backward, if the database engine permits) through the result set. With cursors, the developer must programmatically move data from cursor fields to form fields for users to be able to view the data.

DataWindow Painter provides a visu-

al query design interface, placing result fields in a window automatically. You can customize record layouts and display a multirecord view. This is the only product here that builds in "query by form," where the user puts a form into query mode and enters selection criteria directly. You can search on any DataWindow field.

With PowerBuilder you can produce sophisticated reports, including multi-level grouped reports, that users can launch directly. However, previewing, browsing, or printing selected pages requires a separate program, InfoMaker, that's also included but is particularly awkward to launch from 32-bit PowerBuilder applications. *continued*

## SQLWindows 5.0

With Gupta's SQLWindows, developers work in an interface called the Outliner, a program editor in which you can drill down to varying levels of detail. The Outliner lists, in outline form, the components and subcomponents making up an application. Code is related to specific components in the outline.

The package provides a variety of tools for developing forms, including QuickForms. However, NSTL was unable to use all these facilities in testing because of a 32,768-record limit; instead, we were forced to use standard SQL cursors.

Developers use ReportWindows to design reports, although the main SQLWindows application manages actual record retrieval. It incorporates the data into the report format via a complicated set of event procedures.

The TeamWindows module stores the pieces of an application in a repository on a database server. This repository stores reusable objects that might be needed for multiple applications, as well as serving as a version control system.

This is a short summary of a complex product that clearly finished last in these tests. However, Gupta has changes in the pipeline for the next version (see "New Releases Move the Target" at right), so successors to SQLWindows should not be counted out.

## Visual Basic 4.0

Historically, Microsoft's Visual Basic has suffered from weak database access facilities. But version 4.0 (Enterprise Edition)

## New Releases Move the Target

The two products that finished last in our comparison—PowerBuilder and SQLWindows—aren't standing still. Powerful new versions of both will likely be out when you read this.

Gupta considers its new release so important that it's giving both the company and the product the same new name: Centura. Actually, Centura will be a family of products. Centura Team Developer offers component-based application development, database access, and team development support. Centura Application Server is specifically designed for three-tier development and application partitioning. Centura Ranger manages data replication for easier deployment of decentralized applications, and Centura Web Data Publisher takes aim at the World Wide Web. Centura Team Developer is \$4995, with discounts for current SQLWindows customers. Centura Web Data Publisher and Centura Application Server are scheduled to ship in the second or third quarter.

PowerBuilder 5.0 offers what Powersoft calls "practical application partitioning." PowerBuilder 4.0 already has the ability to create nonvisual user objects—custom-designed components, such as windows with fields and scripts that you can copy between applications—that work in the background and return results to a visual component. Version 5.0 takes the next logical step, allowing you to move these nonvisual objects to a remote server. Powersoft claims there is virtually no learning curve for developers already familiar with nonvisual user objects.

Version 5.0 also has Object-Cycle, a server-based object management system that supports multiple versioning, plus a compiler for improved performance. Other enhancements include OLE 2.0 automation for both clients and servers, Windows 95 functionality, an improved script editor, and an object browser. While these enhancements are extensive, they bring PowerBuilder only up to functional parity with its competitors.

catapults it to the top tier of client/server products, introducing remote data control, which bypasses the Jet database engine to provide direct access to client/server databases. This remote data control is especially well integrated with Microsoft SQL Server, providing support for such server features as server-side cursors. Microsoft also provides clear instructions on how to implement remote automation, which allows for partitioned

applications (see the Technology Focus on page 130.)

Visual Basic's interface is similar to Delphi's. A new project begins with a blank form, on which you place controls selected from a palette. You set properties for the form or individual controls by entering options in a property grid. Double-click on a component icon when you want to write code.

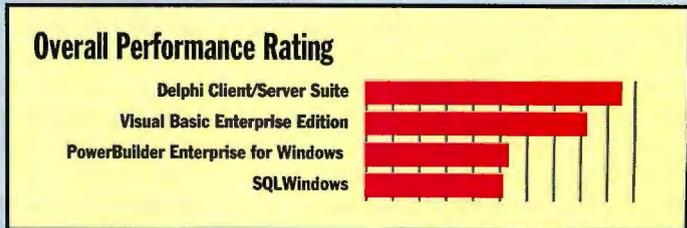
VB uses Open Database Connectivity

## CLIENT/SERVER DEVELOPMENT TOOLS RATINGS

### BEST OVERALL

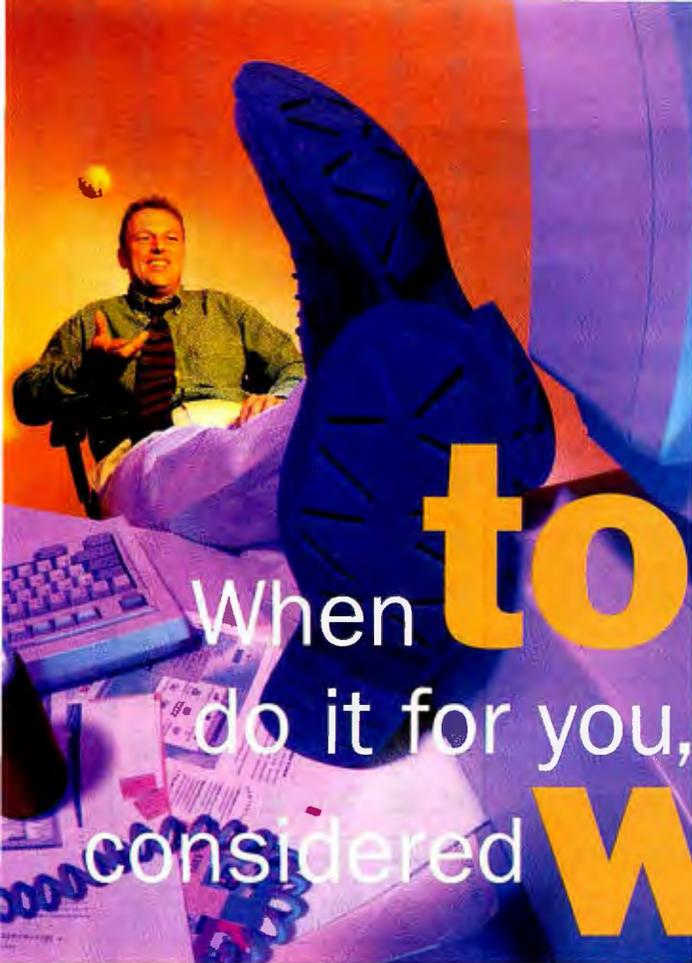
#### Borland Delphi Client/Server Suite 2.0

Outstanding performance that's head and shoulders above the competition, plus features on par with the best of the rest.

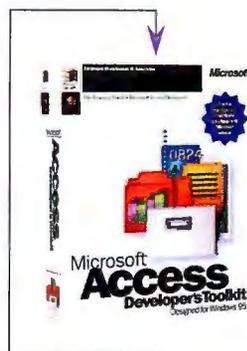


	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	OVERALL VALUE
Delphi Client/Server Suite 2.0	\$2000	★★★★★	★★★★★	★★★★★	★★★★	★★★★★
Visual Basic 4.0, Enterprise Edition	\$999	★★★★★	★★★★	★★★★	★★★★	★★★★
SQLWindows 5.0	\$3495	★★★	★★★★★	★★	★★★★	★★
PowerBuilder Enterprise for Windows 4.0	\$3295	★★★	★★★	★★	★★★★	★★

★★★★★ Outstanding   ★★★★ Very Good   ★★★ Good   ★★ Fair   ★ Poor



# When **tools** do it for you, is it still considered **work**?



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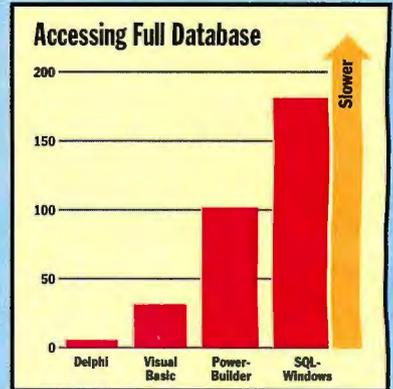
# FEATURES

	DELPHI	VISUAL BASIC	POWERBUILDER	SQLWINDOWS
<b>APPLICATION FEATURES</b>				
<b>Form design</b>				
Visual query builder	✓		✓	✓
Query by form			✓	
Quick form from database table	✓	✓	✓	✓
Move fields after generating	✓	✓	✓	✓
Quick master/detail form	✓		✓	✓
Multiple record display	✓	✓	✓	✓
<b>Application control</b>				
Dynamic menu building	✓			✓
Multitab dialogs	✓		1	✓
Form can call another form	✓	✓	✓	✓
<b>Event handling</b>				
Procedures triggered by events	✓	✓	✓	✓
Detect keystroke/mouse click/time event	✓	✓	✓	✓
Process based on old or new value	✓	✓	✓	2
Cancel any event			✓	✓
<b>Advanced functionality</b>				
Incorporate VBX & OCX controls	✓	✓	✓	✓
OLE 2.0 edit-in-place		✓	✓	✓
Store OLE objects in database	✓	✓	✓	✓
<b>SQL language support</b>				
Generic SQL	✓	✓	3	✓
Engine-specific native SQL	✓	✓	✓	✓
Transparent joins across engines	✓	4		
<b>Report generation</b>				
Specify selection criteria, sort order at run time	✓	✓	✓	✓
Event procedures	✓		✓	✓
Multiple records across page	✓	✓	✓	✓
<b>APPLICATION MANAGEMENT</b>				
<b>Application repository</b>				
Store application components, reusable objects	✓	5		✓
Store multiple versions	✓	5		✓
Store form/report templates	✓			✓
<b>Workgroup features</b>				
Check-out/check-in	✓	✓	✓	✓
Built-in version control	✓	✓		✓
Version control for external files	✓			✓
<b>Remote automation</b>				
Produce remote programs	✓	✓	1	
Call, exchange data with remote programs	✓	✓	1	✓
Remote procedures can access database	✓	✓	1	
Call in-process OLE server	✓	✓	1	✓
Call out-of-process OLE server	✓	✓	✓	✓
Produce OLE servers	✓	✓	1	
<b>Object management</b>				
Copy objects between applications	✓	✓	✓	✓
Copy code snippets between applications	✓		✓	✓
Reusable object classes	✓	✓	✓	✓
Subclasses with inheritance	✓		✓	✓
Multiple inheritance				✓

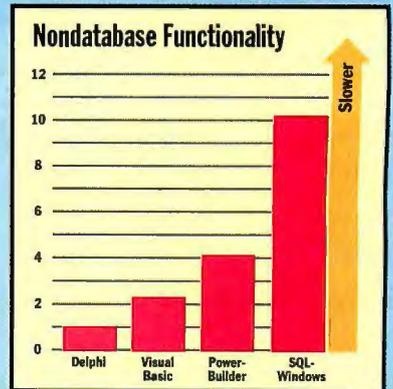
1 Available in next version  
 2 By retrieving status codes from database  
 3 Extensions to native commands for processing query results, e.g., INTO and FETCH  
 4 Using Jet engine only  
 5 Visual SourceSafe provides equivalent functionality but not in client/server database.  
 ✓=yes

# PERFORMANCE

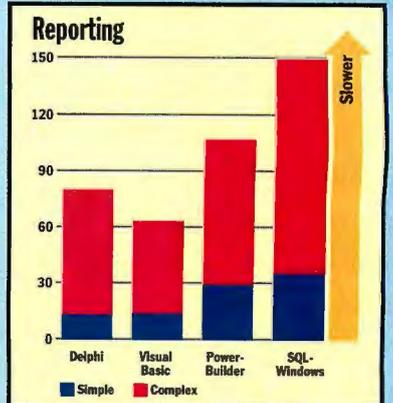
We ran all test client applications on a Dell Dimension XPC P90 with 24 MB of RAM and a 1-GB hard disk, running Windows NT Workstation 3.51. The test database resided on a Digital DECpc LPx 560 with 32 MB of RAM and a 1-GB hard disk, running Windows NT Server 3.51 and Microsoft SQL Server 6.0. All times are shown in seconds.



A string-parsing program that doesn't access the server isolates front-end application performance. Delphi's compiled application easily beats the interpreted programs.



Delphi is in a class by itself in terms of the time needed to load the order browser, display the first record, then move to the end of the database.



Two reports, one simple and one complex, point up significant speed differences between the four development tools.

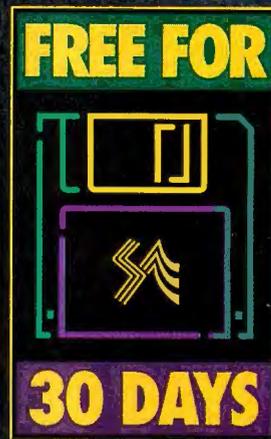
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 SQL/Windows PowerBuilder PROGRESS

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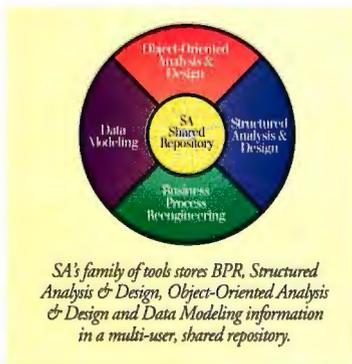
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## PRODUCT INFO

<b>Delphi Client/Server Suite 2.0</b> \$2000 (Windows 95 or NT 3.51; 486/25 or faster; 8 MB RAM, 50 MB disk space)	<b>SQLWindows 5.0</b> \$3495 (Windows 3.1, 95, NT, or OS/2; 486 or faster; 8 MB RAM; 24 MB disk space)
Borland International Scotts Valley, CA (408) 431-1000 <a href="http://www.borland.com">http://www.borland.com</a> Circle 1023 on Inquiry Card.	Gupta (now Centura) Menlo Park, CA (800) 444-8782 fax: (415) 321-5471 <a href="http://www.gupta.com">http://www.gupta.com</a> Circle 1025 on Inquiry Card.
<b>PowerBuilder Enterprise for Windows, version 4.0</b> \$3295 (Windows 3.x or NT; 386 or faster; 8 MB RAM; 19 MB disk space)	<b>Visual Basic 4.0, Enterprise Edition</b> \$999 (Windows 3.1, 95, or NT 3.51; 486/25 or faster; 6 MB RAM; 20-80 MB disk space)
Powersoft Corp. Concord, MA (508) 287-1500 fax: (508) 369-3997 <a href="http://www.powersoft.com">http://www.powersoft.com</a> Circle 1024 on Inquiry Card.	Microsoft Corp. Redmond, WA (206) 882-8080 fax: (206) 936-7329 <a href="http://www.microsoft.com">http://www.microsoft.com</a> Circle 1026 on Inquiry Card.

(ODBC) for database access. You define data sources for applications by specifying ODBC data sources directly. An add-on, Data Form Designer, lets you select fields in a table or query from a pick list, and then it automatically generates a form with those fields.

Visual Basic, like Delphi, provides powerful debugging features. Besides setting breakpoints, stepping through code, and inspecting variables, users can know the routine that called the current routine, and the routine that called that one, etc. You can also have the program break whenever a selected variable's value changes.

You generate reports with Crystal Reports. You can place a report control inside applications, which can assign properties, such as selection criteria and sort order, at run time.

## Making a Choice

The last time NSTL evaluated this kind of software, PowerBuilder was the top-rated product. Its first-to-worst slide reflects mainly considerable improvement by the competition. SQLWindows, a very close second-place finisher last time, has also fallen behind the times. Both are due for heavy-duty upgrades, as detailed in "New Releases Move the Target."

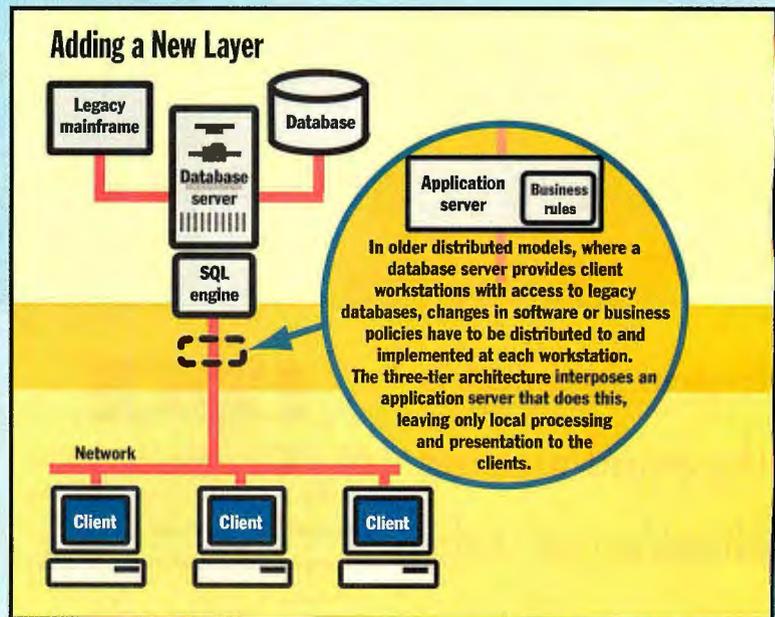
Visual Basic has always been a powerful tool for developing Windows applications, with a wide variety of built-in and

## TECH FOCUS ARCHITECTURE

### Partitioning Adds a Middle Layer

Application partitioning defines the next generation of client/server tools, some analysts say. Sometimes referred to as a "three-tiered architecture," application partitioning adds a third component, the application server, between the client and the database server. Not only the data but portions of the application reside on a remote machine and are accessible by multiple workstations.

An important aspect of partitioning is remote automation—allowing a client program to execute remote procedures running on an application server. This can be achieved with



OLE 2.0. The real benefit comes when OLE clients can communicate with OLE servers on different machines.

Like a database server, an application server can maintain business logic in a central location and make it available to client applications. When business rules change, the server application can be modified without the need to distribute new client applications throughout the organization.

Delphi doesn't emphasize partitioning, but it provides equivalent functions and even offers sample applications. Application partitioning is also the centerpiece of new releases recently announced by Powersoft and Gupta (now called Centura).

third-party controls. And with extensive remote data support in this version, it's better than ever.

*Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by National Software Testing Laboratories, as documented in a recent issue of NSTL's monthly Software Digest. To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; editors@nstl.com. For a subscription, call (800) 257-9402. BYTE and NSTL are both operating units of The McGraw-Hill Companies.*

But good as those products are, Borland's Delphi takes top honors. Developers will find its procedures for form design and accessing of components similar to Visual Basic's, but in many little ways Delphi simply makes it easier and more convenient to access data from a client/server database. And its speed, both in database and nondatabase operations, is far ahead of all the competition. **E**

*Mark Hettler has been with Software Digest for five years, where he pioneered NSTL's coverage of SQL servers and multiuser databases. You can reach him at editors@bix.com.*

# Web Project



## Web Conferencing

*First-generation Web-conferencing applications confront four barriers common to all Web-server-based applications*

**L**ast month we explored conferencing software based on NNTP. This time we'll look at some purely Web-based conferencing systems. There are a lot of them—<http://freenet.msp.mn.us/people/drwool/webconf.html> enumerates more than 50. All that I've tried offer the same benefits and suffer from the same drawbacks (see the text box "Web-Conferencing Benefits and Drawbacks" on page 136). None of those that I made publicly available on The BYTE Site—[net.Thread](http://net.Genesis.net), Allaire's Cold Fusion Forums, and Lundeen and Associates' Web Crossing—captured as much message traffic as did the NNTP-based conference that I ran in parallel.

Why the low participation? Site visitors (and BYTE staffers) found the Web

conferencing applications slow and awkward compared to the NNTP applications, such as Free Agent and the Netscape 2.0 newsreader. So for now, I'm inclined to meet BYTE's own private and public conferencing requirements with NNTP technology. But don't write off Web conferencing. Today's first-generation systems are already useful. Once they break through the four barriers common to all Web applications, conferencing systems will be off and running.

### Barrier 1: Installation

Conferencing springs into action with a mouse-click. Any Web browser can run these applications: Users don't have to

acquire and install other client software. Administrators, of course, do have to acquire and install the server software. Web technology doesn't make this job any easier than it ever was. In fact, it's more complicated. You have to deal with the usual paths and permissions, plus a whole new set of paths and permissions arising from your Web server's Common Gateway Interface (CGI) environment.

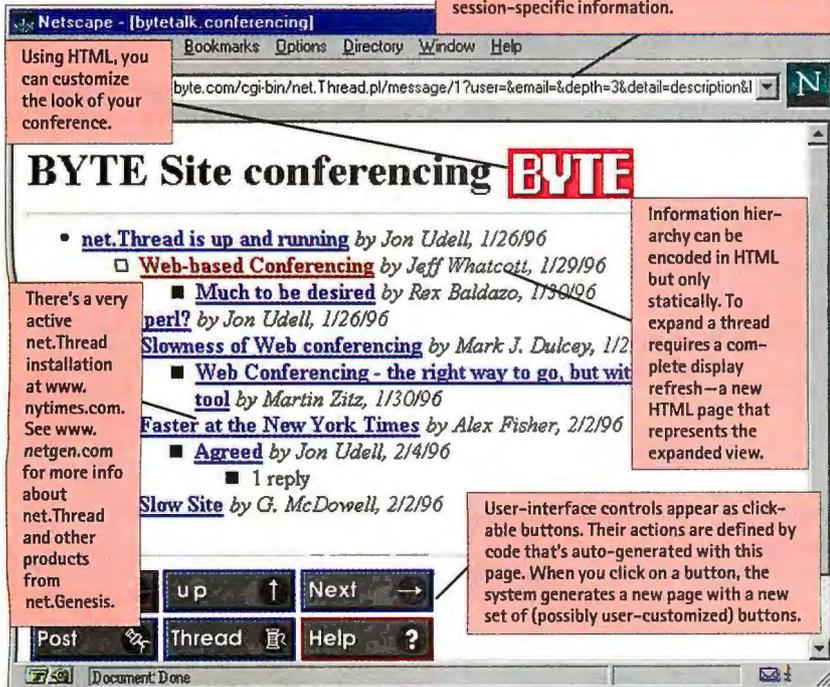
I put [net.Thread](http://net.Thread) on our BSD/OS machine running the NCSA Web server, [net.Thread](http://net.Thread) and [Web Crossing](http://Web Crossing) on an SGI Indy running the Netscape Commerce Server, and Cold Fusion Forums on a Pentium-based NT server running Microsoft's Internet Information Server. None of the installations went like clockwork. But none required more than a little fiddling, either. It wasn't a lot of effort to create a conference that's instantly open to every Web browser on the planet.

Once installed, Web conferencing systems offer spectacularly easy administration. You do everything through a Web browser. Of course, browser interfaces are becoming the de facto standard for all sorts of network administration nowadays. Printers, mail servers, Web applications—anything that lives on a network can benefit from the ubiquity of a browser-based management interface. The Netscape News Server, I'm told, wraps such an interface around the standard INN engine we're running on The BYTE Site. So the administrative convenience of Web-based conferencing isn't a unique advantage.

### Barrier 2: Missing HTML Widgets

Management interfaces work well on the Web because they're simple and forms-based. But applications with more de-

To combat HTTP's statelessness, Web-conferencing applications continually retransmit user identity, preferences, and other session-specific information.



Using HTML, you can customize the look of your conference.

There's a very active [net.Thread](http://www.net.Thread) installation at [www.nytimes.com](http://www.nytimes.com). See [www.netgen.com](http://www.netgen.com) for more info about [net.Thread](http://net.Thread) and other products from [net.Genesis](http://net.Genesis).

Information hierarchy can be encoded in HTML but only statically. To expand a thread requires a complete display refresh—a new HTML page that represents the expanded view.

User-interface controls appear as clickable buttons. Their actions are defined by code that's auto-generated with this page. When you click on a button, the system generates a new page with a new set of (possibly user-customized) buttons.

manding user-interface requirements tend to suffer. HTML lacks the advanced widgetry that enlivens modern GUI applications. In particular, it lacks a tree control. Smalltalk pioneered this widget 15 years ago, and now it's everywhere: Notes 4, the Windows 95 Explorer, the Netscape 2.0 mail and news clients.

Because conferencing often involves some kind of forum/topic/message hierarchy, tree controls that enable users to dynamically expand and collapse levels of this structure play an important role. However, Web developers must attempt

to emulate these effects with a series of pages that creates the illusion of accordion structure. This method works—but not too well.

One solution might be Netscape frames. A frame set can express an information hierarchy as a group of linked panels—see “Web Design,” March BYTE, for a prototype of a frame-enabled BYTE Site. But frames aren't a panacea. They work only in Netscape Navigator 2.0, and they are tricky to use effectively. Even Netscape's own newly frame-enabled site isn't as easy to understand or navigate

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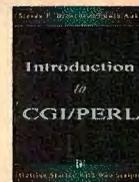
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### BOOKNOTE



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If you're new to both CGI and Perl, here's the tutorial you'll want by your side when you take the plunge.

### TOOLWATCH

#### cgi-lib.pl

[www.bio.cam.ac.uk/cgi-lib/](http://www.bio.cam.ac.uk/cgi-lib/)

[www.mispress.com/introcgi/cgi-lib/](http://www.mispress.com/introcgi/cgi-lib/)

Steven Brenner points out that the version of `cgi-lib.pl` that I referred to in earlier columns is outdated. This new version includes support for the multipart/multiform data encoding that's required for uploading files by way of HTML forms.

as you would like it to be. And because a frame set can include another frame set—even itself—an inadvertently recursive uniform resource locator (URL) creates a disconcerting hall-of-mirrors effect. Perhaps for these reasons, I've yet to run across a frame-based Web-conferencing system, although I'm certain they're coming.

Another solution to the problem would be to add a tree control to the browser's arsenal of widgets. Such a control will surely be one of the first killer Java applets. Expect an ActiveX OLE implementation of the same idea to emerge from the Microsoft camp. Wielding these components, Web developers will be able to break through the Hypertext Markup Language (HTML) barrier. The user-interface advantage that fixed-function conferencing clients now enjoy will erode. Extensible Web browsers will suffice for conferencing and for many other kinds of applications.

#### Barrier 3: Stateless HTTP

You'd soon lose patience with a conferencing system that forced you to log in not just once per session but once per message. Yet that's just how a naive imple-

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mentation of Web conferencing would have to work. HTTP owes much of its huge success to its connectionless (i.e., stateless) mode of operation. That's what enables Web traffic to flow reasonably well despite the high latency and lousy fidelity of a large portion of the Internet. However, HTTP's statelessness greatly complicates applications—such as conferencing—that require persistent user identity.

The classic solution to this problem retransmits user credentials on each CGI invocation. Both net.Thread and Web

Crossing work this way. Because these systems dynamically generate all the HTML pages that users see, they can insert credentials into the `action=` attribute of each page's `<form>` tag. Hidden fields are another way to achieve the same result. (See "Perl Magic," December 1995 BYTE, for an explanation of how hidden fields maintain state in the Virtual Press Room application.)

A consequence of this on-the-fly generation of pages is that conference messages don't live in normal Web space where indexers can find them. That's a

moot point if the system keeps messages in a database anyway, as do all three systems discussed here. But even if messages were stored as plain HTML files, this architecture would hide those files from standard Web indexing and search tools.

Cold Fusion Forums implements an alternative way to create persistent user identity. This technique exploits the Netscape cookie, a name-value pair that a server script can create, store on the client, and retrieve on subsequent interactions with the client. The cookie works in Netscape Navigator (which accounts for 75 percent of BYTE Site visits) and Microsoft Internet Explorer (9 percent), but not in Mosaic (8 percent) or WebExplorer (3 percent). Because the cookie remains on the client until it expires, Cold Fusion Forums can remember a user not only during a conference session, but also across sessions.

Systems that use cookie-based authentication typically generate pages on the fly, as do systems that transmit credentials on the CGI command line (or in hidden form variables). The program that writes the HTML pages governs access to them using cookie data that it extracts from the CGI environment.

Can you use cookie-based authentication in an application that's based on a static archive? Yes. Some Web servers, including Quarterdeck/StarNine's WebStar and Microsoft's Internet Information Server, can insert filters into the processing of client requests. These filters can inspect and act on CGI environment variables. So you can extract cookie data without having to wrap an entire CGI application around every page of an archive. Of course, the mechanisms are server-dependent.

## Barrier 4: The CGI Bottleneck

The 16-MB 486/50 Dell on which INN 1.4 runs happily couldn't handle net.Thread. It was unusably slow. (On an SGI Indy, however, it ran quite well.) Why the molasses-like performance on the Dell? Every user action in net.Thread requires the server to suck in and interpret a big chunk of Perl code. The only way to scale up, given this architecture, is to throw more hardware at the problem.

Net.Genesis says version 2 will rely less on Perl, more on compiled C code. Does that mean an interpreted language like Perl can't break through the CGI bottle-

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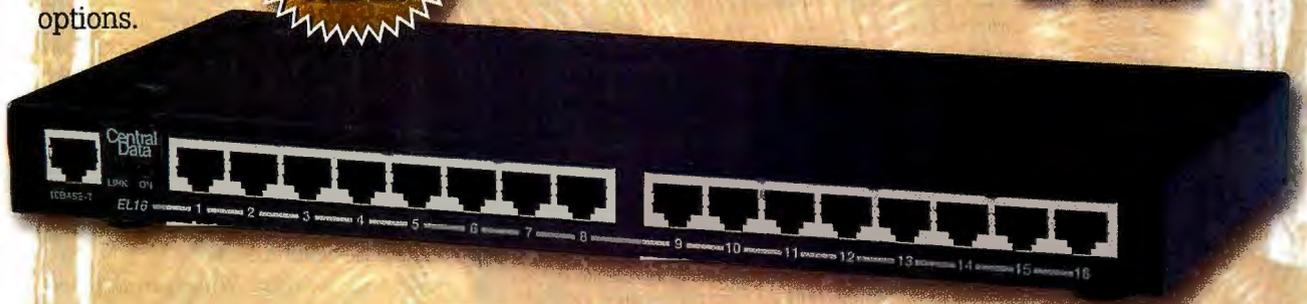
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## Web-Conferencing Benefits and Drawbacks

### BENEFITS

#### Web conferencing

- 1 Universal client; no software installation required
- 1 Relies on connectionless HTTP, which scales well and tolerates lousy networks
- 1 Supports public and private conferencing
- 1 Rich text, graphics, and hyperlinking
- 1 Travels easily through many gateways and firewalls

#### NNTP comparison

- 2 Relies on separate newsreader (but these are common)
- 2 Relies on connection orientation, which is less scalable and less fault-tolerant (but still usable)
- 1 Also supports public and private conferencing
- 2 Hyperlinking and rudimentary graphics supported in some newsreaders (e.g., Navigator 2.0)
- 3 Won't go easily through firewalls

### DRAWBACKS

#### Web conferencing

- 2 Immature; cumbersome user interfaces
- 3 No server-to-client replication
- 3 No server-to-server replication

#### NNTP comparison

- 1 Sophisticated and responsive user interfaces
- 2 Some newsreaders (e.g., Forte's Free Agent) work off-line
- 1 Mature server-to-server replication: It's the backbone of the Usenet

1 Full benefit   2 Partial benefit   3 No benefit

neck? Not necessarily. Consider building an application engine in Perl that runs as a daemon, along with a lightweight CGI stub that transmits user requests to the engine and receives data from it. This architecture will improve any CGI application, compiled or not.

Two compiled applications that take this approach are Web Crossing, whose engine ran as a Unix process on the Indy, and Cold Fusion Forums, whose engine ran as an NT service on a Pentium-based Dell. Web browsers talk to both applications' engines by way of compiled CGI stubs. With the engine always running, the bottleneck becomes the Web server's ability to execute the stubs. Conventional CGI technology requires the server to spawn a process for each stub invocation. That's expensive, particularly on NT. High-performance alternatives are emerging in the form of APIs that enable Web-server-based applications to run as extensions of Web servers.

Cold Fusion Forums supports three of these: the Netscape server API (NSAPI), the WebSite API (WSAPI), and the Process Software/Microsoft Internet Server API (ISAPI). I downloaded the ISAPI version of Forums (see the screen at left). It replaces the regular stub (dbml.exe) with an alternative one (dbml.dll) that runs in-process as an extension of the MS Internet Information Server. (In theory, it also works with Process Software's Purveyor, although I didn't try that.) Was it faster? Not noticeably; however, our conference didn't generate enough traffic for a real stress test.

## Web vs. News

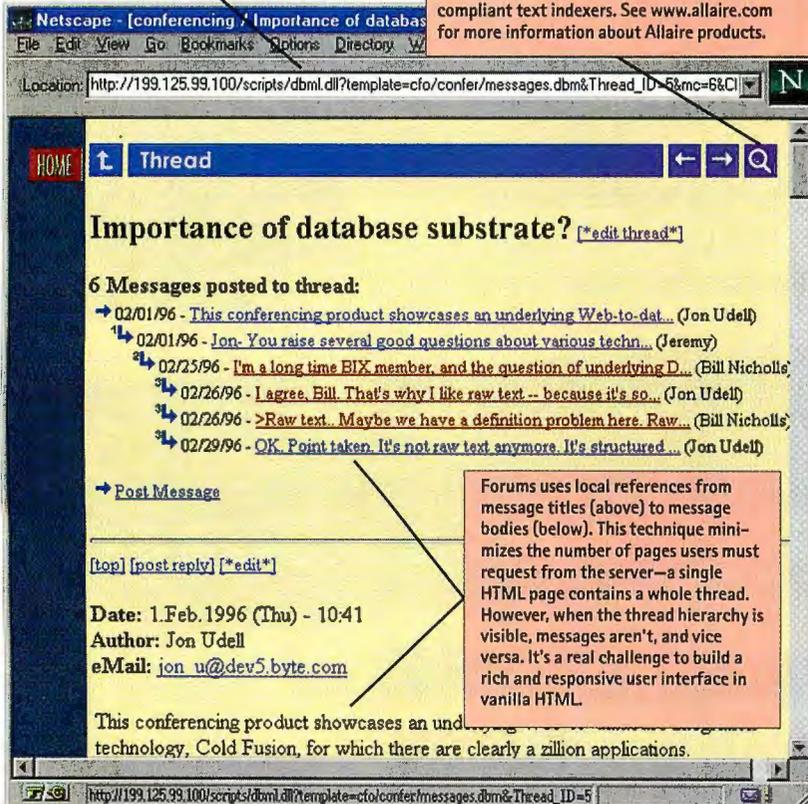
Scanning the chart above, it's easy to see what requirement disqualifies either an HTTP- or NNTP-based conferencing system. Need to cross firewalls? NNTP loses. Need replication? HTTP loses.

It's harder to judge the benefits of each approach because both are evolving at warp speed. Based on the reactions of visitors to The BYTE Site, NNTP wins. But the boundaries are already blurry. Newsreaders are rapidly becoming more browserlike and vice versa. What matters is not how you deploy conferencing, but that you deploy this vital and underutilized communications tool. **B**

*Jon Udell is BYTE's executive editor for new media. You can contact him by sending e-mail to [judell@bix.com](mailto:judell@bix.com).*

dbml.dll is the ISAPI version, more efficient than dbml.exe (the CGI version) because it shares the Web server's address space.

Running on top of Cold Fusion, a Web-to-ODBC (Open Database Connectivity) integration layer, version 1 of Forums handles basic text search. Version 2, Allaire says, will work with ODBC-compliant text indexers. See [www.allaire.com](http://www.allaire.com) for more information about Allaire products.



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# Clusters for the Masses

*Standards-based methods bring about closed clusters' last stand.*

**By Salvatore Salamone**

**M**ultiprocessing fans say two heads are better than one. But proponents of clustering believe that it's even better if you throw some extra bodies into the mix.

Clustering joins many systems together into one virtual system. Theoretically, this means that applications can run on any system in the cluster, and that people working at all the systems in the cluster have access to the same data. A cluster of computers is scalable, fast, and fault-tolerant.

Unfortunately, we don't live in a theoretical world. The main obstacle to this transparent clustering is that different hardware and different OSes don't often cooperate with each other. To set up a cluster today, you'd have to purchase your systems from the same vendor, run the same OS on them all, and run the same clustering software on them to have a perfect cluster.

There is hope, however, in the form of emerging standards, especially in the Windows NT arena. Here's a look at where clustering technology stands and where it's headed.

## What Clustering Is Good For

Simply put, clusters increase availability and performance by loosely coupling two or more systems. These systems, however, appear to you as one. When you log in to a cluster, you needn't know which system in that cluster you're logged in to. If one system in the cluster fails, another takes over.

It sounds like a simple fault-tolerant system, but it has an advantage. In a fault-tolerant system, you will typically have duplicate components that stand by until something bad happens. In a cluster, however, all components are hard at work divvying up work. When something goes wrong, the other systems in the cluster compensate. Unlike a fault-tolerant system, however, you may notice performance degradation when something fails because the cluster will balance the same load on fewer systems.

According to Donna Scott, research director at the Gartner Group, an information technology consultancy, the performance angle for clustering is sometimes overstated. "Clusters are good for reducing downtime," she says. "It's possible you can get a performance boost by adding a node," but you may generate more contention for a shared device, thereby actually lowering the overall performance. "Scalability has not been shown to be terrific in a shared data cluster," according to Scott.

An excellent example of clustering occurred two years ago, when 1500 computers on the Internet worked for about eight months to break RSA Data Security's encryption key challenge. This cluster exemplifies high performance (it was the first system to break the key), fault tolerance (the systems involved went on and off the Internet unpredictably), scalability (1500 systems), and load balancing (the whole system used only free CPU cycles on the systems involved).

Nodes in small clusters that are aimed at business applications typically are connected together using standard network links or other common interfaces. For example, it is quite common to link servers over an Ethernet or Fiber Distributed Data Interface (FDDI) network. Similarly, you might see systems sharing resources, such as memory,

through a SCSI connection or a proprietary link. Digital Equipment's VMScalusters, for example, can run over either the proprietary Cluster Interconnect (CI) bus, DSSI (which is similar to SCSI), or SCSI. And we're just starting to see clusters brought together using newer technologies such as asynchronous transfer mode (ATM) or through a Memory Channel Interconnect interface, a clustering interface developed by Digital.

## Lock Management Is Key

Any application can run on some kind of cluster, even if it isn't designed to do so: If you log into a VMScaluster and run a



spreadsheet, you're running the same spreadsheet as you would if the VAX weren't part of a cluster.

But this spreadsheet isn't taking advantage of all the cluster's features. Say you had some difficult computation to run in that spreadsheet. It would run on only one processor in the cluster, and if the system that the spreadsheet were running on failed, it would crash.

To take advantage of a cluster's load balancing and fault tolerance, you have to write it to use the OS's clustering APIs. Such APIs give an application access to system resources, including CPUs, memory, storage devices, and I/O drivers to peripherals. It is often a nontrivial task. Why? The answer is lock management. This becomes an issue when two users try to access the same record in a database, but they're coming in through two different systems on the cluster—two systems that share the same disk farm, but not memory or processors.

Fortunately, major database management system vendors, such as Informix, Oracle, and Sybase, have taken care of this problem for you. They offer versions or add-ons of their programs that are geared to run in clustered environments.

One way this is accomplished is through a clustering scheduling program called a distributed lock manager. It works in a similar way to a file-locking mechanism in a traditional DBMS. With a DBMS, one user, for example, cannot change a table that is being edited by another user. In a traditional DBMS program, the program resides on one server. This makes it somewhat easier to lock files. You will need a similar type of locking when an application is distributed over several servers in a cluster.

But what if you want to write an application? Ideally, you could write it without worrying about things like record locking between systems. That's accomplished by using APIs to give applications access to services that synchronize multiple CPUs and other system resources. An alternative is to use a distributed OS that handles many of these things for you.

There are also other ways to accomplish the same thing. For example, third-party solutions, such as Local Area Multicomputer and Distributed Queuing System, help you break up an application so that it can run over a cluster.

Also, middleware packages help you build clusters. One example of this type

## Clustering's Path to Platform Independence?

One of the challenges faced by users trying to implement clustering technology is that there are many ways to cluster machines and few standards. Often, you either select a single vendor solution or have to customize the OS and application code yourself.

To overcome this problem, a group of networking vendors has proposed a common way to develop distributed I/O subsystems that will be crucial to the success of clustered systems. The proposal is in the form of a set of specifications (called I<sup>2</sup>O) that describe an I/O architecture. Typically, you have a host system that requires access to a subsystem (e.g., a disk array or a user's terminal display). The traditional way to link the host with the subsystem is to develop customized drivers for the host's OS and drivers for the I/O processor in the system.

The I<sup>2</sup>O architecture eliminates the dependency on the host OS. Additionally, the architecture is independent of the device being controlled.

Essentially, I<sup>2</sup>O makes I/O device drivers portable across multiple OSes, processors, and bus technologies. I<sup>2</sup>O accomplishes this portability by splitting the device drivers in two parts. One resides on the host system and one on the subsystem.

The host portion of the driver is called the Operating System Service Module (OSM). This part of the driver interfaces to host-specific APIs. The subsystem portion of the driver is called the Hardware Device Module (HDM). The HDM is specific to the controller and hardware device that comprise the subsystem.

The OSM and HDM communicate through a piece of software called a *communications layer*. One of the benefits to using I<sup>2</sup>O is that it simplifies the development of clustered applications. That's because developers do not have to write driver software for every OS and version of an OS.

With efforts like I<sup>2</sup>O, the industry is finally developing some standards that should make clustering easier to do.

of software is Hewlett-Packard's Service-Guard middleware, which gives you the ability to create a cluster of T500 servers.

There are also some hardware vendors who are gearing their products toward the clustered distributed relational DBMS (RDBMS) approach. For example, NCR offers a combination of servers and middleware to provide what is essentially a turnkey data warehouse system for large organizations.

## Kinds of Clusters

You can think of clusters in two main ways: from the perspective of how storage devices are shared, or from the point of view of how an application executes on the cluster. Both these perspectives have alternative implementations.

According to Scott, there are three main cluster architectures, divided by how they share their storage: shared disk, shared disk with lock management, and shared nothing.

In a shared-disk architecture, an application has access to data on disks on all other nodes. Examples are IBM's High Availability Cluster Multiprocessing (HACMP) for AIX and Hewlett-Packard's Multi-Computer Service Guard. This method is quite useful since it lets you keep data on machines that are optimized for just such a purpose.

Shared disk with lock management is basically the same, but it adds software

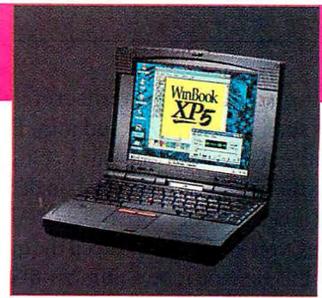
that deals efficiently with contention for the same data (e.g., two users who want to access the same record in a database). IBM's HACMP, Oracle's Parallel Server, and HP's Multi-Computer Lock Manager are examples in this arena.

In the shared-nothing architecture, an application running on a node has access only to the data on its own disk drives. This architecture is optimized for processor-to-processor communication. According to Scott, this type of cluster usually employs data replication or also uses a shared-disk architecture to share data among the systems.

From an application's standpoint, there are two approaches to sharing a cluster's resources. With data-sharing concurrency, applications know about shared storage resources but take little advantage of the other CPUs in the cluster (see the figure "Breaking Up Isn't Hard to Do" on page 136NA 6). With parallel-execution concurrency, the application can run in parallel on several processors. The former requires few code changes to give an application access to the cluster, while the latter requires a major coding effort so that the application runs in parallel on several nodes within a cluster.

One of the troubles with developing a system based on parallel-execution concurrency is that there are many ways to partition an application. For example, you might take a complex SQL statement and

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  - Maybe (continue survey as if you plan to buy).... 2.
  - No (continue survey as if you plan to buy) ..... 3.
- Check here if you have purchased in the last six months

**1A (If yes or maybe) Will this unit be paid for by yourself or by your employer?**

- Self (please go on to Question 2) ..... 1.
- Employer (please go to Question 1B) ..... 2.

**1B (If paid by employer) Approximately how many are employed by your company:**

- (Choose one.)
- 1000 or more employees..... 1.
  - 500-999 employees ..... 2.
  - 100-499 employees ..... 3.
  - 50-99 employees ..... 4.
  - Fewer than 50 employees ..... 3.
  - Uncertain..... 6.

**2 Will you require CD-ROM with your next portable computer?** (Choose one.)

- Yes, internal CD-ROM, built into notebook ..... 1.
- Yes, external CD-ROM, connected to port or docking station ..... 2.
- No ..... 3.
- Uncertain..... 4.

**3 For the unit selected above in question 2, what weight would you be willing to accept?**

- (Choose one.)
- 4.5 lbs. .... 1.
  - 5.0 lbs. .... 2.
  - 5.5 lbs. .... 3.
  - 6.0 lbs. .... 4.
  - 6.5 lbs. .... 5.
  - 7.0 lbs. .... 6.
  - 8 lbs. or more ..... 7.

**4 What type of processor will you require?**

- (Choose one.)
- Intel Pentium 75 MHz..... 1.
  - Intel Pentium 90 MHz..... 2.
  - Intel Pentium 100 MHz..... 3.
  - Intel Pentium 120 MHz..... 4.
  - Intel Pentium 133 MHz..... 3.
  - Intel Pentium 150 MHz..... 6.
  - Intel Pentium 166 MHz..... 7.
  - Intel Pentium, unsure which version..... 8.
  - AMD K5 ..... 9.
  - Cyrix M1 ..... 10.
  - Other ..... 11.
  - Don't know..... 12.

**4A What type of bus will you require?**

- PCI only..... 1.
- ISA only ..... 2.
- Both PCI and ISA ..... 3.
- No preference..... 4.

**5 Which screen will you require for your portable computer?**

- Screen type (Choose one.)
- Dual-scan color ..... 1.
  - Active-matrix color ..... 2.
- Screen size (Choose one.)
- 10.4 inch diagonal..... 3.
  - 11.3 inch diagonal..... 4.
  - 12.1 inch diagonal..... 5.
  - Larger than 12.1 inch diagonal..... 6.

**6 (If you require a color screen) What resolution will you require?** (Choose one.)

- 640 x 480 x 256 colors ..... 1.
- 800 x 600 x 256 colors ..... 2.
- 1024 x 768 x 256 colors ..... 3.
- 1280 x 1024 x 256 colors ..... 4.
- 1024 x 768 true color ..... 5.
- Uncertain..... 6.

**7 Will you require the following in your portable, docking station or both?**

	Docking			
	Portable	Station	Both	Neither
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Available floppy drive.....	9.	10.	11.	12.
Parallel port .....	13.	14.	15.	16.
Serial port .....	17.	18.	19.	20.
Ethernet port .....	21.	22.	23.	24.
Infrared port .....	25.	26.	27.	28.
SCSI port .....	29.	30.	31.	32.
Tape back-up .....	33.	34.	35.	36.

**8 What is the most important feature you look for in a notebook computer?**

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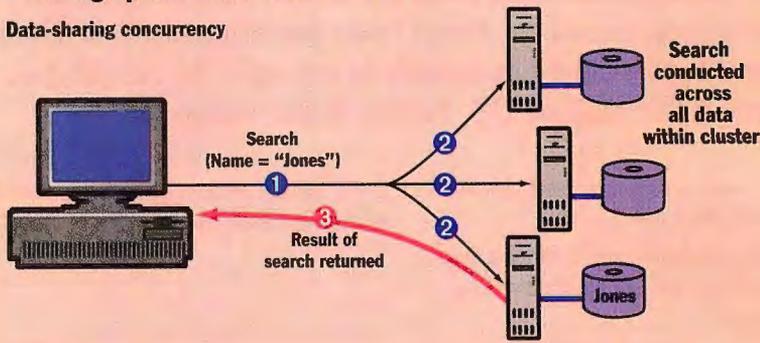
split it into a number of discrete elements such as scan, sort, and join. Each operation is then carried out in parallel within the cluster. In this way, a single SQL query is carried out more quickly. Alternatively, you might instead keep the query intact but execute it on a number of data volumes or tables at the same time.

Choosing between parallel-execution and data-sharing concurrency often depends on the application. With data sharing, you essentially execute the same algorithm on every machine. The algorithm must be modified so that it can take advantage of the fact that all the data the algorithm needs for its search or computation is not on any one node. So the algorithm must know, for example, that some rows of a database table are on this node and other rows on that node. However, overall the algorithm remains largely unchanged. With parallel execution, there must be a high degree of inherent parallelism in the algorithm. Such algorithms typically perform a number of independent operations sequentially.

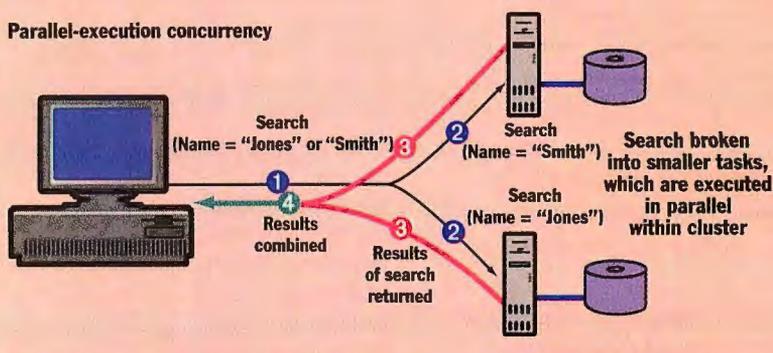
With either clustering approach, you'll need a way to monitor the application and

### Breaking Up Isn't Hard to Do

#### Data-sharing concurrency



#### Parallel-execution concurrency



Data-sharing clusters are good when applications only need to share storage resources. If you also need concurrent processing, choose parallel-execution clusters.

### Shopping for a Cluster

When you're contemplating buying a clustering system, here are some questions to ask:

- What is the maximum number of nodes?
- How far apart can those nodes be?
- What interconnects does the cluster use?
- How does the cluster perform load balancing?
- Is access to I/O devices symmetric, or is one system a master and others must go through it?
- If a node or disk fails, how does the cluster handle it?

The Gartner Group's Donna Scott adds these questions:

- What types of failures does the software check for?
- What kinds of things can fail inside the same box or across other nodes?
- How easy is it to set up the cluster?
- Where is the vendor taking the cluster?
- Can it be used with my current hardware?

to ensure that the system is working as it should. That's where you should see some action this year. For example, HP has announced a package called ClusterView, which lets you manage clusters. It works on clusters formed using ServiceGuard, which lets you link HP T500 servers over a Fibre Channel connection.

With ClusterView, you get a graphical view of clusters and the nodes making up the cluster. Like most management systems, icons representing the nodes change colors when a problem occurs.

### Help Is on the Way

We can all think of many applications that would benefit from clustering—from databases to e-mail servers. As appealing as it is to make applications cluster-enabled, there's a big obstacle holding everyone back: You have to customize the clusterization of an application for each environment the application will run in.

The reason for such one-at-a-time modifications of applications is that there are so many parameters to take into consideration. For example, one company may be running an Oracle database on a Windows NT-based Alpha server and a Unix RISC-based server. Another might

use all NetWare servers. Still another may have a mix of NetWare and VAX systems.

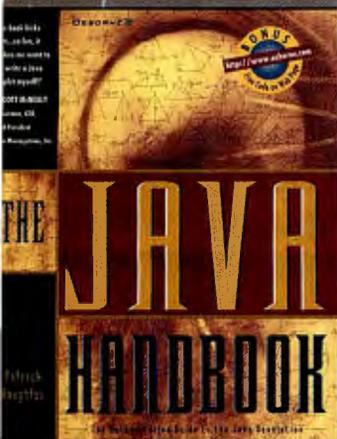
The challenge today is to develop a common way to partition an application so that it can easily be ported to the clustering environment. One step in that direction is I<sup>2</sup>O, a platform-independent device-driver specification (see the text box "Clustering's Path to Platform Independence?"). Ultimately, however, it's going to take more than device drivers.

To that end, Microsoft formed a consortium with other vendors including Digital to develop a set of clustering APIs for NT. Microsoft officials said that the consortium intends to deliver clustering APIs in two phases. In the first phase, it will deliver an API that enables you to write applications that can fail over to a second Windows NT server. In the second phase, the API will enable load balancing. This solution, however, is still OS-specific. Unfortunately, it's not likely that any vendor will overcome the technical and market hurdles to develop a truly cross-platform cluster. **B**

Salvatore Salamone is a BYTE news editor. You can contact him on the Internet at [editors@bix.com](mailto:editors@bix.com).

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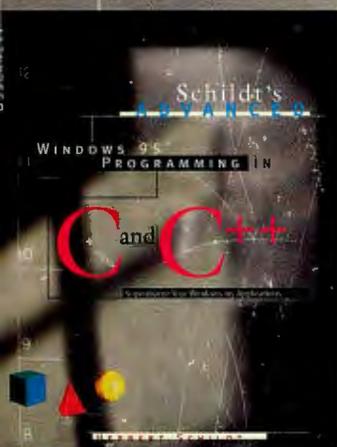


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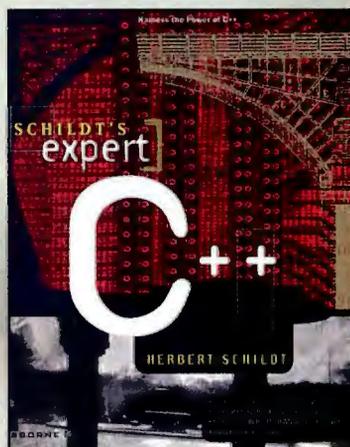
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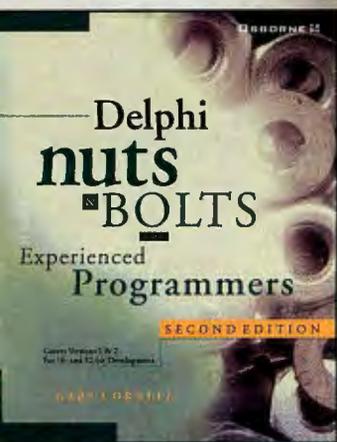
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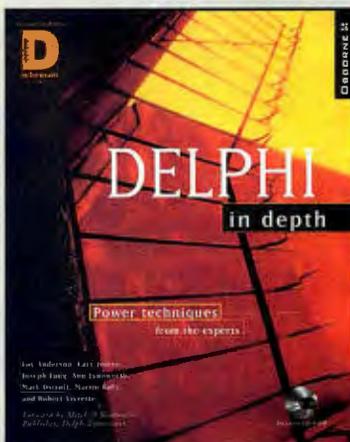
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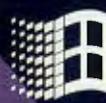
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# Must-See 3-D Engines

An inside look at the most popular 3-D environments:

OpenGL, QuickDraw 3D, and Direct3D.

By Tom Thompson

**I**n the film *Amadeus*, the Emperor says to Mozart, "Too many notes." Developers trying to create 3-D applications could just as easily say, "Too many APIs." At last informal count, we knew of more than 50 (see [www.cs.tu-berlin.de/~ki/engines.html](http://www.cs.tu-berlin.de/~ki/engines.html) for excellent information on many of them). What's a developer to do?

We looked at the information about many of these 3-D engines and created a short list of three you should look at first: Silicon Graphics' OpenGL, Apple's QuickDraw 3D, and Microsoft's Direct3D. Before committing your development efforts to any one of them, you should know how they work and what their strengths are. One caveat: As we went to press, we had only preliminary information on Direct3D.

For cross-platform work, consider OpenGL (available on Unix, Windows NT and 95, and the Mac), especially if you're developing technical applications. Its client/server architecture enables desktop systems to off-load graphics processing to servers. QuickDraw 3D (QD3D) also has an advantage here, running on both Power Macs and Windows (NT and 95).

OpenGL, however, does not handle some high-level functions (e.g., file formats). QD3D and Direct3D both do, removing that particular headache from your development list. QD3D also has hardware abstraction, plus ready-made objects and built-in editing support.

Which one is for you? If you program for the Mac as well as Windows, you want to develop for QD3D. If you want to take full advantage of PC hardware (as a game might), both Direct3D and Apple's RAVE (Rendering Acceleration Virtual Engine, the device-independent interface that QD3D uses) offer solutions.

## OpenGL

OpenGL is the only graphics engine we looked at that extends beyond the PC and Mac to many flavors of Unix. On a Unix sys-

tem running the X Window System, a GLX extension library consisting of approximately a dozen calls initializes the windowing environment. The extension library then sets up a rendering context and makes a connection to the window's frame buffer. OpenGL implementations on other platforms use a similar interface library to handle these system-dependent details.

Compared to QD3D and Direct3D, OpenGL is not a high-level API. Its purpose is to draw objects. Such high-level tasks as object editing and file I/O are left up to the application (e.g., Silicon Graphics' Open Inventor). Instead, OpenGL provides a platform-independent interface to a low-level rendering engine. This interface consists of about 250 drawing commands that let the programmer describe objects and perform a set of operations to produce the final image. You can call OpenGL from a variety of languages, including C/C++, FORTRAN, Ada, and Java.

The most interesting feature about OpenGL is that it uses a client/server mechanism to handle graphics processing (see the figure "Inside OpenGL's Rendering Engine" on page 138). A graphics client (e.g., a 3-D application) uses the OpenGL interface and the host's OS to

transmit such graphics primitives as vertex coordinates, colors, and texture coordinates to a graphics server process that runs the OpenGL rasterizer.

The rasterizer performs one or more graphics operations based on the current OpenGL graphics state and generates pixels. The pixel values undergo a final processing stage that includes texture-mapping, fogging, antialiasing, depth testing, and blending. This information goes to the client for display in the application window.

Normally, the client and server run on the same system. However, the advantage to the separation is that a low-cost desktop system can transmit OpenGL commands across a network to a



high-performance system running the server process, which returns images to the desktop machine.

OpenGL supports both an *immediate* mode and a *retained* mode for graphics operations. In the immediate mode, an application sends graphics commands to OpenGL, which promptly executes them. This provides a quick response to any changes to an image, a critical feature for interactive graphics applications.

In the retained mode, sequences of graphics commands are stored in data structures known as *display lists*. Display lists have two important advantages. First, if you must display a complex object frequently, you only have to reference its display list. Second, they let object information be shipped quickly through a network. A disadvantage is that frequent modifications to an object require generating new object descriptions.

A number of vendors provide 3-D applications and toolkits for use with OpenGL. Open Inventor is a 3-D toolkit that supplies a number of built-in graphics tools such as color and texture editors. It is available on workstations and Windows. It saves 3-D graphics in an Inventor

#### OPENGL CONTACT INFORMATION

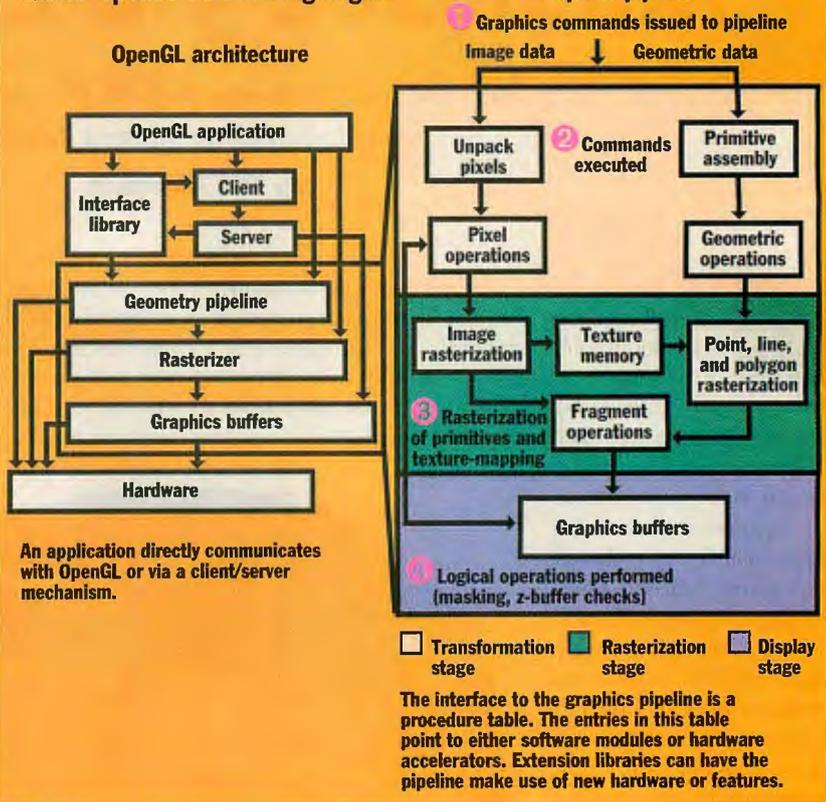
Applications developers don't need to license OpenGL. Companies that are creating and distributing OpenGL implementations and extension libraries need a license. They should contact Silicon Graphics at (415) 993-3062 for licensing information.

file format that's a superset of the Virtual Reality Modeling Language (VRML), the industry-standard file format that describes 3-D objects on the Web.

Here's the lowdown: OpenGL lacks an object-oriented design like QD3D or Direct3D, but it's available on Unix, Windows (NT and 95), and the Mac. It is also a standard, managed by a group called the Architecture Review Board, whose members include Digital Equipment, Microsoft, and Evans & Sutherland.

OpenGL supports a wide range of graphics environments that cover the spectrum in terms of cost and performance. On the low end, it provides software-only rendering for desktop PCs. But it can also communicate directly with high-end workstations equipped with visualization hardware that can draw 10 million polygons per second. With its industrial-strength graphics primitives, it is ideal for CAD and architectural design programs.

### Inside OpenGL's Rendering Engine



### OpenGL's Command Structure

OpenGL's core API provides a number of primitives that deal with points, lines, polygon surfaces, rational polygon curves and surfaces, and bit-mapped images. These primitives can specify position coordinates, colors, surface normals, and texture coordinates. The rasterizer uses these primitives, along with OpenGL's current graphics state, to perform such graphics operations as stippling, fogging, texture-mapping, antialiasing, blending, masking, and depth testing on the resulting output pixels.

To maintain portability, OpenGL doesn't support certain basic geometric objects (e.g., a box). However, you can assemble such objects by combining multiple primitives. The OpenGL Utility Library (GLU) provides commands for building such common objects as spheres, cylinders, and cones.

GLU has functions to coordinate transformations and tessellating polygons, and describe nonuniform rational B-splines (NURBS) curves and surfaces. (A NURBS curve is a 3-D surface, analogous to a Bézier curve in the 2-D PostScript language.) These NURBS surfaces can be trimmed (i.e., have holes cut in them, or irregularly shaped surfaces can be joined without cracks or overlaps), a useful property for CAD work or character animation. GLU also has utilities for scaling images and building texture-maps.

### QuickDraw 3D

QD3D is a complete 3-D graphics environment (see the figure "QuickDraw 3D Supports the Mac and Windows" on page 140). The top level is an API that enables developers to create and manipulate 3-D objects and to read or write 3-D data to files. This API talks to an extensible graphics pipeline that processes drawing operations. The pipeline in turn talks to a thin hardware abstraction layer (HAL) that provides a device-independent API

for game designers. (This HAL is known as QD3D RAVE. It shipped as a separate development kit for both Mac and Windows in March. For more information, see "Crave the RAVE" on page 49.)

QD3D supports an immediate mode and a retained mode. The immediate mode is identical to OpenGL's in that it's up to the application to supply drawing commands to the renderer. In the retained mode, the object-oriented-programming (OOP) structures maintain the scene's geometry for display and manipulation.

*continued*

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While the immediate mode offers fine-grained control for those applications that need it (e.g., animation, where all the objects change constantly), the retained mode lets you store the scene's geometry in an object database. The retained mode makes it easier to read and write objects, and it enables data structures to be cached for fast display or hardware acceleration. Programmers can opt to use one image mode exclusively, or both as the situation demands it.

Where QD3D differs radically from OpenGL is that it is an object-oriented graphics system. A new instance of an object can inherit characteristics from its class, including the geometry, size, orientation, color, texture-maps, and lighting, which makes for rapid construction of a scene's objects. This also simplifies the maintenance of each object's information for manipulation and display.

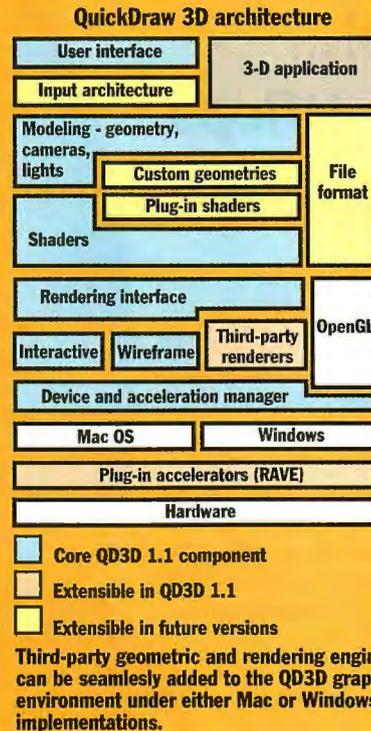
High-level API commands let you create, rotate, edit, illuminate, and apply transformations to objects. A widget mechanism provides visual "handles" that allow you to edit or scale an object interactively. Thanks to QD3D's object-oriented design, you need no knowledge of the 3-D object's internal structure to perform these actions. Currently, you can use only C/C++ to make QD3D calls.

Also unlike OpenGL, QD3D lets you read and write 3-D images in a common 3-D metafile (3DMF) format. This format saves not only each object's geometry, but also its lighting and texture-maps. Also, 3DMF enables applications to copy and paste 3-D graphics or drag and drop them into other applications.

Apple provides the ANSI source code for the parser functions that read 3DMF files. You can find Unix, Windows, and Mac versions of the parser code at <http://product.info.apple.com/qd3d/Parser.HTML>. In March, Netscape, Silicon Graphics, and Apple jointly announced plans to develop a binary file format for Moving Worlds, a cross-platform specification for dynamic 3-D environments on the Web based on the 3DMF format.

QD3D is for those who want the OS to sweat 3-D's technical details. The API supplies a wide variety of basic objects (e.g., lines, spheres, and cones) that let you prototype a scene rapidly. It provides an interface that lets you visually edit these objects. Its architecture is extensible, so you can use third-party renderers or obtain access to hardware accelerators.

## QuickDraw 3D Supports the Mac and Windows



## QuickDraw 3D's Command Structure

Like OpenGL, QuickDraw 3D (QD3D) is a platform-independent graphics API, implemented as shared libraries on the Mac OS and as DLLs on Windows. Similar to OpenGL's platform-specific GLX library, QD3D has approximately 10 system-dependent calls that initialize the graphics environment, create a window, and obtain a pointer to the window's frame buffer. In all, QD3D has approximately 1050 calls, but remember that this API manages not only rendering and display, but applications support and file I/O.

The QD3D API offers a number of drawing primitives, called geometries in Apple parlance. (A geometry includes the graphics command and its data. That is, a triangle geometry also stores its vertices' coordinates. Geometries are similar to OpenGL's display lists, except that they provide additional support for editing and file I/O.) The initial release supported primitives such as a line, polyline, triangle, point, simple polygon, mesh (polygons that share common vertices), box, marker, and nonuniform rational B-splines (NURBS) curve, to name a few. Release 1.1 supports more complex objects, such as cylinders, cones, tori, ellipsoids, triangle meshes, and NURBS patches with view-dependent tessellation.

You can also cut and paste graphics between applications or save the information into the cross-platform 3DMF for-

### QUICKDRAW 3D CONTACT INFORMATION

There are no licensing fees for QD3D. Developers should obtain a QD3D license from [sw.license@applelink.apple.com](mailto:sw.license@applelink.apple.com).

mat. Because of its acceptance as part of Moving Worlds, QD3D's 3DMF format is becoming a de facto standard. Finally, QD3D is available on both Macs and PCs.

### Direct3D

Direct3D is Microsoft's 3-D API. It's a new addition to the company's DirectX inter-

active-media technology family. At the time of this writing, it is scheduled to ship in the second quarter, for Windows 95 only. Microsoft tells us we can expect releases for Windows NT and the Power Mac by the end of the year. On the basis of preliminary specifications, we believe that Direct3D will provide an excellent environment for Windows 95 3-D developers—especially game developers. Its cross-platform capabilities, however, are currently nonexistent.

Although it is not cross-platform, Direct3D hides some of the differences in vendors' 3-D acceleration hardware (see the figure "Microsoft's 3-D Platform"). It

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does this by using a HAL. The HAL interface lets programmers obtain information about the underlying hardware's characteristics, including device-specific and performance information. Because some systems might lack acceleration hardware, a Hardware Emulation Layer (HEL) emulates these features in software. The HEL ensures that all the Direct3D services are available to an application on any system, possibly at reduced performance.

Like OpenGL and QD3D, Direct3D supports both immediate and retained modes of operation. Direct3D's retained mode resembles QD3D in that it offers developers an object-oriented high-level interface to applications for manipulating 3-D objects. After you load an object using one API call, you can rotate and scale it using other API calls. The retained mode provides API calls that read and write a file format that stores 3-D data. This data consists of predefined 3-D objects, meshes, textures, and animation sets. This file format lets applications exchange 3-D information and play back animation sequences in real time.

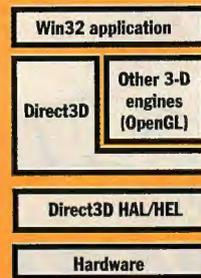
Direct3D's immediate mode is a thin API layer that deals with polygons and vertices. The immediate-mode API passes display lists composed of vertex data and graphics commands—known as *execute buffers* in Microsoft terminology—to the rendering engine for processing. This system provides a high-performance device-independent mechanism that lets programmers access a system's graphics hardware or tap into hardware accelerators. This mode doesn't offer any object or scene management engines; such functions are the application's responsibility.

The immediate mode is best suited for developers who have an application with its own rendering engine, yet wish to access a system's hardware-acceleration features. Currently, you use C/C++ to access Direct3D calls. Support for Visual Basic is planned.

Direct3D offers a variety of graphics objects. In the immediate mode, these objects include execute buffer, matrix (for transformations), light, texture, material (an object's surface properties), viewport (the screen region owned by the object), device (the hardware managing the screen), and interface. The retained mode provides additional objects based on the immediate-mode objects, including polygon face, mesh, frame (manages the position of all the objects in a scene

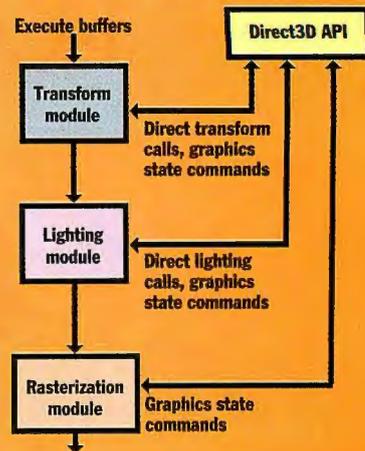
## Microsoft's 3-D Platform

### Direct3D architecture



The Direct3D pipeline uses three software modules to create an image. These modules can be switched under software control or pass data and commands to acceleration hardware.

### Graphics pipeline



## Direct3D's Engine

At the heart of the Direct3D architecture is a 3-D rendering engine that consists of a three-stage graphics pipeline. Each stage is a separate dynamically loaded software module. You start a rendering operation by first making Direct3D API calls to set up the graphics state for each module and then dropping an execute buffer into the engine. The first module, the transformation module, processes any required geometric transformations on the object. The second module, the lighting module, computes the illumination for each object and can handle several types of light sources (e.g., ambient, point, directional, and spot lighting). The final module is the rasterization module, which takes the results of the first two modules and generates a bit-mapped scene.

You can switch each of these modules on the fly via software control. This allows modules with different or enhanced capabilities to be substituted in the pipeline. Some of these modules might communicate with hardware accelerators. Note that it's possible for every stage of the graphics pipeline to be accelerated by hardware.

and their orientation), shadow, and animate (used to apply transformations to an object, such as scaling and position).

Direct3D is more like OpenGL in that it provides drawing primitives, but not such basic objects as spheres, cylinders, or cones, as QD3D does. It's not clear at this time whether such objects will be available in a separate library, or whether you will have to construct them from scratch. Also, information on the interactive editing of these objects is lacking.

Direct3D has been a long time coming,

### DIRECT3D CONTACT INFORMATION

You don't need a special licensing agreement or have to pay royalty fees to use DirectX 2.0 SDK, which contains Direct3D. To obtain further information about DirectX, consult the Microsoft Web site ([www.microsoft.com/imedia](http://www.microsoft.com/imedia)).

but it stands to exorcise all the hardware headaches that plague both 3-D programmers and game designers. It and the other DirectX technologies promise to clean up the PC's low-level act, possibly achieving real device independence for all software, not just 3-D applications. Like QD3D, it has an extensible architecture and can take advantage of systems with hardware accelerators. It also provides animation features that will be of use to game and multimedia programmers. However, Direct3D is available only on systems running Windows 95, which limits its audience in the short term.

## Three 3-D Choices

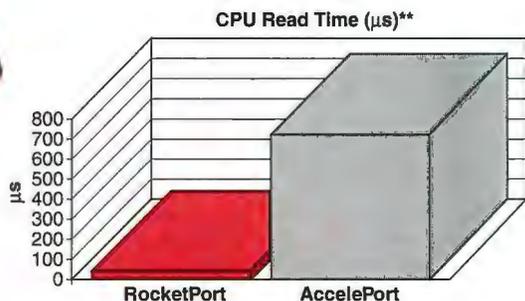
Your choice of API clearly depends on your needs. The easiest question is, "What platforms will the final application run on?" OpenGL runs on Unix, Mac, and PCs running Windows NT and Windows 95. QD3D has the next largest audience, running on Power Macs, Windows NT, and Windows 95. At present, Direct3D has the smallest audience, running only on Windows 95.

After that, the questions get more difficult and the answers become less black-and-white. OpenGL is particularly good at technical applications such as CAD and architectural drawing. QD3D is here today. It offers high-level access to 3-D acceleration hardware. It also provides

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nonuniform rational B-splines (NURBS) support, which makes it attractive for CAD work. Direct3D should boast such impressive features as a high degree of

hardware abstraction, and its animation features will be of use to game and multimedia programmers.

Game designers probably have the

hardest decision to make regarding a 3-D API, especially for the Christmas season. Direct3D's presence is limited at present. Combined with the fact that the Power Mac implementation will arrive too late in the year to be of value, those going the Direct3D route should anticipate a small market. Apple's QD3D RAVE has been available for several months on Power Macs and PCs. Thus, this API offers the developer a larger market.

While Apple's lead of several months in this area seems slim, remember that most of the QD3D components shipped last year and have been field-tested on the Mac. Although Microsoft released a beta version of Direct3D in October 1995, the specification has been under constant flux until recently. Direct3D thus starts out new when it ships. Practically, game programmers might opt for QD3D RAVE for this year, or write to the Reality Lab interface until the Direct3D situation settles. **B**

*Tom Thompson is a BYTE senior technical editor at large. You can reach him on the Internet at tom\_thompson@bix.com.*

### Three Ways to Tackle Multithreading

Three-dimensional rendering often consists of many small tasks that need to be done almost in parallel. To boost performance, all three of the APIs we talk about in this article consist of reentrant code, which makes them well suited to work in multithreaded OSes. However, there are subtle differences in how they handle threads.

OpenGL can handle several program threads, where each thread manages a separate window. Alternately, several threads can divide and conquer an imaging job within a single window. It's important to note that reentrant code by itself doesn't guarantee concurrent graphics processing. The OpenGL commands that control the graphics state make concurrent processing possible by saving and restoring the graphics environment for each window as the execution context switches among threads.

Release 1.1 of QuickDraw 3D (QD3D) supports interactive rendering using multiple processors or a multithreaded application. Because QD3D's View class object retains the graphics context, context switches between different graphics states for different threads or different processors are handled automatically. Unlike OpenGL, QD3D has no support for distributed processing over a network, but QD3D's architecture permits third-party plug-ins to do this.

Direct3D supports a multithreaded environment where different applications can draw to different windows simultaneously. It is not optimized for multiprocessing, because Windows 95 is optimized for single-processor systems. Like QD3D, retained-mode objects encapsulate graphics state information. This allows the graphics state of the rendering pipeline's modules to be updated automatically when a context switch occurs between threads that manage different scenes. Applications using the immediate mode must save and restore the graphics state of the pipeline themselves on a context switch.

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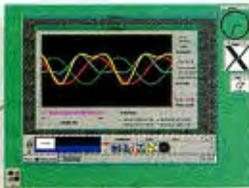
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# Comparison

## Building Bandwidth

**A** year ago, buying ISDN terminal adapters was easier than it is now. There were only a handful to choose from. Today, you must sort through a crowded field to find the terminal adapter (TA) that best meets your business needs, but you'll find an improved product. The most capable TAs can handle jobs ranging from PC-to-PC communications to videoconferencing.

We've selected three external, single-line units that have the features we believe

**3COM**



**RATINGS**

TECHNOLOGY	★	★	★
IMPLEMENTATION	★	★	★
PERFORMANCE	★	★	

are most important for serial-port communications, including remote LAN and Internet access. All three support the PPP used by Internet service providers (ISPs) and Multilink PPP (MP) for channel aggregation. PPP supports a single 64-Kbps ISDN B channel, while MP aggregates up to six B channels for greater throughput (see the Tech Focus on page 147).

The reviewed TAs support V.120, the lingua franca for PC-to-PC ISDN links. It's an international standard for single-channel serial communications that supports rate negotiation. These devices also include the convenience of an RJ-11 jack

or two. Thus, you can make outgoing calls with your old analog phone or send faxes from your fax machine. The TAs handle the A/D conversion. In addition to feature sets, we also evaluated performance, interoperability, and—because of the difficulties encountered with ISDN installations—technical support.

The three TAs we tested are ADAK Communications' Model 221, Motorola Information Systems Group's BitSurf Pro, and 3Com's Impact ISDN External Digital Modem. (These products are not technically modems.) All come with DOS/Windows 3.x software. The TAs from Motorola and 3Com also support the Mac. Under other OSes, you must resort to AT commands. By the time you read this, other TAs will have similar feature sets, including Farallon's Netopia and U.S. Robotics' Courier I-modem.

### Interface and Configuration

ISDN has two physical interfaces, U and S/T. The telephone network delivers a two-wire U interface. A device called a network terminator (NT-1) converts the

**ADAK**



**RATINGS**

TECHNOLOGY	★	★	★	★
IMPLEMENTATION	★	★		
PERFORMANCE	★	★	★	

U interface to an eight-wire S/T interface. In a typical single-line installation, you'll want a TA with a built-in NT-1 to convert the U interface. All three reviewed TAs have this feature.

In an environment with a large network, such as the test facility that was used for this review, you may have many incoming ISDN channels arriving via rack-mounted NT-1s located in a building's wire room. In such a case, only the S/T interface is provided at the faceplate. However, because they all have a built-in NT-1, the TAs we tested couldn't connect to an S/T interface. Therefore, we had to rewire the ISDN feeds in the wire room. Ideally, a TA should have a built-in NT-1 and provide both U and S/T interfaces on the unit.

ISDN line configuration, which is normally a nasty issue, was no problem with any of these devices, once we wired U interfaces. The TAs from Motorola and 3Com support the ISDN Ordering Code (IOC) system. IOCs relate the device's ISDN configuration to predefined code words such as *Capability S*. This spares you from having to provide complex configuration parameters to the telephone company.

**MOTOROLA**

**BYTE BEST**



**RATINGS**

TECHNOLOGY	★	★	★	★
IMPLEMENTATION	★	★	★	★
PERFORMANCE	★	★	★	

We test single-line ISDN terminal adapters that can handle any job. *By Jeffrey N. Fritz*

## ADAK 221

### ADVANTAGES:

- + feature-rich
- + best performance
- + supports a plethora of protocols
- + quick, competent technical support

### DISADVANTAGES:

- complicated configuration/operation
- lacks autobaud
- no Internet access software

The ADAK 221 TA has more features than the other two TAs we tested, but it's also the most difficult to set up and use. It handles both switched and packet data, and it operates with many protocols, including clear-channel data, V.120, X.25, SLIP, PPP, and MP. Besides supporting analog devices, such as modems and fax machines, this TA also provides connections for external ISDN devices through its S/T output jack.

The front panel has two RJ-11 jacks for analog devices, two RJ-45 jacks for the ISDN U and S/T interfaces, and two RS-232 connectors. LEDs indicate power, network activity, and error status. The network activity lights indicate U and S/T interface synchronization but not call status, which sometimes left us wondering whether we had a call active.

The ADAK 221 is the only one of the three with both U and S/T interfaces. However, the S/T jack is deceiving; it handles only external ISDN devices, not an incoming S/T interface. Because the ADAK 221 carries FCC Class A certification, it isn't legal for residential use.

The intimidating 136-page manual is a highly technical document, and configuration options are complex. The documentation devotes nine pages, for example, to flow diagrams that illustrate the unit's many menu options. Clearly, this is a device that's designed for network

and communications professionals, not for home or small office use.

You can configure the ADAK 221 through AT commands, the ITU X.28 packet-data command set, its built-in menu system, with a Windows 3.x configuration utility, or, most interestingly, through a voice interface. The Windows utility had several bugs. With one bug, scroll bars disappeared from a text window, hiding off-screen data. Another bug prevented the saving of configuration files to the host PC's hard drive. Because the utility could properly read and write configuration information to the TA's nonvolatile memory, the configuration file was somewhat redundant. ADAK promised an updated version of the

configuration utility (it didn't arrive).

The voice-configuration interface works through a telephone you plug into one of the analog line jacks. Voice commands are supposed to guide you through the configuration of the device, but it didn't work well enough to make it worth using.

One flaw we noted was the ADAK 221's inability to adapt to the terminal speed. The Motorola and 3Com units monitor terminal speed and automatically adapt themselves to speed changes. By comparison, changing speeds with the ADAK 221 requires you to do a series of awkward commands. If you intend to use the unit at a single preset rate, this won't be much of a problem. Otherwise, its lack of autobaud capability is very limiting.

## TECH FOCUS ARCHITECTURE

### Using All Your Pipes

A Basic Rate Interface (BRI) ISDN connection provides two 64-Kbps B channels for data communications. Inverse multiplexing can aggregate both into a single 128-Kbps virtual channel—if your terminal adapter supports it. Two of the most popular ISDN inverse multiplexing schemes are Bandwidth on Demand Interoperability (Bonding) and Multi-link PPP (MP).

Bonding is typically used for aggregating multiple B channels during videoconferencing sessions. MP, as defined in the specification called RFC 1717, is more commonly used for network connectivity. The main difference between the two protocols is in how the additional bandwidth is handled.

Bonding aggregates channels in hardware, and the bandwidth negotiation occurs during call setup. Once the call is in place, there is no mechanism to add or remove channels. MP channel aggregation, on the other hand, is generally done less expensively in software. MP can also allocate and deallocate channels on the fly, and negotiation is rapid, making it ideal for the bursty nature of data applications.

A proposed MP extension is called Bandwidth Allocation Control Protocol (BACP). BACP allows both ends of an ISDN connection to inform each other when they are about to bring up an additional channel or when they are preparing to tear down a channel. This will allow for cleaner administration of bandwidth changes than occurs now with MP.

For remote LAN connections and Internet hookups, the ability to add or shed B channels is desirable, making MP preferred. For a WAN, it keeps remote-connection costs down by trimming channels to fit the current load. For a single user, you can have a fast two-channel Internet connection and yet drop a channel to take an incoming voice call. V.120 doesn't support channel aggregation.

### Motorola BitSurfr Pro

**ADVANTAGES:**

- + straightforward installation and use
- + lots of bundled software

**DISADVANTAGES:**

- long holds for technical support
- lacks B channel indicators (this is not a biggie)

Instead of the usual utilitarian box, Motorola's BitSurfr Pro is a sleek, rounded design. With a small footprint, it fits unobtrusively on a desk. Front-panel lights indicate ISDN link status, analog call status, and ISDN call status. LEDs also indicate receive and transmit data. Unfortunately, there are no lights to indicate how many or which B channels are connected. BitSurfr Pro supports both MP and Bandwidth on Demand Interoperability (Bonding) channel aggregation.

The rear panel provides two analog ports with RJ-11 connectors, an RJ-45 connector for the ISDN U interface, and a single RS-232 connector. There is also a four-position DIP switch, but other than making sure that all switches are off, you don't need to bother with it.

An intimidating barrage of errata, addenda, and advisories greets you upon opening the BitSurfr Pro carton. There are no less than nine separate documents bundled with the unit. Motorola should update its manual and do away with some of the superfluous sheets.

Some of the additional documentation is due to the generous amount of software that Motorola bundles with the unit. Besides the Windows configuration software, Motorola included NetManage's Internet Chameleon, a Windows-based

TCP/IP package; Pacific CommWare's TurboCom/2, a Windows communications driver set; and a limited version of Hilgraeve's excellent HyperAccess communications program. Motorola also offers a version of the BitSurfr Pro with Mac software (for the same price).

It's relatively straightforward to configure and use the BitSurfr Pro. You can configure the device with the Windows configuration manager (the most convenient way), AT commands, or a rudimentary menu system invoked by typing AT@MENU. If you have experience with modems, you will feel at home using the BitSurfr Pro.

### 3Com Impact

**ADVANTAGES:**

- + straightforward installation and use
- + individual B channel indicators
- + compact, useful documentation
- + competent technical support

**DISADVANTAGES:**

- Spartan configuration utility
- no Internet access software
- doesn't let you set certain options

The boxy 3Com Impact ISDN External Digital Modem is also fairly simple to use, though it comes with fewer extras than Motorola's offering. Unlike the BitSurfr Pro, front-panel indicator lights do show the call status for both B channels. There are also D channel status, test mode, and power indicators. Strangely, the D channel status light goes off when the line is synchronized. Also, the Impact has no receive or transmit data indicators.

The rear panel includes one RJ-11 phone out jack for an analog device and an RJ-45

for the ISDN U interface. The Impact has one DB-9 serial connector instead of the larger DB-25 connectors used by the other ISDN TAs, but it comes with the appropriate cable and a nine-to-25-pin adapter.

Bundled software is limited to a copy of the TurboCom/2 communications drivers and a Windows-based configuration manager. The brief but well-written user's manual is packed with useful information. A quick start guide is also included.

The Impact's simple configuration utility is too Spartan. A single screen provides only five configuration parameters, and there are things it can't do (e.g., switch between PPP and V.120 or use 64-Kbps ISDN connections). These and several other options require setting S registers through AT commands.

Strangely, the Impact is set up for 56-Kbps connections by default. You have to specifically set it to 64 Kbps by typing the command AT\$60=64. Also, each time you run the configuration utility, it resets the S60 register back to 56 Kbps. If you don't know this, you will sacrifice 8 Kbps of throughput in end-to-end ISDN calls.

## Performance and Interoperability

We asked each vendor to provide two production units for testing. We connected one unit to the serial port of a Dell Latitude 4100CX notebook with a 100-MHz 486 processor and the other to a 120-MHz Dell OptiPlex XMT 5120 Pentium system. Both systems had up-to-date serial ports with buffered 16550 universal asynchronous receiver/transmitters (UARTs).

As a V.120 throughput test, we transferred a 155-KB bit-map file from one system to the other over an ISDN connection using the ZMODEM protocol with Procomm Plus under DOS. At 9.6 and 19.2 Kbps, the transfer performance of all three pairs of TAs was similar. At 57.6 Kbps, we started seeing throughput differences, with the BitSurfr Pro leading slightly (see the figure "ISDN TA Comparison" on page 150).

When we pushed TA settings to 115.2 Kbps, all the devices experienced frequent cyclic-redundancy-check (CRC) errors as data was corrupted at the higher speeds. The errors and resulting transmission slowdown may have been due, in part, to serial-port limitations on one of the Dell systems. However, some of the CRC errors were due to the inability of the TAs to process asynchronous data at rates of

## Feature Comparison Table

	ADAK 221	MOTOROLA BITSURFR PRO	3COM IMPACT
PPP	✓	✓	✓
MP	✓	✓	✓
V.120	✓	✓	✓
POTS connection	Two RJ-11	Two RJ-11	One RJ-11
Built-in NT-1	✓	✓	✓
U interface	✓	✓	✓
S/T interface	Output only	-	-
FCC class	A	B	B
Serial ports	Two RS-232	One RS-232	One RS-232
Supports IOC	-	✓	✓

✓ = yes; - = no

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#1 Networking Hardware Vendor



\*For a complete report, visit the LANQuest Labs Web site at <http://www.lanquest.com>

above 57.6 Kbps. As it was, the three TAs reacted differently to the problem. While the ADAK's transmission speed dropped less than 10 percent, the BitSurfr Pro cut to around half-speed, and the Impact couldn't complete the file transfer at all.

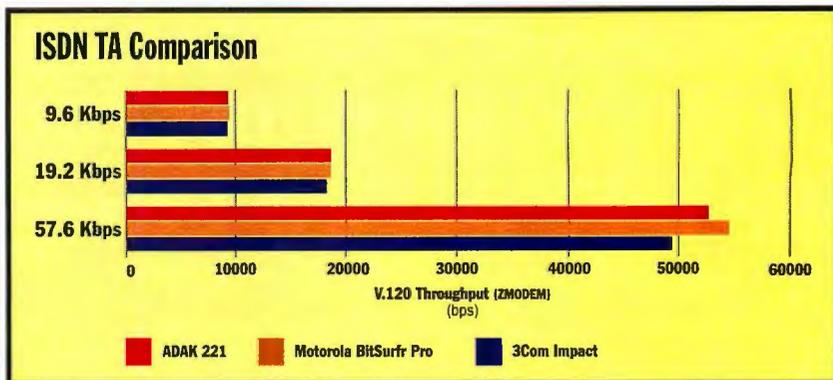
If you plan to use MP with one of these devices for an Internet hookup, make sure your system's serial port supports a 115.2-Kbps rate. Also, the Microsoft Windows 3.1 communications driver (COMM.DRV) supports data rates of only 38.4 Kbps or below. This is why the Motorola and 3Com TAs include a copy of Pacific CommWare's TurboCom/2.

We found that interoperability was excellent with PC-to-PC communications, proving that V.120 is a well-implemented standard. Each device could place and receive calls with both of the other vendors' devices and complete a Kermit transfer without difficulty.

However, PPP interoperability was a different story. None of the TAs could establish a PPP session with a Cisco Combinet CB-900 Primary Rate Interface (PRI) bridge operating on an enterprise network. In each case, a connection occurred and authentication completed, but then the PPP session would simply die. This is surprising considering the amount of attention given to the "ISDN interoperability bake-offs" sponsored by the California ISDN User's Group. It would seem that vendors have more work to do putting to practice what they learn from testing.

### Technical Support

Given that ISDN installation can be tricky and frustrating, a TA vendor's technical support is an important purchase consideration. Although the ADAK 221 has the most complex installation, ADAK also has the most responsive technical support. It's not accessible through an 800 number, and support is limited to regular business hours, but an answer is just a ring or two away. The person we talked to was knowledgeable about the product, understood ISDN well, and was generally helpful.



Over a single 64-Kbps B channel, Motorola's BitSurfr Pro topped the field with 54.9-Kbps throughput.

As might be expected from a networking giant, 3Com provides good technical support through a toll-free number. When we called the company late in the day, 3Com indicated that there were eight calls ahead of us and that its support people would call us back the following business day. Not only was 3Com true to its word, we also received several follow-up calls from the same support technician on a problem we encountered with high-speed data transfers.

The same efficiency cannot be ascribed to 3Com's customer service. The test units arrived with the wrong power supplies (from marketing). Technical support indicated that this was a packaging problem, assigned a case number, and referred us to customer service. Customer service issued an RMA number and promised to ship replacement supplies to us the following day. It took a week and several follow-up calls before the power supplies finally arrived.

Like 3Com, Motorola offers an 800 support number. Unfortunately, while support is competent, it requires great patience. It takes nearly 3 minutes just to navigate Motorola's voice-mail system and get into the support area. Once you arrive in the support queue, be prepared for a long wait. Our first call took 34 minutes before we got a human on the line. A

follow-up call the next day put us in the hold queue for 31 minutes. Our third attempt took 46 minutes. Considering the long hold times, one can only marvel at what Motorola's 800 phone bill must look like every month.

### Careful Choices

The three TAs we tested worked well for PC-to-PC communications using V.120. Because of its complicated configuration and operation, the ADAK 221 is not a good choice unless you have experience with ISDN. The best choice is a trade-off between the Motorola BitSurfr Pro and 3Com Impact. Both of them get the job done. Because of its unique design, bundled software, and better performance, the BitSurfr Pro is a somewhat better choice for home users.

If your intent is to access an ISP or enterprise network, PPP and MP interoperability is still a problem. Be sure to check with your ISP and the TA vendor before you buy any of these devices. You may also want to look at some of the ISDN bridge/router products. These devices typically implement a more robust and mature implementation of PPP and MP. **B**

*Jeffrey N. Fritz is a telecommunications engineer who plans and manages WINnet, West Virginia University's network. He chairs the National Information Infrastructure Working Group and the North American ISDN Users' Forum Enterprise Network Data Interconnectivity Family. He is the author of Sensible ISDN Data Applications (West Virginia University Press) and Remote LAN Access (Prentice-Hall). You can contact him on the Internet at [jfritz@wvu.edu](mailto:jfritz@wvu.edu). The author thanks Ralph Chapman and Bird Vilseck for their assistance in testing these terminal adapters.*

#### PRODUCT INFORMATION

**ADAK 221/\$999**  
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fax: (517) 882-3194  
[www.adak.com](http://www.adak.com)  
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**BitSurfr Pro/\$495**  
Motorola Information Systems  
Group  
Huntsville, AL  
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(205) 430-8000  
[www.mot.com/isdn](http://www.mot.com/isdn)  
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**3Com Impact ISDN External Digital Modem/\$499**  
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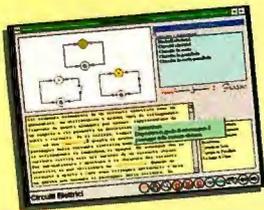
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No "Notes killer," Exchange Server is a very good e-mail system for Microsoft-centric sites. **By Steven J. Vaughan-Nichols**

# Exchange: E-mail on Steroids

**L**et's get this out of the way first: Microsoft Exchange Server is no Lotus Notes killer. If it's groupware you want, programs like Notes and Netscape's Collabora Share are better choices. If you want to move up from your existing Microsoft Mail setup, however, Exchange Server will do the trick while expanding the ways you use e-mail.

However, if your server isn't state of the art, chances are Exchange won't even start. With a minimum RAM requirement of 24 MB (32 MB is recommended), Exchange Server isn't for companies making do with older machines. Furthermore, the new Exchange client, in its Macintosh, Windows 3.1x, and Windows 95 incarnations, is itself a memory hog, requiring at least 8 MB. On our test network, Exchange ran like an overweight fullback with a guaranteed contract. Lotus cc:Mail 2.01 ran circles around it.

Both mail servers ran on 33-/66-MHz 486DX2s with 32 MB of RAM and gigabyte hard drives. Previous tests have shown that these machines are as close to two peas in a pod as any two servers can ever be. To connect with the rest of the network, both test systems had Artisoft NPro Ethernet cards set to run in NE2000 mode using the IPX protocol. On the same machines, Exchange edged out Lotus Notes in raw mail transaction speed, but Exchange has only a fraction of Notes' groupware functions.

Exchange's slow design does have one thing going for it. Unlike most network mail systems, including its predecessor Microsoft Mail, Exchange puts all its mail eggs in one basket. Almost all mail systems place the mailboxes in one database or directory set while farming out mail gateways and message transfer agents (MTAs) to other systems. Exchange, in stark contrast, puts all mail services on a single machine. The slight increase in

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Redmond, WA

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**An Exchange recipient is any object in the directory that can receive messages. Here, Schedule+ is identified as a mail recipient.**

danger to the mail system is more than made up for by having a single, integrated, easy-to-manage server.

Exchange Server works and plays well with the rest of the NT Back Office Suite. But this is a good news/bad news situation. The good news is that if you're already committed to NT, you can buy a

RATINGS				
TECHNOLOGY	★	★	★	
IMPLEMENTATION	★	★	★	
PERFORMANCE	★	★		

complete, homogeneous network solution for all your office problems. The bad news is that you're tying your office to a single vendor.

### Beyond Microsoft

Even though Exchange Server runs only on NT, it communicates well with other networks. Besides Microsoft's NetBEUI, Exchange speaks fluent TCP/IP, NetBIOS, IPX/SPX, and AppleTalk. Better still, Exchange Server comes ready to chat with SMTP and Multipurpose

Internet Mail Extensions (MIME); Open Systems Interconnect's X.400/X.500 services; and, of course, mail programs compatible with Microsoft's MAPI. It would have been better still if Exchange Server could talk politely to the other popular LAN mail transfer protocols—Lotus' Vendor Independent Mail (VIM) and Novell's MHS.

Exchange Server also works well at migrating data from preexisting networks and mail systems. For example, the program can take user information from the NetWare bindery or from NT's user register to create instant mail accounts. If you already have mail accounts on cc:Mail or Microsoft Mail, Exchange Server can switch hundreds of accounts from the old systems to Exchange in less time than it takes to read this review.

### Groupware: Not!

If you ignore the idea that Exchange Server is groupware, it compares well with "mere" e-mail programs like Novell's GroupWise and Lotus' cc:Mail. And,

## Exchange vs. Notes: No Contest

For a time before the product's release, Microsoft was positioning Exchange Server as a possible direct competitor to Lotus Notes, the top-selling groupware program. The version of Exchange that Microsoft finally shipped turned out to be more of a beefed-up e-mail program than an entire groupware platform like Notes.

unlike the still cranky Notes, it's much easier for developers and administrators. Of course, you can't do as much with Exchange Server as you can with Lotus Notes. For example, Notes users have more freedom to pick and choose exactly which files will be replicated from their home system or server to their laptop. Exchange users, on the other hand, are stuck with either choosing all folders or tediously selecting each file one by one. When you're on the road trying to get only your vital mail while paying a hotel's usurious phone rates, this can become a major annoyance.

Exchange could also stand improvement to its mail-filtering controls. Notes and cc:Mail make automatic mail management much easier with their more extensive and simple-to-use mail rule system.

Things don't get better if you're a developer. Notes' LotusScript isn't a world-beater for application design, but it produces better results than Exchange—with its reliance on Visual Basic—does. Notes' agent approach enables you to quickly build time-sensitive applications. For example, it's easy with Notes to construct a canned report relying on data from several different databases at the close of the business day and have it mailed to the top brass. Exchange does let you take full advantage of OLE, but you'll spend a good deal of your coding time building basic work-flow functions that come shrink-wrapped with Notes.

Exchange does include one excellent, ready-to-run groupware application: Microsoft Schedule+. This has always been an outstanding network scheduling and calendar package. Unfortunately, Exchange doesn't add much that's new. For example, even though Exchange adds Internet mail as part of the base package, you can't synchronize appointments across the Internet the way you can with Campbell Services OnTime 3.0.

### HERE ARE HOW THE TWO COMPARE IN SOME IMPORTANT CATEGORIES:

	Lotus Notes 4.0	Exchange Server 4.0
Server operating systems	All major PC/network/workstation OSes	NT 3.51
Client software	Windows/DOS/Mac	Ditto
Supported mail protocols	VIM, MAPI, SMTP, X.400	MAPI, SMTP, X.400
Internet integration	Mail, Web use, Web publishing	Mail, Web use
Development languages	LotusScript	Visual Basic
Database support	Notes DBMS, NotesPump for ODBC-compliant data	None

## TECH FOCUS MAIL STANDARDS

### Changing Addresses and the Universal Inbox

To provide a Universal Inbox, Exchange Server must be able to translate and manage different e-mail addressing conventions. It does this by requiring the administrator to assign to each directory object a distinguished name (DN) that provides the information Exchange Server needs to generate equivalent addresses in X.400, Internet (SMTP), and MS Mail formats (see the figure).

#### "Multilingual" Translation

Exchange Server Distinguished Name (DN)

**O=FAB/ou=NAmerica-W/cn=recipients/cn=MariaBl**

X.400 address

**g=Maria; s=Black; o=NAmerica-W; p=FAB; a=mcj; c=us**

MS Mail

**FAB/NAmerica/MARIABL**

Internet (SMTP)

**mariabl@NAmerica-W.FAB.com**



Organization name



Site name



Mailbox name

Exchange takes the names of objects in the directory and converts them to addresses understood by different e-mail systems.

Each DN must contain an organization name, a site name, and the user's mailbox name. The organization name may be 64 characters long. The example here shows a mailbox name that consists of both the user's alias (helpful in avoiding conflicts with e-mail systems that support fewer than 64 characters) and the name of the directory container on the server.

### To the Net and Beyond

Despite Microsoft's all-out assault on the Internet, the company is still a Johnny-come-lately to the Net, and Exchange shows this. While Exchange's Internet mail does well, with MIME and the ability to launch a Web browser by clicking on an embedded URL in a message, it still falls short of other programs.

For example, InterNotes enables Notes servers to be more than just Web gateways; it lets them act as actual Web sites as well. Exchange's information, by comparison, remains locked within its own databases unless you feel up to some Visual Basic,

Hypertext Markup Language (HTML), and OLE programming.

The bottom line is clear. If you want an advanced mail system, and you have the hardware to support it, Exchange Server deserves a look. Still, there's little that makes it stand out from cc:Mail and GroupWise. And if it's groupware or software for collaborative real-time work you want, Lotus Notes and Netscape Collabra are unquestionably better choices. **B**

*Steven J. Vaughan-Nichols is a freelance writer. You can reach him by sending e-mail to [sjvn@bix.com](mailto:sjvn@bix.com).*

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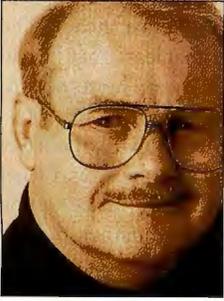
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## Pournelle



## When D Equals E

*Global environmental models capture Dr. Pournelle's attention—and installing a removable drive on Pentajluge brings on a world of problems.*

**T**his year, the annual meeting of the American Association for the Advancement of Science was in Baltimore. There wasn't as much about government policy and the Internet as I'd expected, but there were some surprises.

The digital-recording TV camera is revolutionizing the TV documentary business. Video News International (VNI) is turning print journalists into TV journalists: they lend them an editing camera, train them in what they call the "grammar of TV reporting," and send them off on assignments. Traditional TV journalism requires a large crew and several crates of equipment, meaning that it's terribly expensive to keep reporters

**For the first time, I've seen a convincing case for doing something about human action in the atmosphere.**

on-station for long. VNI's system sends one reporter with a hand-held camera, so that it costs little more than putting a print journalist on the scene; the camera lets the journalist do the editing as well.

A recent documentary about a reporter on a cruise and expedition to the South Pole was finished in weeks and cost about 5 percent of what such documentaries usually cost. Look for many others in the future.

With the Niven/Pournelle novels *Lucifer's Hammer* and *Footfall*, I've made quite a lot of money out of hitting the Earth with large and heavy objects. Chris Chyba of Princeton presented a general model of meteoric impacts; did you know that the Earth is hit with megatons of impact energy every year? Fortunately, most of it burns up at high altitude.

Chyba's model makes it clear that the

mysterious Tunguska event of 1908 in Siberia wasn't a small black hole or a comet, but instead a stony asteroid that exploded with 15 to 20 megatons of energy about 10 kilometers above ground zero—fortunately, before the U.S.S.R. had retaliatory weapons poised and waiting. The asteroid had to be stone, because an iron asteroid would have left an impact crater like the one near Flagstaff, Arizona, while an ice-ball would have exploded so high that it wouldn't have had much effect. It would be pretty easy to use Chyba's data and Allegiant Technologies' SuperCard on a Mac to build a general case model of asteroid and comet impacts, and one of these days I may do that.

Another new model: for the first time, I've seen a convincing case for doing something about human action in the atmosphere. NASA's Goddard Institute for Space Studies now understands how fluorine/chlorine compounds, such as Freon, can affect ozone in the high stratosphere. It's complicated, requiring aerosols injected into the upper atmosphere by volcanic action like that of Mt. Pinatubo to act as reaction surfaces for halogen catalytic activity. The bottom line is that the stratosphere is saturated with halogens from human activities, and it doesn't take a lot of new halogen release to sustain high levels.

The best general data source up to now has been the Stratospheric Ozone CD-ROM from Lenticular Press, for Macs only. The CD was compiled before the role of aerosols was understood; even so,

analysis shows that ozone depletion tracks volcanic events.

Alas, there aren't comparable data sources for a cost/benefit analysis of what to do about this. Banning Freon entirely has some heavy costs, mostly financial in the U.S., but life-threatening in much of the Third World. The costs of ozone depletion and consequent increases in UV levels, particularly in the tropics, have hardly been looked at. There is probably enough data floating around on the Web for a decent analysis, but I haven't seen that done. The important thing is that we're running an uncontrolled experiment on the atmosphere, and that doesn't sound like a very good idea.

On the other hand, the evidence for global warming is where it was a year, or even a decade, ago. The theory has been around since the turn of the century, when Arrhenius made back-of-the-envelope calculations. If you increase greenhouse gases like CO<sub>2</sub> (from burning fossil fuels) and methane (a lot comes from the flatulence of domestic cattle), there ought to be consequent warming.

We've certainly added significant greenhouse gases to the atmosphere in this century. However, our most sensitive instruments—earth satellites that can detect the night temperature differences between a full and new Moon—aren't finding new warming.

There's certainly been warming in the past 200 years. In 1776, Lt. Col. Alexander Hamilton dragged cannons captured at Fort Ticonderoga across the frozen Hudson; nowadays, the Hudson doesn't freeze that hard. It's difficult to connect that warming with human industry, because most warming took place before 1900. In this century, most took place before 1950. There's been even less

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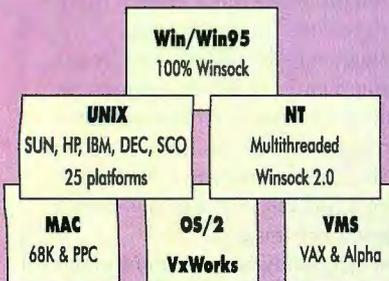
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cost/benefit analysis of global warming and its prevention than of stratospheric ozone depletion.

These matters are important. We rushed into "prevention" of "acid rain" without adequate understanding and wasted billions of dollars fighting the wrong problem. Now that the supercomputers at Los Alamos and Livermore aren't needed for weapons design, perhaps they ought to be turned loose on these potentially costly environmental issues.

Meanwhile, the economists keep looking for the increased productivity the computer revolution ought to have brought about, and they're not finding as much as they expected. I think I know where it went: small computers finally made it possible for governments and companies to collect all the information they want, and much of our productivity increase went into compliance with reporting requirements, enforcement of compliance, and not much study of the resulting reports.

While in Baltimore, I installed Earthlink Total Access for Windows on my elderly Zenith 486 notebook. In about 5 minutes, I had full access to my Earthlink Internet account. It couldn't have been more painless, partly because I used a Supra 28.8-Kbps external modem. PC Card modems are light and convenient, but they still can't beat a good Supra or U.S. Robotics external modem.

I'd also intended to test Zenith's new Z-Note MX Pentium notebook, but unfortunately its screen failed. My son Richard

transferred, use LapLink. It always works.

He tells me that Zenith's AccuPad mouse substitute takes getting used to, but once you've used it awhile, you will prefer it to trackballs and eraserheads. The machine also gets hot; at least once he had to shut it down after several hours of continuous use.

More next month. It looks like he'll buy the Z-Note MX, and after he does, I'll get another from Zenith. Laptops are getting so powerful that many businesspeople don't bother with desktops. Zenith's Z-Note MX is good enough for that.

If you have SCSI hard drives and Windows 95, be very careful what you add to the system.

Syquest has dominated the high end of the removable drive market, largely through speed. Their EZ135 drive works fine with Apple SCSI, and we had no problems with it in a Windows for Workgroups machine, or in RacingCow, the Gateway 2000 P5-133XL with Win 95—but RacingCow's hard drive is IDE.

The problem came when we installed it on Pentafluge, the Pentium 60 that seems terribly fast because it is all SCSI, including the boot drive. The Distributed Processing Technology SmartCache III SCSI Host Adapter really speeds up disk operations, and for what I do, disk operations are what limit system speed. When I write, I save early and often.

Installing the EZ135 on Pentafluge looked easy enough: just use a Granite Digital SCSIView Gold Diagnostic Cable to

## At first glance, it looked as if that had worked; the drive appeared in My Computer...

volunteered to do a test. He borrowed the machine and called Zenith without telling them it was an evaluation machine. Being a new model, it was under warranty, so the technical-support people told him to ship it to them. He sent it on Friday; Tuesday morning he got it back in perfect working order. Now my only problem is getting it away from him: he loves it.

Richard doesn't use a desktop, and for complex reasons had to give up his IBM ThinkPad. After exhausting the Windows serial-port file transfer options, he used LapLink for Windows 95 to move all the ThinkPad's files and programs to the Z-Note MX. Now he's experimenting with LapLink's Internet file transfer capabilities. If you simply have to get your files

connect it into the external SCSI port of the SmartCache and turn the machine on. At first glance, it looked as if that had worked; the drive appeared in My Computer, and I could read and write to it. I did some read/write tests before I realized that the EZ135 was the D drive. The D partition of my hard disk had become the E drive, the Maxoptix T3-1300 optical drive that's usually E had become F, and the CD-ROM drive had become G. Since a lot of programs have drive locations mapped into them, this wouldn't do.

I shut the system down and disconnected the SCSI drive. When I rebooted, Win 95 appeared to load, but the hourglass never went away; I couldn't get control of the system. Hardware reset and then

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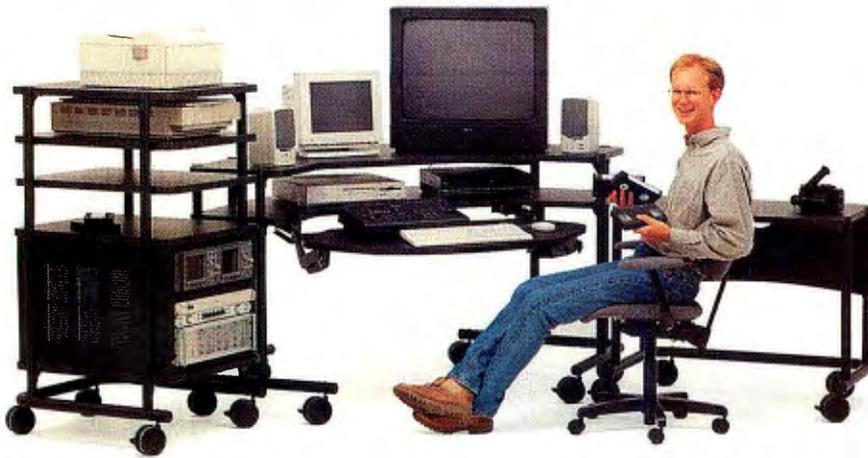


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reboot in safe mode by holding down the Shift key as it starts up. That worked. Clicking on Disk Drives in the Device Manager tab inside the System icon in Control Panel revealed that the system still believed a Syquest drive was attached to it. I deleted it. Alas, the Maxoptix T3-1300 seemed to have vanished. You can't do a hardware search from safe mode.

Rebooting produced the eternal hourglass again. I tried booting with floppy disks and with the Norton Rescue disk. I tried curses. I tried evil and potent magic. Nothing worked. In desperation, I did Ctrl-Alt-Del at that hourglass. I found that Explorer, which launches automatically when Win 95 starts up, was hanging the system. I told Win 95 to halt Explorer, and behold, I had an active desktop again.

My Computer showed me what was wrong: several of the drives were mislabeled. Back to Control Panel, System, Device Manager, Disk Drives, cursing how

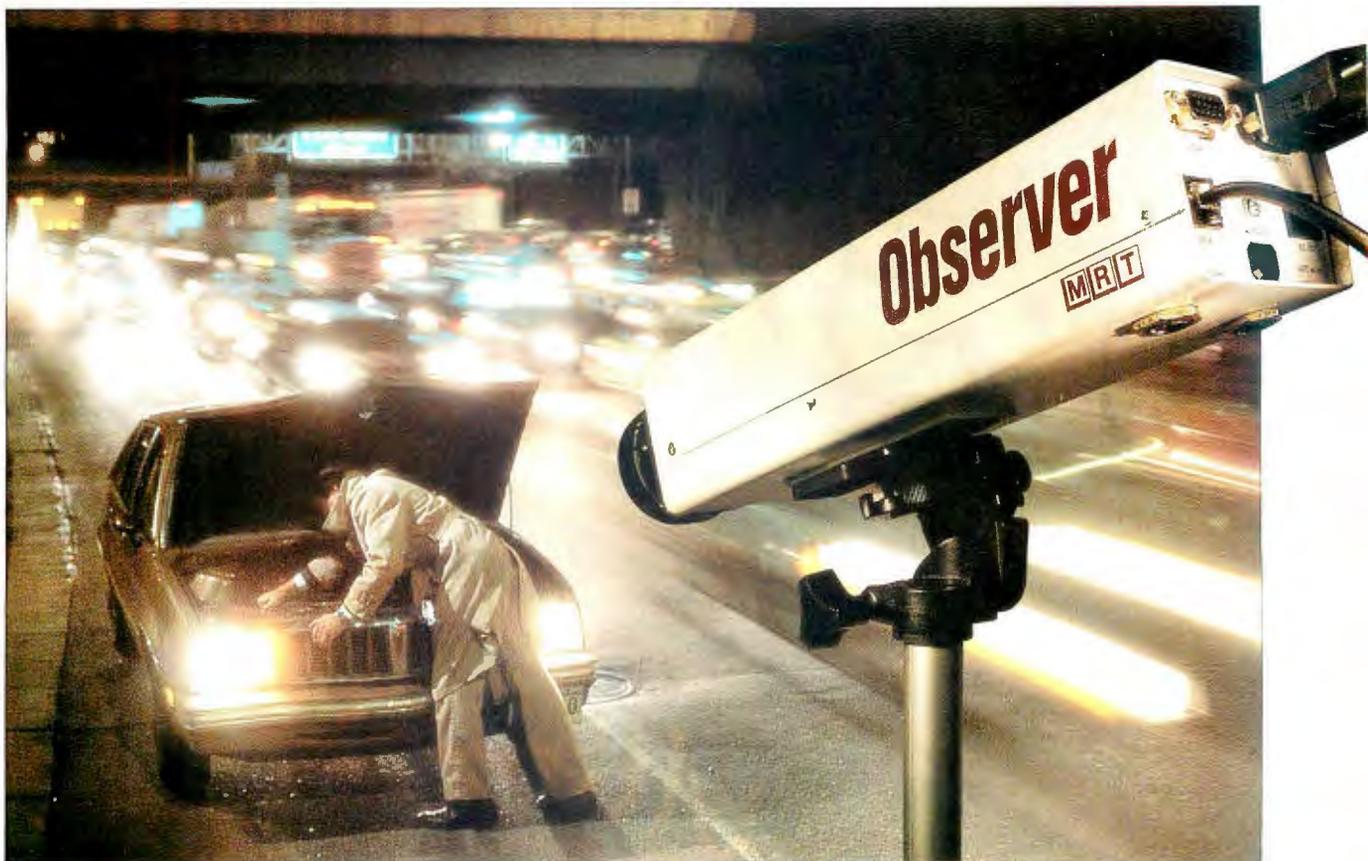
**I tried curses. I tried evil and potent magic. Nothing worked. In desperation, I did Ctrl-Alt-Del...**

hard it is to find things nested that deep. Eventually, I had all the drives properly labeled. Reboot again. This time, Norton Utilities told me I had C drive problems. When I ran Norton Disk Doctor, it said I had over a hundred errors, one in nearly every subdirectory.

Disk Doctor said it had fixed all the problems, but when I ran it again, some remained. I shut down and rebooted in DOS; then in Win 95 DOS, I ran Disk Doctor one more time. It found errors and fixed them. That did it, and Pentafluge was his old self again.

I haven't the foggiest notion of what went wrong. Syquest has some notoriously bad device drivers for the EZ135, but we hadn't installed any. Whatever happened took place at a much lower level. I wasn't particularly eager to have this problem happen again, but it did seem important to understand the situation. Therefore, I got out the old Pioneer DRM-604X six-pack CD-ROM minichanger and hooked that up the same way I'd installed the EZ135. When I booted up, the DRM-604X installed itself as drives G to L, just as it was supposed to do, and everything worked fine.

The next experiment was to shut down, turn off the DRM-604X, and reboot. Again



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all went well. The CD-ROM drive remained F, the Maxoptix T3-1300 was E, and the two partitions of the big SCSI hard disk were C and D. I then experimented with a Pioneer DE-UH7101 optical drive, with the same result. It became G without any problems, and the DE-UH7101 plus the DRM-604X worked together, without changing the designations of the C to F drives. All that SCSI stuff worked the way it's supposed to work with Win 95, real Plug and Play.

Finally I gulped hard, disconnected everything else, and reconnected the EZ135. The result was the same as before: it installed itself as the D drive and everything was a mess. I did as little as possible before exiting from the system and disconnecting the EZ135. Reboot gave me the endless hourglass. Reboot in safe mode; open Control Panel, System, Device Manager, Disk Drives; remove the EZ135 from the drive list; exit and reboot in regular mode. Ctrl-Alt-Del to close the endless hourglass.

**If you have SCSI hard drives, be very careful, and if things lock up, Don't Panic.**

Device Manager again, this time to tell it that the CD-ROM drive was F and not G (and I don't understand how it got displaced to G since I had done all I could to nail the drive-letter assignments down). Reboot once more, and rearrange my desktop, which was all scrunched up because safe mode uses 640- by 480-pixel screen resolution and I like 1280 by 1024 pixels with my ViewSonic Professional Series PT810 21-inch monitor. Now I knew the problem was reproducible.

The next experiment: we have a new Pioneer DRM-624X six-pack CD-ROM minichanger. I tried it and got the eternal hourglass. When I got past that with Ctrl-Alt-Del, the system couldn't find the new drives, but everything else worked, and recovery consisted of turning off the machine and disconnecting the DRM-624X. Understand, the DRM-624X works fine on IDE systems under Win 95 and is a lot faster than the DRM-604X. I'm pretty sure it will work if I install its drivers. The question is, why does the older one work automatically, while the new one does not?

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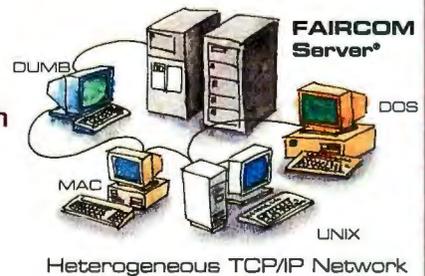
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the Microsoft installation disks, so I didn't need any updates. No one had asked them about support for Syquest removable drives, but they did understand why the drive wanted to be D; the disk cartridge was formatted as a primary partition. Try booting up with no cartridge in the EZ135.

I did that, and this time it didn't displace the D hard drive, nor the E optical drive. However, it did brush aside the F CD-ROM drive and take over its spot. Installing the latest Syquest drivers obtained from their Web site didn't help. The drive worked, but it was determined to be the F drive, and nothing I could do with Device Manager would convince it otherwise.

What if I booted up with the drive installed but turned off? I tried that, and the system blew up; it was back to boot in safe mode and all the rest. Needless to say, we have consigned the Syquest EZ135 to work with the Mac, where it seems better behaved.

I don't know what is going on. Apparently, Win 95 can handle some SCSI devices—particularly older ones—but not others. Perhaps the new Service Pack patches will cure the problem. Perhaps not. The bottom line is, if you have IDE hard drives and Win 95, adding SCSI devices is simple. If you have SCSI hard drives, be very careful, and if things lock up, Don't Panic. Just remember to Ctrl-Alt-Del at the endless hourglass and shut down all non-responding programs. Then get to Device Manager and fix things. It's tedious, but not as tedious as reinstalling Win 95. By next month I'll know more. Meanwhile, be careful.

Eric Pobirs, who helps out at Chaos Manor, got an Iomega Zip/Z100P drive at Fry's last week. This connects to the parallel port; you then install some driver software, and it looks like another drive. We tested it on RacingCow, and it worked perfectly. It also worked on SuperCow and everything else we tried it on.

The Zip/Z100P is rapidly becoming the standard sneakernet method for large file transfers. It's not as fast as the EZ135, but it's small, lightweight, and, most important, extremely easy to install and use. It works for backup, archiving, and file transfer. While it's slow compared to Ethernet, it's darned fast compared to floppy disks, and when you remove it, there's no evil aftereffect.

If you've invested in a big machine, you should seriously consider getting an Iomega Zip/Z100P not only for backup, but to carry your working environment

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from machine to machine. Some of you may remember that was the goal of the Tandon systems back in the IBM AT days. The difference is, the Zip/Z100P works, and it's cheap, too. Recommended.

We've been doing a lot of Web exploring lately, and I'm impressed with the potential of Java. For instance, there's no reason you couldn't get a flash-RAM PC Card, program it with your computer, and insert it into a slot in your car. A Java program would tell the car to configure itself for you, adjusting the seats and mirrors and suchlike to your satisfaction.

And Eric suggests Java for Genomes. Once the human genome sequence is completed in the first part of the next century, you build an organic compounds constructor into your desktop, connect that to a hypodermic needle, and download your health updates as a Java program to instruct your system. Maybe like Larry Niven's autodoc machines it will give you a manicure as well. On reflection, I'm not sure I won't live to see something like it happen. It will drive the FDA nuts.

I was one of the early users of MCI Mail, and I still have my account, but I'd sort of fallen away from using it because it was a pain to read and answer mail on-line. I had for years let Norton Commander for DOS take care of MCI Mail, but for some reason, it doesn't want to do that under OS/2 Warp or Win 95. Even if I figure out how to make it work again, it was never faster than 2400 bps.

MailRoom from Sierra Solutions does all that Norton Commander ever did and works at your modem's speed. It can automatically get your MCI Mail at scheduled times, send and receive MCI faxes, keep an address book, and sort incoming mail into folders. There's also a decent off-line editor to build new messages or compose replies.

The only disappointment is that MailRoom won't handle mail from other sources, like BIX or direct Internet mail, so I'm stuck with three mail readers. However, with MailRoom, MCI Mail is the most painless. If you use MCI Mail, you need this program. Recommended.

Oracle and IBM have been pushing the notion of dumb Internet terminals for the obvious reason that the only things these can talk to are big mainframes running highly sophisticated software. The problem is that the chip industry has already gone well past that. You can now put on a single chip a computer complete with wave-table sound and a modem that's

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more sophisticated than the "Internet computer" was supposed to be. The next generation of game boxes like Sega Saturn will incorporate those and should eat out the bottom of the dumb terminal market. Gateway is coming at them from the top with what amounts to a really smart TV set.

Gateway already makes a dream game machine. RacingCow can take a game like 7th Level's Arcade America and run it with action faster than I can keep up with. Arcade America isn't the kind of game I enjoy playing, but I like watching it played. It's a sort of Super Mario Brothers with incredible detail, and very cleverly done. The P5-133XL I have came with a Gravis Gamepad game controller (also known as a four-button joystick) that most of these arcade-like games recognize and most game addicts are accustomed to.

Arcade America in theory will run under Windows, but in fact installation is difficult. It's also less fun: you have to use the keyboard controls (or do weird things with a two-button joystick) because there's no support for the Gamepad. What this game really wants is Win 95.

Coming from the opposite direction is Interplay's Whiplash, a car-racing game that in theory will run in DOS; in fact, even on the IBM Dominator, the fastest 486 we know, it's no fun at all. Whiplash really requires a 90-MHz Pentium or better. One wonders why, given that anyone with a P-90 or better is likely to be running Win 95, Interplay rushed it out as a DOS game that can't use the Win 95 sound interface. On a high-end machine like RacingCow, though, it's pretty spectacular, both sound and graphics.

Over a year ago, I noted that Intel believed the home market—particularly the game market—was their best bet for really high-end systems. That's proven to be true, and the game developers have rushed in. With games comes sophisticated multimedia capability, and, except for text-to-speech, the Intel platforms have caught up with and passed the Mac in that regard. (What this will do to traditional Mac dominance in education isn't clear.)

Tools like SuperCard made it possible to build something as wonderful as Myst on the Mac; but more copies of Myst sold

for Intel platforms than for Macs. When Myst first went to the PC, Broderbund Software got about 100 times as many technical-support requests as the Mac version did; but that was before Win 95. Now, the Discovery Channel's Multimedia's Connections, a game built around James Burke's TV series and book, and Interplay's Frankenstein: Through the Eyes of the Monster, both far more sophisticated (if not more interesting) than Myst, run on RacingCow right out of the box. No technical support needed.

Apple has finally come around to making it easier to port games from Intel systems to the Mac, and SuperCard continues to improve in both capabilities and ease of use. So does Visual Basic. Of course, most games aren't developed in either SuperCard or Visual Basic; but when the hardware gets good enough, that will change. The neat part is that competition is driving the industry toward better hardware and easier-to-use development tools; and that's good.

The book of the month is *The Beginnings of Rome* by T. J. Cornell (Routledge Publishing, 1995). As much as you want to know about the founding of Rome. If you like that kind of book, you will like this one a lot. The computer book of the month is *BYTE Guide to Optimizing Windows 95* by Lenny Bailes (McGraw-Hill, 1996). It doesn't tell everything I would like—I wish someone would explain how to make Windows lock in a drive letter to a device—but it's as complete as any such book and quite readable. The game of the month is Westwood Studios' Command & Conquer, a tactics/strategy game you can play against the computer or on-line against live opponents. Good action and graphics, and, alas, addicting.

The program of the month is Intuit's TurboTax—it's certainly the most vital to me as I get my taxes done.

I know I promised more on the Intergraph; next month for sure, as artist David Em reports on what he's been able to do with it. Also, starting next month, a Web site of the month. **B**

*Jerry Pournelle is a science fiction writer and BYTE's senior contributing editor. You can write to Jerry c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please include a self-addressed, stamped envelope and 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 at jerry@bix.com.*

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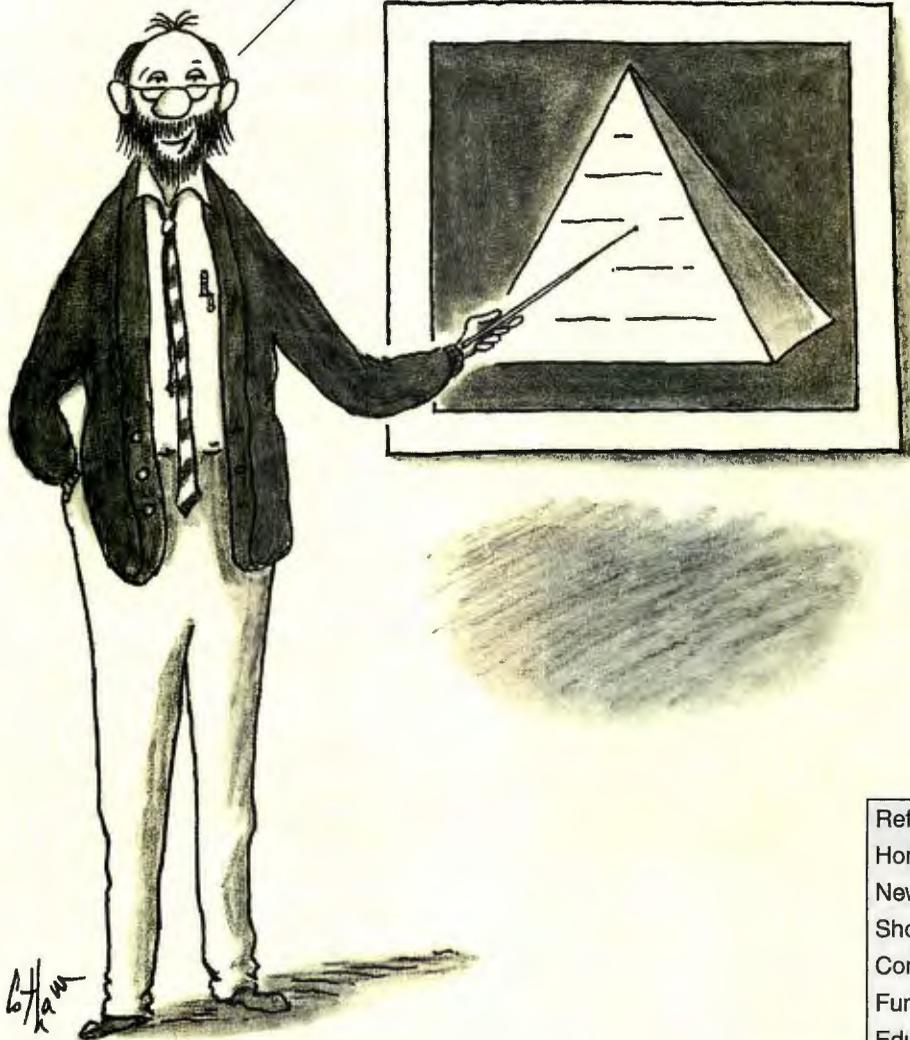
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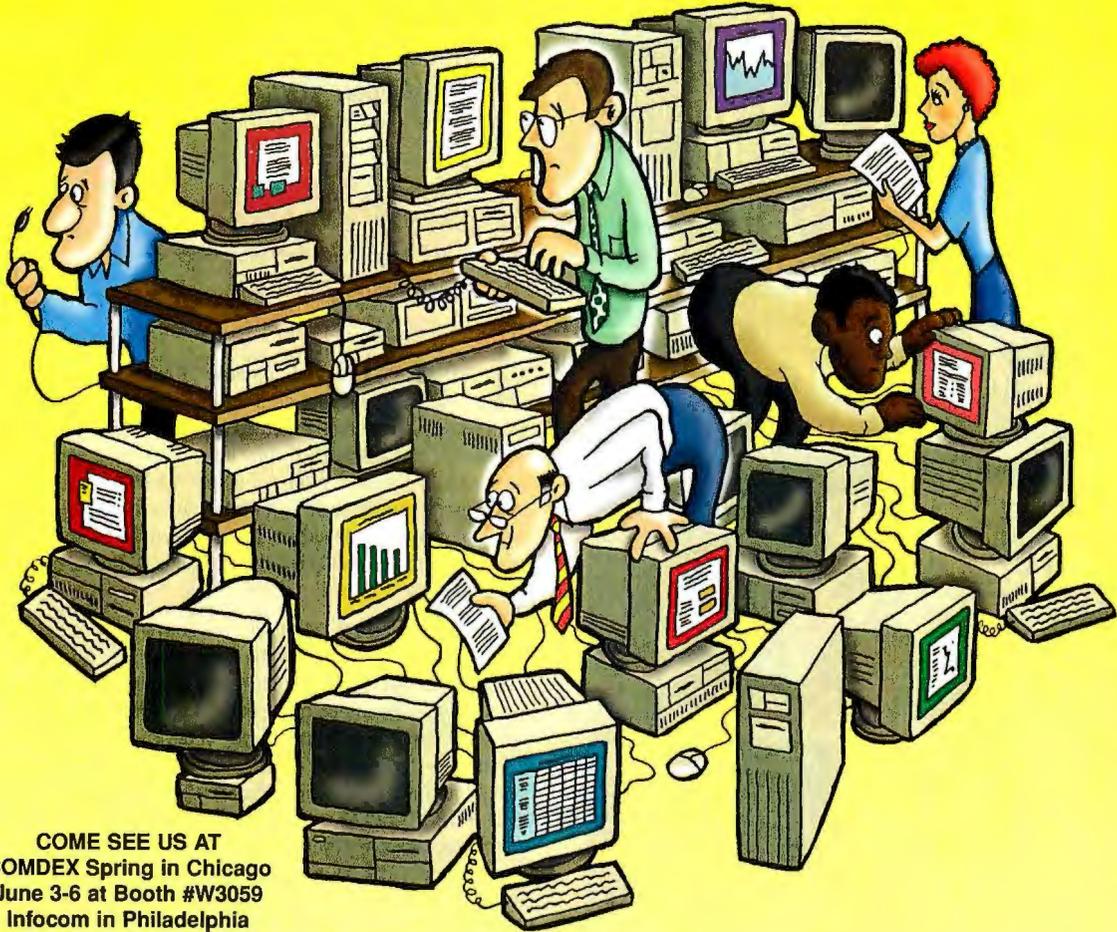
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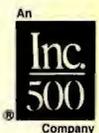
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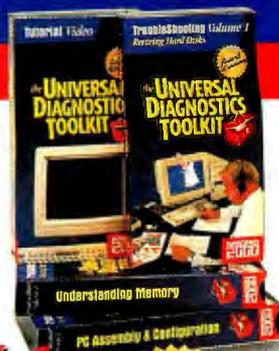
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**A MUST-HAVE REMOTE DIAGNOSTICS TOOL** for PC Service Technicians everywhere. Supply your customers

with this inexpensive software and let CLIENT diagnose what's wrong with their PCs without leaving your office! When

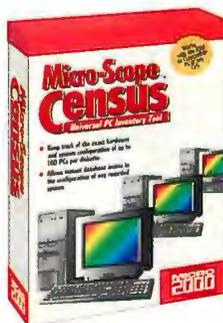
your customer calls you with a service problem, simply have him boot his PC with the Micro-Scope CLIENT floppy disk in drive A and select either the Quick Test or the Extensive Test. Then just look up the resulting error codes in your CLIENT manual and you'll know exactly what's wrong and be able to bring the correct replacement chips, drives, cables, etc. Ensures complete system compatibility. Available in packs of 10, 50 and greater.



## Micro-Scope CENSUS™

**LETS YOU KEEP TRACK OF HUNDREDS** or even thousands of computers and know each one's exact hardware and system configuration at a glance. Many technicians and MIS Directors use this software tool to save hours of downtime in companies with multiple computers.

Simply load the supplied disk into each computer on site (up to 100 PCs recordable on each disk). CENSUS automatically records complete system information and assigns each PC a unique ID number. The data can now be downloaded from the disk into any database program so it's ready to retrieve at a moments notice. For even greater productivity and speed, use CENSUS in combination with MICRO-SCOPE CLIENT to remotely diagnose each PC and arrive with the exact parts required, fully compatible. You'll be in and out in a flash with a greater profit margin. Call us for information on increasing productivity.



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#### AST MEMORY

MODEL	MEMORY	AST PART#	PRICE
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Draco 3, Advantage Pro D303 3025	72 Pcs	500700-005	64 Pcs
	160Meg		8174
	320Meg		1208
	384Meg		1208
	448Meg		1208
	512Meg		1208
	576Meg		1208
	640Meg		1208
	704Meg		1208
	768Meg		1208
	832Meg		1208
	896Meg		1208
	960Meg		1208
	1024Meg		1208
	1088Meg		1208
	1152Meg		1208
	1216Meg		1208
	1280Meg		1208
	1344Meg		1208
	1408Meg		1208
	1472Meg		1208
	1536Meg		1208
	1600Meg		1208
	1664Meg		1208
	1728Meg		1208
	1792Meg		1208
	1856Meg		1208
	1920Meg		1208
	1984Meg		1208
	2048Meg		1208
	2112Meg		1208
	2176Meg		1208
	2240Meg		1208
	2304Meg		1208
	2368Meg		1208
	2432Meg		1208
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	2560Meg		1208
	2624Meg		1208
	2688Meg		1208
	2752Meg		1208
	2816Meg		1208
	2880Meg		1208
	2944Meg		1208
	3008Meg		1208
	3072Meg		1208
	3136Meg		1208
	3200Meg		1208
	3264Meg		1208
	3328Meg		1208
	3392Meg		1208
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	3520Meg		1208
	3584Meg		1208
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	3712Meg		1208
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	4672Meg		1208
	4736Meg		1208
	4800Meg		1208
	4864Meg		1208
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	4992Meg		1208
	5056Meg		1208
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	5184Meg		1208
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	5312Meg		1208
	5376Meg		1208
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	5632Meg		1208
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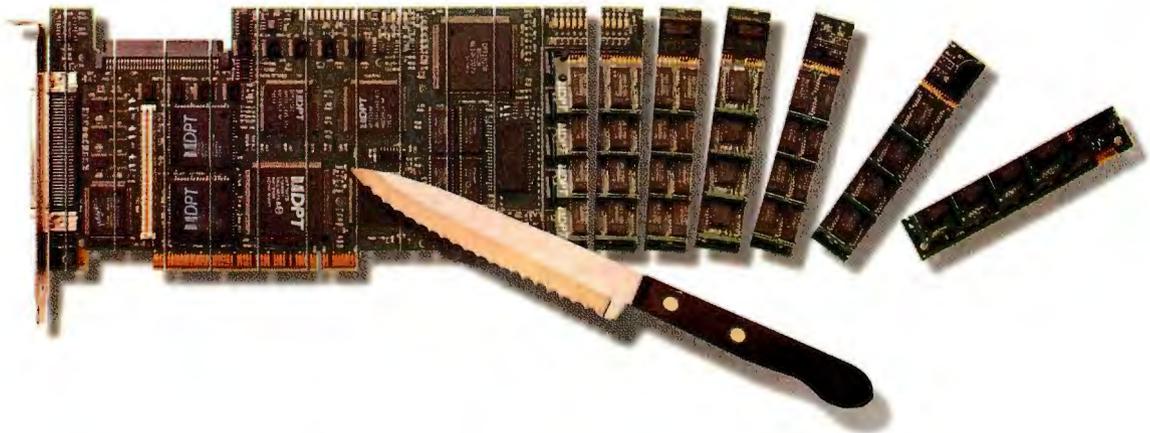
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ST9360A	9.3GB	10MS	IDE	979-1029
ST9560A	9.5GB	10MS	IDE	999-1049
ST9760A	9.7GB	10MS	IDE	1019-1069
ST9960A	9.9GB	10MS	IDE	1039-1089
ST10160A	10.1GB	10MS	IDE	1059-1109
ST10360A	10.3GB	10MS	IDE	1079-1129
ST10560A	10.5GB	10MS	IDE	1099-1149
ST10760A	10.7GB	10MS	IDE	1119-1169
ST10960A	10.9GB	10MS	IDE	1139-1189
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ST11760A	11.7GB	10MS	IDE	1219-1269
ST11960A	11.9GB	10MS	IDE	1239-1289
ST12160A	12.1GB	10MS	IDE	1259-1309
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ST12560A	12.5GB	10MS	IDE	1299-1349
ST12760A	12.7GB	10MS	IDE	1319-1369
ST12960A	12.9GB	10MS	IDE	1339-1389
ST13160A	13.1GB	10MS	IDE	1359-1409
ST13360A	13.3GB	10MS	IDE	1379-1429
ST13560A	13.5GB	10MS	IDE	1399-1449
ST13760A	13.7GB	10MS	IDE	1419-1469
ST13960A	13.9GB	10MS	IDE	1439-1489
ST14160A	14.1GB	10MS	IDE	1459-1509
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ST14560A	14.5GB	10MS	IDE	1499-1549
ST14760A	14.7GB	10MS	IDE	1519-1569
ST14960A	14.9GB	10MS	IDE	1539-1589
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ST15760A	15.7GB	10MS	IDE	1619-1669
ST15960A	15.9GB	10MS	IDE	1639-1689
ST16160A	16.1GB	10MS	IDE	1659-1709
ST16360A	16.3GB	10MS	IDE	1679-1729
ST16560A	16.5GB	10MS	IDE	1699-1749
ST16760A	16.7GB	10MS	IDE	1719-1769
ST16960A	16.9GB	10MS	IDE	1739-1789
ST17160A	17.1GB	10MS	IDE	1759-1809
ST17360A	17.3GB	10MS	IDE	1779-1829
ST17560A	17.5GB	10MS	IDE	1799-1849
ST17760A	17.7GB	10MS	IDE	1819-1869
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ST23360A	23.3GB	10MS	IDE	2379-2429
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ST23960A	23.9GB	10MS	IDE	2439-2489
ST24160A	24.1GB	10MS	IDE	2459-2509
ST24360A	24.3GB	10MS	IDE	2479-2529
ST24560A	24.5GB	10MS	IDE	2499-2549
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ST26760A	26.7GB	10MS	IDE	2719-2769
ST26960A	26.9GB	10MS	IDE	2739-2789
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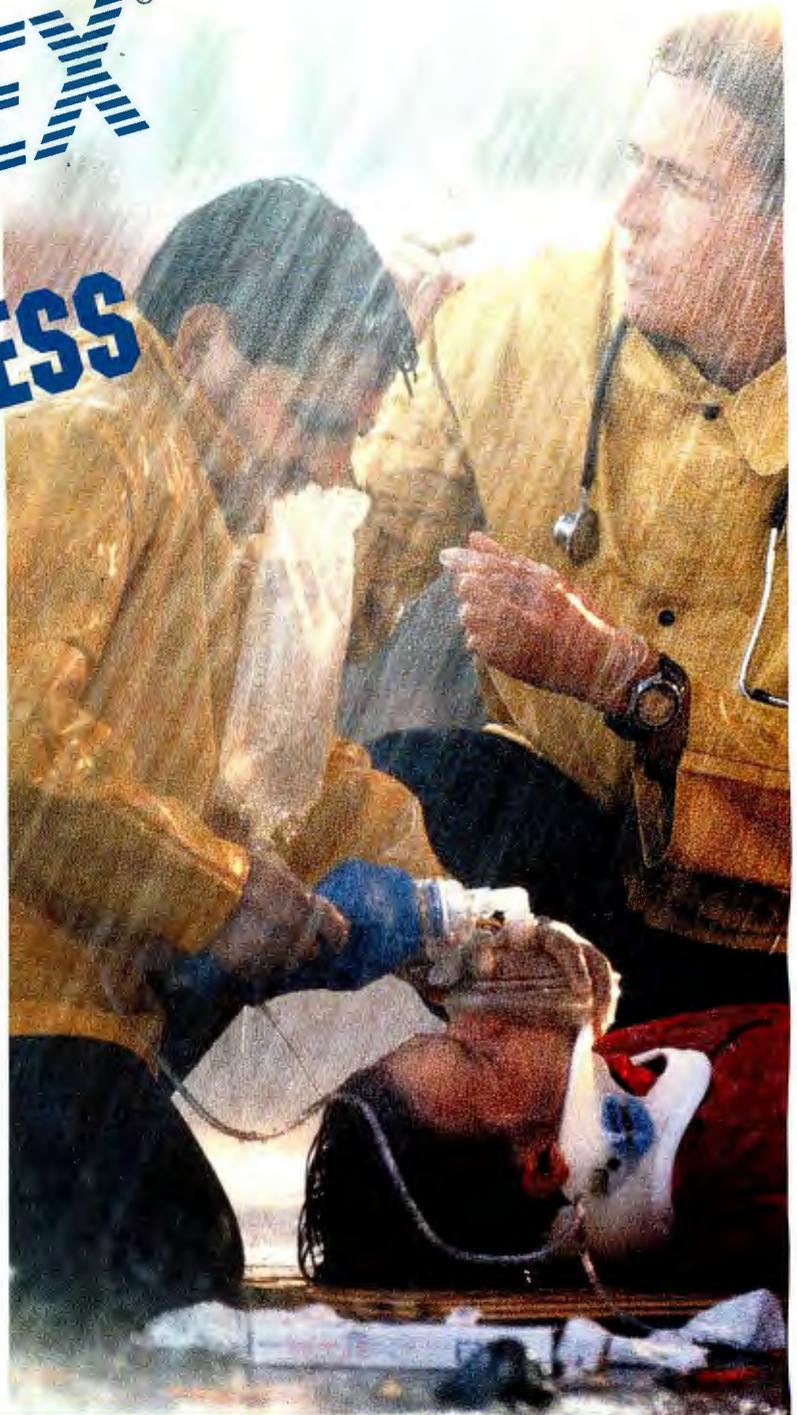
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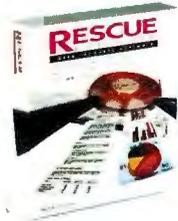
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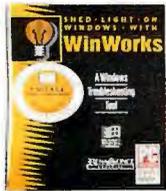
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Dimension P100, P73+	4MB [EDO] n/a	\$89	8MB [EDO] n/a	\$179
	16MB [EDO] n/a	\$469	32MB [EDO] n/a	\$959
Dimension XPS [all models]	4MB n/a	\$79	4MB [EDO] n/a	\$89
	8MB n/a	\$159	8MB [EDO] n/a	\$179
	16MB n/a	\$329	16MB [EDO] n/a	\$469
	32MB n/a	\$799	32MB [EDO] n/a	\$959

### IBM

PC 700 Series [all models] & Valuepoint Performance Series [all models]	4MB n/a	\$79	8MB n/a	\$159
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PC 300 Series [all models] Aptiva [all models]	4MB n/a	\$79	8MB n/a	\$159
	16MB n/a	\$329	32MB n/a	\$799
Aptiva 300, 500 and 700 series	4MB n/a	\$79	16MB n/a	\$329
Edquest 55	4MB	74G1299		
Edquest 30, 40 and 50 models	4MB	60G0899	\$174	
	4MB	60G0899	\$174	
	2MB	92F9935	\$79	4MB 92F9694
				\$169
Valuepoint Performance models	4MB	92G9201 or 73G3131	\$89	
	8MB	92G7310 or 73G3132	\$179	
PS/1 Consultant, Essential, Expert models x43, x44, PS/1 Valuepoint all models except Cxx models	4MB	96F9200	\$177	16MB 96F9201
			\$369	\$369
PS/1 Consultant, Essential, Expert models	16MB	96F9201	\$369	

### GATEWAY 2000

PS-160L, PS-166, PS-150, PS-133, PS-120, PS-75, PS-75 Family PC, PS-100 Fam. PC, PS-120 Family PC, PS-133 Fam. PC	4MB n/a	\$89	8MB n/a	\$179
	16MB n/a	\$469	32MB n/a	\$959

### HEWLETT-PACKARD

Vectra VE, V13, V12 66/100, XMS, XMS2, M2	4MB D2690A	\$79	8MB D2691A	\$159
	16MB n/a	\$329	32MB n/a	\$799

PS/2 25/286, 30/286	2MB	30F3360	\$79
PS/2 355X; 15, 405X, 50Z, 555X; 15, 655X; 15, 70, XStation	2MB	64S0064	\$87
	4MB	64S0064	\$139
PS/2 70-A21; A61; B21; B61; PS/Valuepoint Cxx models	PS/1 Consultant, Essential, Expert models	2MB	64S0068
		4MB	64S0090
PS/2 355X; 15, 405X, 555X; 15, 655X; 15, XStation, PS/Valuepoint Cxx models	4MB	34F2933 or 87F9977	\$139
PS/2 355X; 15, 405X, PS/Valuepoint	8MB	64S0129	\$179
PS/2 90 XP, 95 XP, P75 [point] 56, 57 [all] PS/1 Pro M1213	2MB	64S0128	\$85
PS/2 90 XP, 95 XP, P75 [point] 56, 57 [all] models	4MB	64S0128	\$89
PS/1 Consultant, Essential, Expert models, PS/1 Pro M1213	4MB	64S0128	\$89
	8MB	64S0130	\$179
PS/2 80-111; 311; 121; 321; 081, 161	2MB	64S0379	\$88
	4MB	64S0379	\$139
Expansion boards for PS/2 80386 based models	4.16MB w/4MB	64S0609 [use 72-pin]	\$299
	2.14MB w/2MB	34F3077 [use 72-pin]	\$295
	4.16MB w/4MB	34F3011 [use 72-pin]	\$309

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Pro 180 Magnum, Pro 200 Magnum Plus, P133 Power Server	4MB n/a	\$79	8MB n/a	\$159
	16MB n/a	\$329	32MB n/a	\$799
SMF, P266 Power Server SMF, 4100 PCI Magnum	4MB n/a	\$79	8MB n/a	\$159
	16MB n/a	\$329	32MB n/a	\$799
PS/1 PCI Memory, P166 PCI Memory Plus, P75 Power Station, P100 Power Station, P100 Home PC, P150 Home HPC PRO	4MB n/a	\$79	8MB n/a	\$159
	16MB n/a	\$329	32MB n/a	\$799

### AST

Bravo LC, MS [all models]	4MB	500987-002	\$79	8MB	500987-003	\$159
	16MB	500987-004	\$329	32MB	500987-005	\$799
Premiera GX [all models]	4MB	501565-001	\$159	16MB	501566-001	\$369
	32MB	501567-001	\$759	64MB	501568-001	\$2,199
Premiera MX [all models]	8MB	500987-003	\$159	16MB	501340-002	\$369
	32MB	500987-005	\$759	64MB	501569-001	\$2,359

### COMPAQ

Presario 720, 724, 744, 774, 920, 924, 840, 992, 982, 972, 978, 954, 526, 524, 528, 520, 510	4MB	147522-001	\$79	8MB	147523-001	\$159
	16MB	147524-001	\$329	32MB	147525-001	\$799
Presario 650, 660, 663, 433, 425, 866, 850, 833, 866	4MB	14184-000	\$89	8MB	14185-000	\$179
	16MB	149320-001	\$369	32MB	149147-001	\$799
Proline 575MX, 590MX, 5133, 5100, 575, 590, 4100, 466, 450	4MB	172712-001	\$79	8MB	172713-001	\$159
	16MB	172714-001	\$329	32MB	172715-001	\$799
Proline Enhanced [all models], 466, 433, 450, CDS, 4255, 4335	4MB	14184-001	\$89			
	8MB	14185-001	\$179			
	16MB	149320-001	\$369			
DuoPro 590MX, 575MX, 575, 590, 5100	4MB	172712-001	\$169	8MB	172713-001	\$329
	16MB	172714-001	\$369	32MB	172715-001	\$799
DuoPro XI [all models]	4MB	148187-001	\$89	8MB	148188-001	\$339
	16MB	148189-001	\$669	32MB	148190-001	\$1,299

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First Source International Always Includes Installation Instructions! (on standard simms)

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## CACHE MEMORY

Your 486 or Pentium computer should have at least 256k of cache memory for optimal performance!

### STANDARD CACHE CHIPS

8k x 8 15ns DIP	\$2.25
8k x 8 20ns DIP	\$2.25
32k x 8 15ns DIP	\$4.00
32k x 8 20ns DIP	\$4.00
32k x 9 15ns DIP	\$4.00
32k x 9 20ns DIP	\$4.00
64k x 4 15ns DIP	\$4.00
64k x 4 20ns DIP	\$4.00

### Intel Pentium Motherboards

256k Pipeline Burst Cache Module	\$49
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### Compaq

256k Cache Module	\$49
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### IBM

256k Cache Module	\$69
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### AST

256k Cache Kit	\$59
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## LAPTOP & NOTEBOOK MEMORY

Call for Apple notebook memory

### COMPAQ

Contura Aero	4MB	190532-001	\$125
	8MB	190597-001	\$225
	16MB	190598-001	\$459
Contura 4/25, 4/33	4MB	144790-001	\$125
	8MB	144790-002	\$225
	16MB	144790-003	\$459
UE Elite 4/40, 4/50, 4/75	4MB	199012-001	\$125
	8MB	199015-001	\$225
	16MB	199017-001	\$459
Contura 400, 410, 420, 430	4MB	147653-001	\$125
	8MB	147655-001	\$225
	16MB	147657-001	\$459
Elite 5000	4MB	213515-001	\$619
	8MB	213515-002	\$999
	32MB	213515-003	\$999
	64MB	213515-004	\$2,089

### DELL

Latitude XPI, P75, P90	8MB	3103435	\$259
	16MB	3103436	\$379

### IBM

ThinkPad 360	4MB	84G5699	\$125
	8MB	84G5692	\$225
	16MB	84G5695	\$459
ThinkPad 365, 365CD	4MB	92G7287	\$151
	8MB	92G7293	\$319
ThinkPad 701	4MB	04H6193	\$125
	8MB	04H6194	\$225
	16MB	04H6195	\$459
ThinkPad 700, 720	4MB	07G1419	\$125
	8MB	07G1420	\$225
	16MB	07G1421	\$459
ThinkPad 760, 760CD	4MB	92G7316	\$322
	8MB	92G7316	\$599

### NEC

Venno S, Venno 2000	4MB	OP-410-1201	\$125
	8MB	OP-410-1202	\$225
	16MB	OP-410-1203	\$999
Venno V, M, P, 4050, 4050, 4080	4MB	OP-410-4001	\$125
	8MB	OP-410-4002	\$225
	16MB	OP-410-4003	\$459
	32MB	OP-410-4004	\$999

### TEXAS INSTRUMENTS

Extrema 450	4MB	98039220001	\$151
	8MB	98039300001	\$309
	16MB	98039330001	\$599
Extrema 550, 550CD, 560, 560CD	4MB	980810-0001	\$225
	8MB	980841-0001	\$399
	16MB	980891140001	\$1,319
Extrema 550, 5010, 5030, 5100, 5200, 5200	4MB	979816-0001	\$303
	8MB	979816-0002	\$479
	16MB	9793357	\$171
	32MB	9793358	\$379

### TOSHIBA

T2100, T2105, T2110, T2115, T2130, T2135, T2150, T2155	4MB	NW2026U	\$125
	8MB	NW2027U	\$225
	16MB	NW2028U	\$425
	24MB	NW2029U	\$625
T1190, T4600, T4700, T4800, T4850, T4900	4MB	PCRA2011U	\$140
	8MB	PCRA2013U	\$249
	16MB	PCRA2014U	\$599
	32MB	PCRA2015U	\$1,139
T3400, T3600	4MB	PCPA2017U	\$141
	8MB	PCPA2020U	\$269
	16MB	PCPA2023U	\$549
	32MB	NW2031U	\$279
	8MB	NW2032U	\$459
	16MB	NW2034U	\$829
	8MB	NW2035U	\$409
	16MB	NW2036U	\$909
	32MB	NW2037U	\$1,799

### DIGITAL

Ascentia 800N, 810N	4MB	501488-001	\$125
	8MB	501488-002	\$225
	16MB	501488-003	\$459
Ascentia 900N, 910N	4MB	501392-001	\$125
	8MB	501392-002	\$225
	16MB	501392-003	\$459
	8MB	501728-001	\$289
	16MB	501728-003	\$599

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“We recommend 16MB of RAM (for Windows 3.1 or Windows 95), particularly if you plan to run multiple applications.”

— PC Magazine, May 16, 1995

## LASER PRINTER MEMORY

HP LaserJet 4L	1MB	C2024A	\$48
HP LaserJet 5L	1MB	C3939A	\$50
	2MB	C3147A	\$79
	4MB	C3148A	\$129
	8MB	n/a	\$239
HP LaserJet IP, II, III, IIIi	2MB	33475B	\$79
	4MB	33477B	\$129
HP LaserJet II, 2	2MB	33444B	\$79
	4MB	33445B	\$129
HP LaserJet III, 4, 4M, 4X, 45MX, XL300, DeskJet 1200C	1MB	C2063A	\$48
	2MB	C2064A	\$89
	4MB	C2065A	\$99
	8MB	C2066A	\$199
HP LaserJet 4, 4MP, Color LaserJet	2MB	C3131A	\$79
	4MB	C3132A	\$99
HP DeskJet 500, 500C, 520, 520C, 550C, 560, 560C, 250K	2MB	22078	\$40
HP DesignJet 5P, 5MP	4MB	C3132A	\$99
	8MB	C3133A	\$199
Okidata OK400	1MB	70014701	\$110
	2MB	n/a	\$129
Okidata OK400E	2MB	n/a	\$119
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486SX/DX 33MHz	100MHz DX4	\$183
486SX/DX 25MHz	63MHz Pentium	\$140
486SX/DX 33/66MHz	83MHz Pentium	\$187
Pentium 60/66MHz	120/133MHz Pentium	\$367
Pentium 75MHz	125MHz Pentium	\$367
Pentium 90MHz	150MHz Pentium	\$437
Pentium 100MHz	166MHz Pentium	\$592

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Ascentia P - Pentium/100, 8MB, 11.3" Dual Scan, 800MB	\$3,255
Ascentia P - Pentium/100, 8MB, 11.3" Dual Scan, 1.2GB	\$3,719
Ascentia P - Pentium/133, 8MB, 11.3" Active, 800MB	\$4,185
Ascentia P - Pentium/133, 8MB, 11.3" Active, 1.2GB	\$4,649

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Stylus Color II	\$282
Stylus Color Pro	\$465
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Zip Drive 1GB SCSI Int/Ext	\$478/\$558
Zip PC 100MB single 100mb preformatted for pc	\$19
Jaz 540MB 3.5 single pack	\$69
Jaz 1GB 3.5 single pack	\$119

### CD-ROM

GoldStar 6x, Int. EIDE	\$109
TEAC 6x, Int. EIDE Kit	\$136
Toshiba 6x, Int. EIDE Kit	\$139
Toshiba 6x, SCSI Int./Ext.	\$267/\$336
Nec 6x, SCSI Int./Ext.	\$341/\$486
Nec 4x4, EIDE, Int.	\$271
Nec Multimedia 4V Internal SCSI/EIDE	\$167/\$279
Plextor 4Plex Plus 4x, SCSI Int.	\$258/\$340
Plextor 6x, SCSI Int./Ext.	\$305/\$387
Panasonic 2X Portable PCMCIA	\$204
Panasonic 4X Portable PCMCIA	\$392

### NOTEBOOKS

AST Acemia 310, Pentium/75, 8MB, 10.4" DS, 520MB	\$2,119
Acemia 310, Pentium/75, 8MB, 10.4" DS, 800MB	\$2,311
Acemia 310, Pentium/100, 8MB, 10.4" DS, 800MB	\$2,399
Acemia 310, Pentium/100, 8MB, 10.4" DS, 800MB	\$2,799
Acemia 310, Pentium/133, 8MB, 10.4" DS, 800MB	\$2,799
Acemia 310, Pentium/100, 8MB, 11.3" DS, 800MB	\$3,255
Acemia 310, Pentium/100, 8MB, 11.3" DS, 1.2GB	\$3,719
Acemia 310, Pentium/133, 8MB, 11.3" Active, 800MB	\$4,185
Acemia 310, Pentium/133, 8MB, 11.3" Active, 1.2GB	\$4,649

### PRINTERS

CANON COLOR BUBBLEJET BJC70	\$349	BJC210	\$333
BJC610	\$434	BJC4100	\$321
OKIDATA OKIET 2010	\$239	OK600c	\$394
OKI610e	\$488	OKI610e	\$755
OKI2100	\$1,098		

### SCANNERS

KODAK DC 40 Digital Camera w/s/w	\$499
DC 50 Digital Camera w/s/w	\$999
MICROTEK PageWiz for Windows 300dpi pagesuite OCR sw	\$189
Scanmaker E3 fibred 600dpi 24bit clr SCSI w/sw	\$377
Scanmaker IHR fibred 1200dpi 24bitclr SCSI w/sw	\$565
Scanmaker III fibred 600dpi 68.7bclr SCSI w/sw	\$2,023

### TAPE BACKUP

Caloraid T1000 800mb Int/Ext.	\$137/\$186
Comer TapeStar 800mb Int/Ext.	\$119/\$230
Comer TapeStar 3200mb Int.	\$239
Imagema Dite Easy 800mb Int/Ext.	\$119/\$146
Imagema Dite 3200 Int/Ext.	\$237/\$291
Microsilutions Back Pack 800mb to Ext.	\$139
3M Travan Tape Cartridge 800mb/3200mb	\$31/\$335
TapeStar 4000, 1.4GB, SCSI, Int./Ext.	\$383/\$509
TapeStar 4000, 1.4GB, EIDE, Int.	\$383

### TOSHIBA

T100CS, Pentium/75, 8MB, 10.4" DS, 520MB	\$1,936
T210CS, 486DX/75, 8MB, 10.4" DS, 520MB	\$1,549
T410CS, Pentium/90, 8MB, 11.3" DS, 810MB	\$2,099
T410CD, Pentium/90, 8MB, 11.3" Active, 810MB, CDROM	\$4,261
T410CT, Pentium/90, 8MB, 9.5" Active, 720MB	\$3,874
Tera 700CS, Pentium/120, 8MB, 11.3" DS, 1.2GB	\$3,874
Tera 700CD, Pentium/120, 16MB, 11.3" Active, 1.2GB	\$4,942
Tera 700CD, Pentium/133, 16MB, 12.1" Active, 1.2GB	\$7,384

### TEKRA INSTRUMENTS

MicroStar WinViz	\$422	MicroStar 600	\$844
MicroStar Pro/B	\$1,097	MicroStar Pro/12	\$1,330
HEWLETT-PACKARD Deskjet 340	\$296	Deskjet 600	\$203
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1050MB	12ms	5400	Quantum	FB1080S	3	\$259
1050MB	9ms	5400	Seagate	ST31051N	3	\$349
1080MB	11ms	5400	Seagate	ST51080N	3	\$239
1280MB	12ms	5400	Quantum	FB1280S	3	\$279
2050MB	8.5ms	7200	Micropolis	MC4221	5	\$609
2050MB	8.5ms	7200	Micropolis	MC4221AV	5	\$685
2147MB	9ms	5400	Micropolis	MC4421	5	\$499
2147MB	9ms	5400	Conner	CFP2105S	5	\$595
2147MB	9ms	7200	Conner	CFP2107S	5	\$645
2147MB	9ms	5400	Seagate	ST32151N	5	\$619
2147MB	9ms	5400	Seagate	ST32430N	5	\$609
2147MB	8ms	7200	Seagate	ST32550N	5	\$675
2150MB	8ms	7200	Quantum	XP32150	5	\$639
4290MB	8ms	7200	Seagate	ST15150N	5	\$999
4290MB	9ms	5400	Seagate	ST15230N	5	\$905
4294MB	9ms	7200	Conner	CFP4207S	4	\$935
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9091MB	12ms	5400	Micropolis	MC1991	5	\$1919
9091MB	12ms	5400	Micropolis	MC1991AV	5	\$2029
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2147MB	8ms	7200	Seagate	ST32550W	5	\$749
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850MB	10ms	4500	Western Digital	AC2850	3	\$195
850MB	14ms	4500	Quantum	TB850A	3	\$195
1080MB	11ms	5400	Seagate	ST51080A	3	\$209
1080MB	9.5ms	5400	Fujitsu	M1606T	3	\$209
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1084MB	14ms	4480	Maxtor	M71084A	2	\$205
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1250MB	15ms	3600	Quantum	BF1250A	3	\$215
1275MB	14ms	3600	Conner	CF51275A	2	\$229
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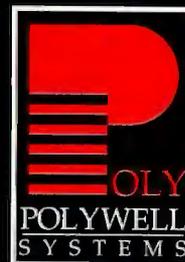
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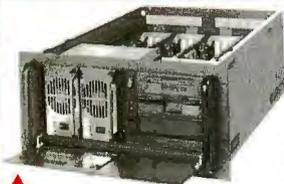
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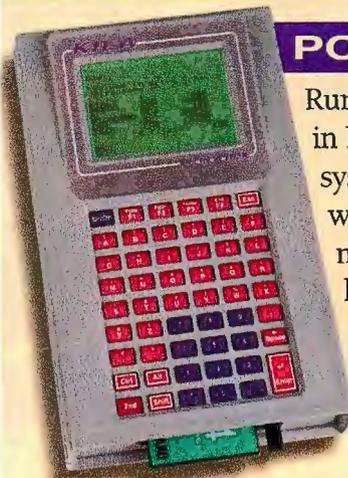
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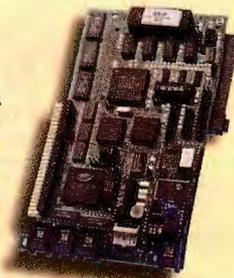
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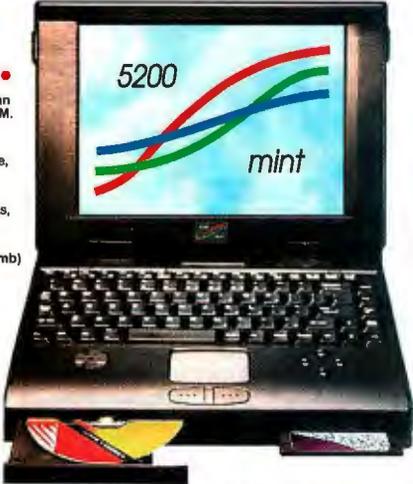
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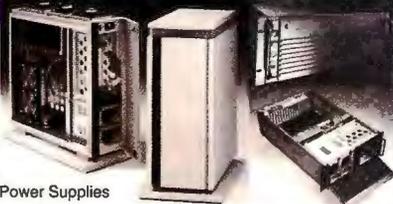
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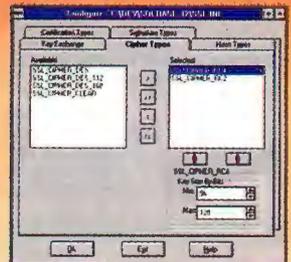
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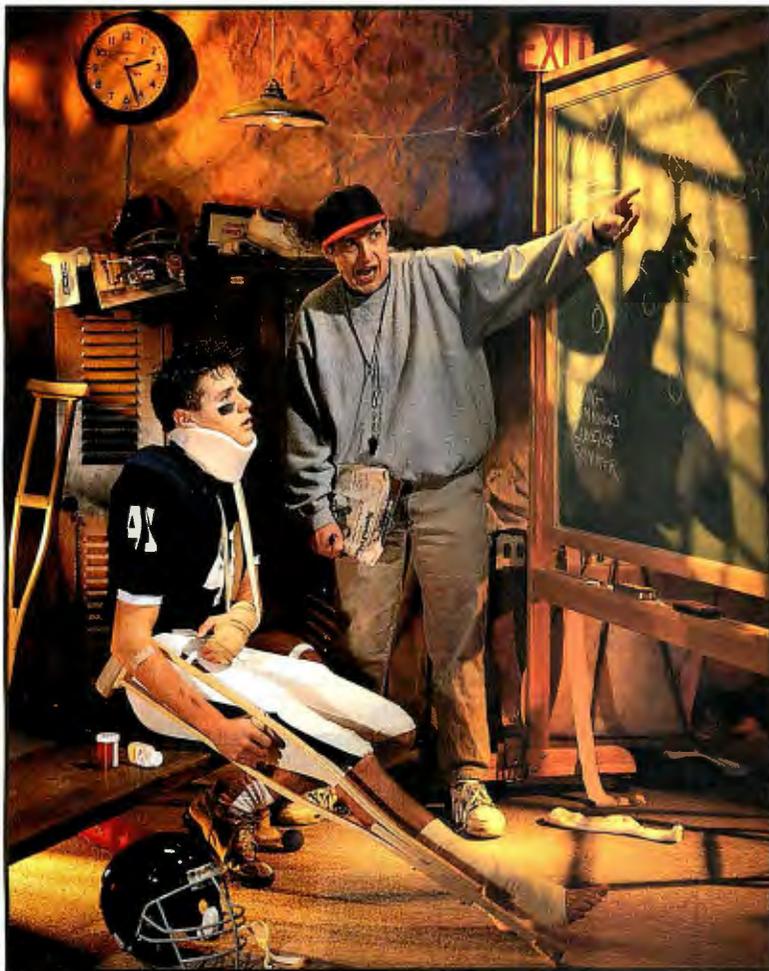
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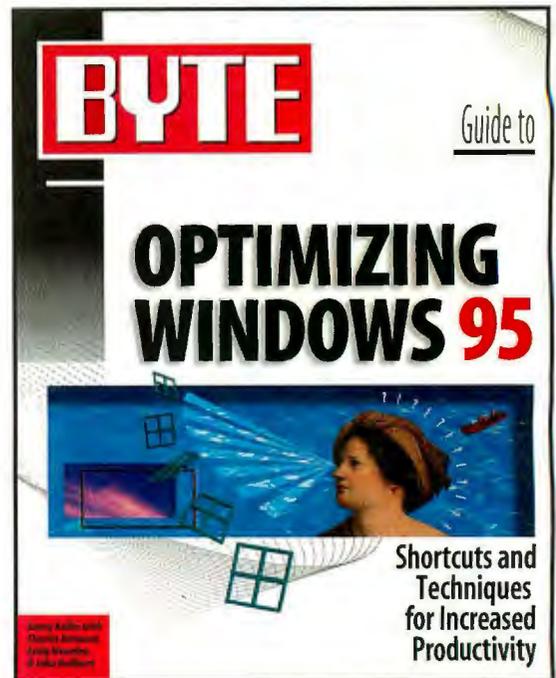
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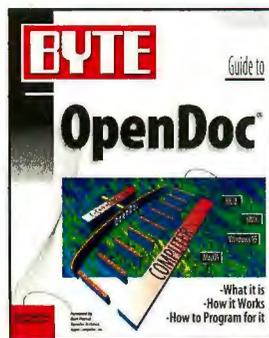
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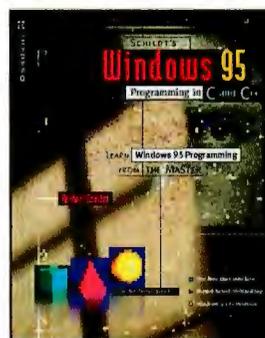
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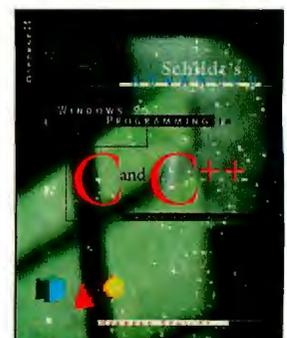
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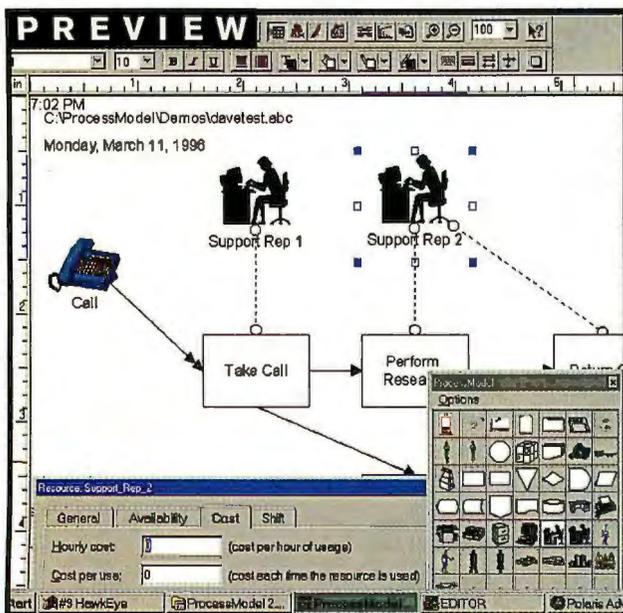
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## A Friendly Face for Reengineering

Companies dedicated to continuous process improvement should investigate ProcessModel, a Windows 95 application for reengineering your business. The program combines a simulation engine from ProModel (Orem, UT), a vendor of simulation software for manufacturing, and the user-friendly flowcharting interface of Micrografx ABC FlowCharter. The result is an easy-to-use program that lets you model an environment's processes (including such things as cost of goods and employee labor per hour) and then run a simulation that uses live animation. You can also compare different scenarios to predict the effect of a process change.

I found ProcessModel's interface (see the screen) easy to learn. As you create the model, you fill in a series of tabbed dialog boxes that assign resource costs to various activities. Within minutes, I created a working model of a typical work-flow scenario and ran a simulation. ProcessModel's simulation engine lets you view more than blinking boxes: You see actual objects flowing through the system. I then viewed the simulation results in a variety of reports and charts that showed me potential bottlenecks.

ProcessModel should be a boon to those who want to evaluate new ways to reduce costs or improve efficiency. My only concern is that the high cost of ProcessModel (\$695) may keep the program off some desks.  
 — Dave Andrews

## Business

### Accounting and Payroll for Windows 95, 3.1, and NT

DESIGNED FOR BUSINESSES WITH ONE TO 50 employees, DacEasy Accounting & Payroll 95 (\$149.95) features a customizable interface, six integrated help systems, modifiable invoices for service- and inventory-based companies, multilevel security, more than 100 business templates, a report designer, communications tools, and a payroll module. New features include an audit-trail drill-down, credit-card processing, automatic error correction in posting routines, LIFO inventory control, multiple prices and discounts, contra entries, fixed assets, multiple company consolidation, global changes, reorder notification, and importing capabilities.

Contact: DacEasy, Inc., Dallas, TX, (800) 322-3279 or (214) 248-0205; [www.daceasy.com](http://www.daceasy.com).  
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## Connectivity

### Virtual CD-ROM Drives over a LAN

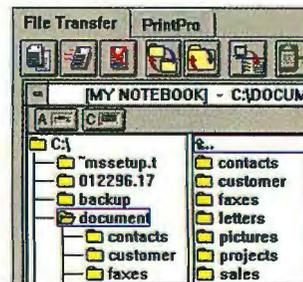
NOW NETWORK AND REMOTE USERS CAN share CD-ROM-based information simultaneously without actually having a CD-ROM drive on their PCs. The d-Time Office program (\$500 for 20 users) stores frequently used CD-ROM information

in an "acceleration file" that's stored on your hard disk instead of constantly accessing information from a network CD-ROM drive. In this way, the program allows an entire office to use a single CD-ROM drive via the network. For DOS, Windows, and the Mac, d-Time Office enables you to replace the information stored in your acceleration file as well as increase the acceleration file's size.

Contact: Ballard Synergy, Silverdale, WA, (800) 754-1204 or (206) 656-8070; [www.ballardsynergy.com](http://www.ballardsynergy.com).  
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### Infrared Data-Exchange Software

TRANXIT PRO LETS MOBILE AND DESKTOP PC users seamlessly and wirelessly synchronize, print, and transfer files and data across diverse OSes and hardware platforms in real time.



The product is available both as a software-only package (\$99.95) for users needing IR connection between systems that are IR-enabled and as a TranXit Pro Connectivity Kit (\$129.95), which includes an IR serial adapter and software, for those who have an IR-enabled notebook but whose desktop is not IR-enabled.

Contact: Puma Technology, San Jose, CA, (800) 774-7862 or (408) 321-7650; [www.pumatech.com](http://www.pumatech.com).  
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#### Available Titles:

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We're seeing lots of products for the Web. This month's lineup includes a program that lets you translate international-language Web sites, plus programs that help you create, manage, search, and stylize Web sites.

## Programming

### Reuse and Share OLAP Objects

A COMPANION PRODUCT TO THE ORACLE Express Analyzer object-oriented data-analysis tool (\$595), Oracle Express Objects (\$3995) enables you to reuse and share OLAP objects, such as tables, graphs, models, and data-mining criteria, in your applications. Oracle Express Objects includes inheritance, encapsulation, and polymorphism capabilities; multidimensional data-aware controls; event-driven and visual programming; Windows controls; menu and toolbar customization; a color-coded source editor; interactive debugging; and support for OLE 2.0 and OCXes.

Contact: Oracle Corp., Waltham, MA, (800) 672-2531 or (617) 768-5600; [www.oracle.com](http://www.oracle.com).

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### Streamline Error Detection

AVAILABLE FOR UNIX AND WINDOWS NT and 95, CodeWizard (\$999) reads your code and automatically reports any rule violations, specifying the filename, the line number



in which the violation occurs, the rule that you violated, and an explanation of the violation. In addition, you can adapt CodeWizard to learn your preferred rules.

Contact: ParaSoft Corp., Monrovia, CA, (818) 305-0041; [www.parasoft.com](http://www.parasoft.com).

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## Science

### Partial Differential Equation Toolbox

AN ADD-ON TO MATLAB 4.2C, PARTIAL Differential Equation (PDE) Toolbox enables you to model and solve elliptic, parabolic, hyperbolic, and eigenvalue PDEs. The program steps you through defining the 2-D geometry, setting boundary conditions, selecting the type of PDE, solving the PDE, and displaying the results. The Toolbox (from \$595) is available for Windows-based PCs, Macintosh systems, and Unix-based workstations.

Contact: The MathWorks, Inc., Natick, MA, (508) 647-7000; [www.mathworks.com](http://www.mathworks.com).

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## The Web

### Create Intranet and WWW Applications

AVAILABLE FOR WINDOWS 3.X, 95, AND NT, the NetCraft and ObjectCraft programs help you construct reusable intranet and Web applications. NetCraft (\$995), a browser/server tool, generates Java source code optimized for building platform-independent intranet applications that you can deploy throughout an enterprise. ObjectCraft (\$1995), a client/server development environment, generates Visual C++ source code that ensures application portability, scalability, and OLE and OCX compliance.

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Contact: SourceCraft, Inc., Burlington, MA, (800) 462-5328 or (617) 221-5665; [www.sourcecraft.com](http://www.sourcecraft.com).

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### Search Relational Databases on the Web

WORKING WITH SQL DBMS DATA sources and Web HTTP servers, Level5 Quest Server (\$4995) allows visitors to your Web site to perform a search and receive their search information ranked and scored according to their preferences. The Quest Server provides you with customer-interest profiles by tracking what visitors select as search targets and what they indicate as important. The Level5 Quest Workstation (\$495), a Windows application, controls and maintains database connectivity, fuzzy-search-engine settings, and search-results-formatting settings.

Contact: Level Five Research, Melbourne, FL, (800) 444-4303 or (407) 729-6004; [www.l5r.com](http://www.l5r.com).

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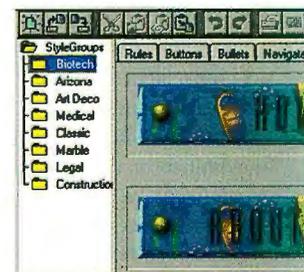
Component Editor, the Image Manager, and the Load Manager. The program (Starter Edition, \$199; Standard Edition, \$299; Designer Edition, \$529) complements HTML editors, such as Microsoft FrontPage and Netscape Navigator Gold, which you use to create Web content and structure. The package supports over 15 major graphics file formats and runs under Windows 3.1, 95, and NT and Windows for Workgroups 3.11.

Contact: DigitalStyle Corp., San Diego, CA, (800) 388-7895 or (619) 673-5050; [www.digitalstyle.com](http://www.digitalstyle.com).

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### Translate International-Language Web Sites

NOW YOU CAN TRANSLATE THE CONTENTS of sites on the Internet that are currently written in Spanish, French,



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Contact: Globalink, Inc., Fairfax, VA, (800) 255-5660 or (703) 273-5600; [www.globalink.com](http://www.globalink.com).

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**SOFTWARE UPDATE**

The Visual SlickEdit for X Windows graphical programming editor is compatible across Windows 3.x, 95, and NT; OS/2; and X Window System platforms, including AIX RS/6000, HP-UX, Solaris-Sparc, Solaris-Intel, Sun OS, SGI Irix, Digital Unix, and Linux. For most X platforms, \$395 per user; for Linux, \$195 per user; for Windows-based platforms, \$295 per user; for OS/2, \$219 per user.

Contact: *MicroEdge, Inc., Raleigh, NC, (800) 934-3348 or (919) 831-0600; www.slickedit.com.*

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For developing test and measurement applications, DT VEE 3.2 adds Windows 95 support; more options for building custom instrument panels, data displays, and controls; real-time hardware control; and easy connectivity to HP-IB and VXI interfaces. \$1290.

Contact: *Data Translation, Marlborough, MA, (800) 525-8528 or (508) 481-3700; www.datx.com/.*

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You can create virtual objects with photo-mapped surfaces and export 3-D models that you generate with PhotoModeler 2.1 in VRML format. US\$795.

Contact: *Eos Systems, Inc., Vancouver, British Columbia, Canada, (604) 732-6658; www.wimsey.com/PhotoModeler/.*

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A TCP/IP mail client, Pronto96 3.0 includes a sound-recorder icon that records voice messages as Windows 95 or NT voice files and then sends them as e-mail attachments using the MIME format. \$69.

Contact: *CommTouch Software, Inc., Sunnyvale, CA, (408) 245-8682; www.commtouch.com.*

**Circle 1000 on Inquiry Card.**

**HARDWARE****Accessories****Compact Audio Speaker System**

BOTH PC- AND MAC-COMPATIBLE, THE SP-3d (\$199) incorporates SRS Labs' SRS 3-D stereo technology, which creates a panoramic, 3-D sound experience with no centered listening position. The self-powered, bi-amplified system features two ultracompact, lightweight satellite speakers and a subwoofer. All three components are driven by separate power amplifiers and have vibra-



tion-isolated circuitry. You can place the magnetically shielded, angle-adjustable speakers on most surfaces, including the sides of video monitors.

Contact: *Nakamichi America Corp., Torrance, CA, (310) 538-8150; www.nakamichi-corp.com.*

**Circle 1001 on Inquiry Card.**

**Flexible Pointing Device**

THE GYROPOINT DESK (\$149) OFFERS standard on-the-desk mouse features and, using two gyroscopes inside to sense motion, also allows you to pick up the device and then move your wrist in the direction that you want to move the cursor: up, down, left, right, or diagonally. The pointing device is compatible with Windows 3.x, NT, and 95 and Apple Macintosh and PowerPC computers.

Contact: *Gyration, Inc., Saratoga, CA, (800) 316-5432 or (408) 255-3016; www.gyration.com.*

**Circle 1002 on Inquiry Card.**

**Display Computer Images on TVs**

A POCKET-SIZE SCAN CONVERTER, THE PC Micro Presenter (\$149) lets you display images from a desktop or laptop PC on any size TV. Four micro-touch buttons let you manipulate



the computer image on the TV screen, so full windows, toolbars, and other functions are visible. The PC Micro Presenter supports up to 16.7 million (24-bit) colors, connects to the PC's video port, and is compatible with NTSC and PAL TV standards.

Contact: *Focus Enhancements, Inc., Woburn, MA, (617) 938-8088; www.shore.net/~focus.*

**Circle 1003 on Inquiry Card.**

**Connectivity****Multiprotocol Ethernet Print Servers**

SINGLE-PARALLEL-PORT PRINT SERVERS, THE M205 for 10Base-T and the M206 for 10Base-2 (US\$375 each) support up to 500 workstations. You can manage them via SNMP, simple telnet, or NPWIN, Microplex's Windows-based GUI manager, and preconfigure multiple virtual-printer destinations to perform ASCII-to-PostScript conversion and font or tray selection. Monitoring and status reporting via SNMP and SMTP e-mail provide information for print queues, error conditions, off-line, and paper out.

Contact: *Microplex Systems, Ltd., Burnaby, British Columbia, Canada, (800) 665-7798*



or (604) 444-4232; [www.microplex.com](http://www.microplex.com).

**Circle 1004 on Inquiry Card.**

**Point-to-Point Infrared Communications**

THE SIDEPOINT 3000 ENABLES YOU to transfer files and data between desktop PCs and peripherals up to 9 feet apart without a physical cable connection. The device (\$89) provides wireless serial infrared communications at data rates of 19.2, 38.4, 57.6, and 115.2 Kbps.

Contact: *Quick Technology Corp., Tustin, CA, (800) 950-8999 or (714) 258-4500; quick8@ix.netcom.com.*

**Circle 1005 on Inquiry Card.**

**28.8 Modem/Sound Card**

COMMANDO (\$249) COMBINES THE functions of a 28.8-Kbps V.34 fax modem, a wave-table sound card, a full-duplex speakerphone, a voice-mail answering system, and fax on demand on a full-size ISA bus card. You can have a conversation and exchange information during the same phone call, discuss document edits while making changes on-line, update spreadsheets, and play interactive modem games, all over the same phone line.

Contact: *Amquest Corp., Lancaster, PA, (800) 577-3335 or (717) 569-8030.*

**Circle 1006 on Inquiry Card.**

**Data Acquisition****Interchangeable Data Acquisition Subsystems**

CONSISTING OF A VME MOTHERBOARD, interchangeable daughtercards, and a range of front-panel data-interface modules, the VGX family of products (from under \$5000) offers data acquisition solutions for most environments. The daughtercards, called the VGD 1, VGD 2, VGD 3, and VGD 4, provide two, 16, eight, and 96 channels of A/D conversion, respectively, at rates up to 30 MHz,

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Circle 136 on Inquiry Card.

3.75 MHz, 1.5 MHz, and 80 kHz, respectively.

Contact: *Pentland Systems, Ltd., Plano, TX, (800) 517-9343 or (214) 517-9343; www.linnet.co.uk/linnet/pentland/index.html.*

Circle 1007 on Inquiry Card.

## Data Acquisition for Windows

AVAILABLE WITH 16-BIT ANALOG INPUTS and outputs, the 5803HR data acquisition board comes with Windows-specific hardware features, such as dual and interrupt DMA; a

1024-word ADC FIFO; on-board RAM for channel-gain list storage; programmable gain of 1, 2, 4, and 8 (\$995) or 1, 10, 100, and 500 (\$1095); multiple triggering modes; 40 digital I/O lines; and a 16-bit ISA interface. The included Direct View for Windows software performs high-speed data collection, display, and streaming to disk.

Contact: *American Data Acquisition Corp., Woburn, MA, (800) 648-6589 or (617) 935-3200; www.adac.com.*

Circle 1008 on Inquiry Card.

## Thermal-Dye Printers

THE KODAK DIGITAL SCIENCE 8650 PRINTERS can produce photo-quality



prints and transparencies and CMYK page-size proofs. The printers provide faster transparency printing, a 10 percent to 15 percent increase in EtherTalk performance, a 50 percent increase in Novell and TCP/IP system capability, and multiple image composition, which enables you to designate the placement of images on each page. There are three versions of the 8650, each of which can print in three colors or black only: a raster-only device (\$8995) and two PostScript-compatible or raster printers, one with 32 MB of memory (\$9995) and one with 48 MB of memory (\$10,795), upgradable to 64 MB.

Contact: *Eastman Kodak Co., Rochester, NY, (800) 235-6325 or (716) 726-7260; www.kodak.com.*

Circle 1011 on Inquiry Card.

## Dye-Sublimation Color Printers

THE COLORSTREAM II DP AND COLOR-Stream II DPL printers come with embedded Adobe PostScript Level 2 support, an on-board 33-MHz AMD 29030 RISC processor, a 543-MB internal hard drive, a resolution of 300 by 300 dpi, and professional color-matching software. The DP (\$7995) ships with 16 MB of RAM, upgradable to 128 MB, and can print full-bleed Super A size at 9.4 by 12.6 inches. The DPL (\$14,995) ships with 24 MB of RAM, also upgradable to 128 MB, and has the ability to print full-bleed Super B images up to 12.2 by 18 inches with crop marks.

Contact: *Shinko Technologies, Inc., Hayward, CA, (800) 997-4465 or (510) 441-1175.*

Circle 1012 on Inquiry Card.

## Printers

### HP PCL 6 LaserJet 5s

THE HP LASERJET 5 (\$1629), 5N (\$1929), and 5M (\$2229) come with HP PCL 6, which provides faster graphics printing, improved gray-scaling, new font-synthesis technology, and backward compatibility. Designed for workgroups of up to 10 users, the 12-ppm, 600-dpi LaserJet 5 printers include a 33-MHz i960 JF RISC processor; 2- or 4-MB flash-memory modules for storing forms, fonts, and signatures; a new control panel; a job-cancel button; paper-level indica-

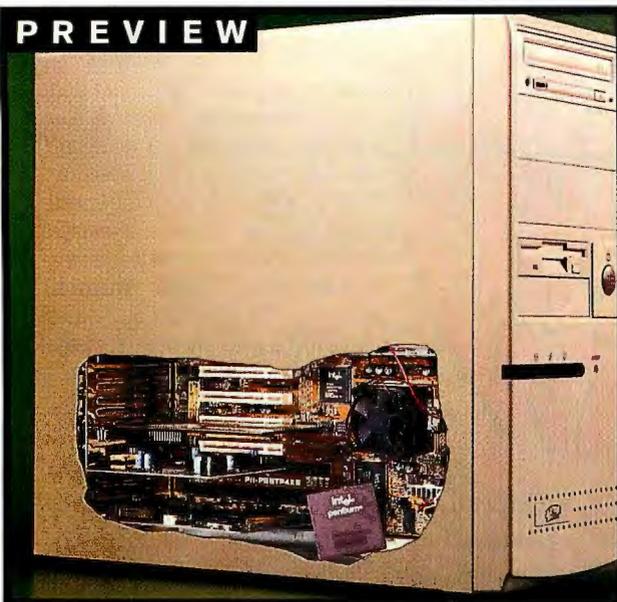


tors; and dual paper trays capable of handling 100 and 250 sheets. Options include an IR Connect infrared port, which lets you print by placing your IRDA-compatible portable device within about 3 feet of the printer; a third paper tray; duplex printing; and a power envelope feeder. The LaserJet 5N, which is network-ready for PCs in Ethernet environments, comes with a 10Base-T card and HP JetAdmin software. The LaserJet 5M is for Mac environments.

Contact: *Hewlett-Packard Co., Santa Clara, CA, (800) 752-0900 or call local HP dealer; www.hp.com.*

Circle 1010 on Inquiry Card.

## PREVIEW



### Performance C166+

with Cyrix P166+ or

Performance P166T with i66-

MHz Pentium with 16 MB of

RAM, \$2669; with 32 MB, \$3119

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### Sys Technology, Inc.

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www.systechnology.com

## Pentium Performance from Cyrix's P166+

FOR the same price, Sys Technology offers two identical systems with a choice of CPUs—a Cyrix 133-MHz P166+ or a 166-MHz Pentium. We swapped the CPUs on the Asustek P/I-P55TP4XE motherboard in and out of one system and ran the BYTEmark 2.0 and BAPCO SYSmark benchmarks. Both systems came with 32 MB of 60-ns EDO RAM.

The BYTEmark is a CPU/FPU test, and the Cyrix-based system posted an integer score of 1.76, just 3 percent slower than the Pentium's 1.81 score. Its floating-point performance of 0.78 was 57 percent less than the Pentium's 1.81 score. If your work involves FPU-intensive applications, such as 3-D graphics, go with the Pentium. On BAPCO's SYSmark 95 for Windows 3.1, the Cyrix score of 541.62 lagged behind the Pentium's 543.14 by 3 percent. However, its SYSmark NT score of 332 was faster than the Pentium's 307 by 8 percent.

The Cyrix P166+'s architecture includes a fully compatible x86 instruction set, two seven-stage pipelines (versus the Pentium's two five-stage integer pipelines), register renaming, multibranch prediction with speculative execution, and out-of-order execution. Depending on the applications that you run, the Cyrix 133-MHz P166+ delivers 166-MHz Pentium performance.

—Selinda Chiquione

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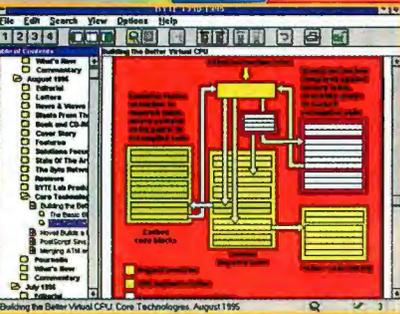
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## Large-Format Ink-Jet Printer

WITH A PRINTABLE WIDTH OF 49½ INCHES and media lengths up to 300 feet, the NovaJet Pro 50 (\$16,995; with optional RIP, \$22,995) comes with a motorized media-feed and take-up system, which winds finished images onto a separate spool. The optional NovaJet 50 RIP, a software raster-image processor in a hardware black box, features 32-bit processing, 32 MB of RAM, an 840-MB internal hard drive, built-in color calibration links via Color Solutions' ColorBlind engine, and seven user-specified screening patterns, including stochastic screening for photo-realistic prints and fixed-dot random-pattern diffusion for detail and crispness.

Contact: *Encad, Inc., San Diego, CA, (800) 453-6223 or (619) 452-0882; www.encad.com.*

Circle 1013 on Inquiry Card.

## Storage

### 9-GB CD-ROM Array

THE CD TOWER-14 ETHERNET SUBSYSTEM (\$7725) comes in a 14-drive enclosure that Procom Technology can configure with four, seven, 10, or



14 quad- or six-speed CD-ROM drives. The drives deliver an average seek time up to 100 ms and a sustained data transfer rate up to 1 GBps.

Contact: *Procom Technology, Irvine, CA, (800) 800-8600 ext. 414 or (714) 852-1000; www.procom.com.*

Circle 1014 on Inquiry Card.



### Dual-Controller RAID Storage for Midrange Sun Servers

SUPPORTING RAID LEVELS 0, 1, 0+1, and 5, the SuperFlex 5000 (from \$15,500) provides dual redundant controllers; battery-backed, mirrored cache, which preserves cache contents for up to 48 hours; a differential fast/wide SCSI connector to the host; seven bays, each capable of housing a 3½-inch, 2- or 4-GB, 7200-rpm drive module; and RAIDFlex-D, an i960 RISC-based processor providing 4 to 32 MB of write-through or write-back cache. Contact: *Storage Dimensions, Milpitas, CA, (408) 954-0710; www.storagedimensions.com.*

Circle 1015 on Inquiry Card.

### Travan-Compatible Tape Drives

THE TAPE800 (ABOUT \$149) USES Travan TR-1 minicartridge technology to achieve a compressed capacity of 800 MB, and the Tape1600 (about \$179) employs 2-to-1 compression of TR-2 tape cartridges to achieve a compressed capacity of 1.6 GB, or 800 MB uncompressed. Both internal drives feature a dual data transfer rate of 500 Kbps/1 Mbps, a backup speed of up to 9.5 MB per minute, and support for QIC standard/QIC wide tape formats. Contact: *Teac America, Inc., Montebello, CA, (213) 726-0303.*

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## Systems

### 333-MHz AlphaStation

INCORPORATING THE 64-BIT, 333-MHz Alpha 21164 microprocessor, the AlphaStation 600 5/333 (\$28,885) comes with 32 MB of memory, a 17-inch color monitor, a 1-GB hard

drive, 4 MB of fast cache, a ZLXp-E1 graphics adapter, a floppy drive, a CD-ROM drive, audio, a mouse, and a keyboard. The AlphaStation 600 5/333 runs Windows NT, Digital Unix, and OpenVMS.

Contact: *Digital Equipment Corp., Maynard, MA, (800) 842-7027; www.alphastation.digital.com.*

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### Plug-and-Play Internet Servers

THE WEBCUBE SERIES P (FROM \$7995) includes a 100-MHz Pentium CPU,



32 to 128 MB of RAM, 2-GB SCSI disk and tape drives, a quad-speed CD-ROM drive, 32-bit PCI Ethernet, SVGA video, 32 high-speed serial ports, and a router (with CSU/DSU) that supports T1, fractional T1, 56-KB, or frame-relay connections. The Series P also comes with Internet applications and utilities, including TCP/IP, PPP/SLIP, and UUCP; Mail, FTP, News, telnet, Web, gopher, and WAIS server software; and system accounting and BBS software.

Contact: *Pacific Internet, Culver City, CA, (800) 572-2638 or (310) 410-9700; www.pacnet.com/.*

Circle 1018 on Inquiry Card.

### 100-MHz 486DX4 Tablet PC

WEIGHING JUST 3.4 POUNDS, THE FUJITSU Stylistic 1000 (from \$2895) offers 8 MB of DRAM, expandable to 24 MB; a 260- or 340-MB hard drive;



advanced power management; a metal-tip stylus; standard peripheral ports; two stacked Type II PC Card slots and one Type III ATA slot; an infrared wireless adapter; 4 to 6 hours of operation on a battery charge; Windows 95; and Microsoft Pen Services 2.0. The PC is available with a 7.8-inch DSTN color display, a 7.9-inch transmissive monochrome display, or a 7.9-inch trans-reflective monochrome display.

Contact: *Fujitsu Personal Systems, Inc., Santa Clara, CA, (800) 831-3183 or (408) 982-9500.*

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## Video

### CGI/Video Authoring Workstations

NOW YOU CAN CREATE, RENDER, AND VIEW computer-generated images (including 3-D animations) and then generate digital Betacam-quality video. The StudioZ CGI/Video Authoring Workstation (from \$27,095) also enables you to perform video



authoring, assembly, nonlinear editing, and playback of your animated models, images, and rendered sequences. StudioZ workstations come with 180-MHz (single configuration) and 200-MHz (dual- and quad-configuration) Pentium Pro processors; 1- or 2-megapixel screen resolutions; 64 or 128 MB of RAM; 12, 24, or 34 MB of video memory; 8 or 32 MB of texture memory; a 2- or 4-GB hard drive; and a quad-speed CD-ROM drive.

Contact: *Intergraph Computer Systems, Huntsville, AL, (800) 763-0242 or (205) 730-2000; www.intergraph.com/ics.*

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Descended from military heads-up displays, twin miniature LCD projection units improve color fidelity. With the right software, stereoscopic imaging tricks the brain into seeing a 3-D image.

These toys won't be just for games for long. Soon businesses will immerse customers in that new building or car in a much more informative way than with flatlander graphics. That same new car will be designed with this technology. Dispersed teams of engineers—each with their own avatar—will interact with the product and each other as if they were in the same room (OK, touch is limited and smell is out). Meanwhile, Christmas is only six months away.

For applications that require a joystick, a puck feels more natural. Hand motions tell the computer which way to move; the three buttons actuate preprogrammed functions.



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- PCI Bus Architecture
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