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SEPTEMBER 1993

BYTE

THE WORLDWIDE COMPUTING AUTHORITY

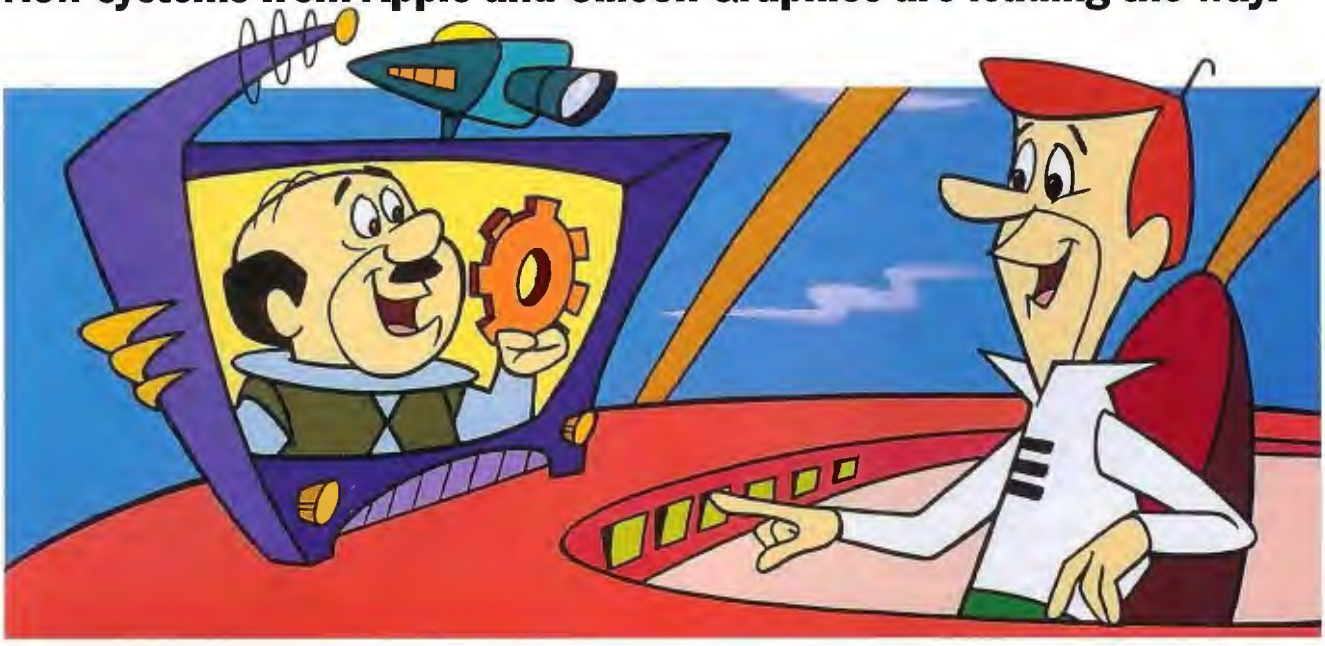
Michael Crichton on Prehistoric Install Programs

C++ Compilers for Windows

Peer LAN Review: LANtastic vs. Invisible LAN

Video Computing

It's not just for the Jetsons. Video is arriving as a real business tool. New systems from Apple and Silicon Graphics are leading the way.



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intel inside

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July 1993

PC WORLD

1993 BYTE READERS' CHOICE AWARD

Service Award

Gateway 2000 Outmaneuvers The Co

In the fast-moving, hard-driving PC industry, the race for leadership is more competitive than a heat at your local stock car speedway. All classes of PC manufacturers are on the direct market track together, trading paint and slamming each other into the wall at every turn. All the while, the unassuming cow-spotted Gateway car consistently outmaneuvers and overpowers the competition. Repeatedly, Gateway 2000™ leads the field by providing you with the best value in the PC industry. When Gateway takes the checkered flag in this race, you're the winner!

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BYTE
SEPTEMBER 1993 VOL. 18, NO. 10

News & Views

Cover Story

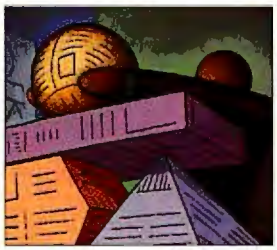
Features

Reviews

State of the Art

This month's cover image—*showing George Jetson and his boss taking advantage of digital video communications—was created exclusively for BYTE by artists at Hanna-Barbera.*

Hands On



Opinions

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From BIX: Join "listings/frombyte93" and select the appropriate subarea (i.e., "aug93").

From the UUNET:ftp to ftp.uu.net, log on as "anonymous," and enter your user ID as your password. Type "cd/published/byte" and type "DIR." Files appear in subdirectories arranged by month.

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

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BYTE Contents by Platform

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

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OS/2

Macintosh

Unix

Networks

Client/Server

Index

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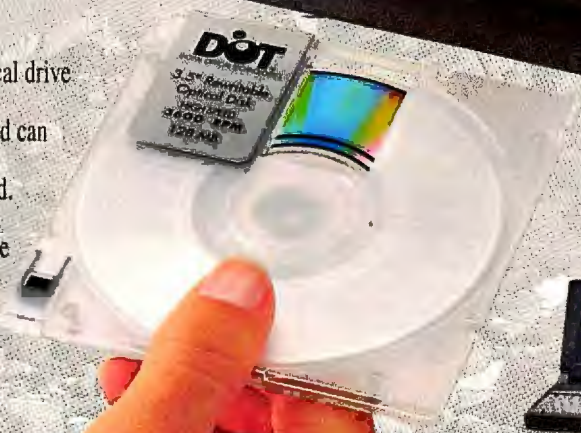

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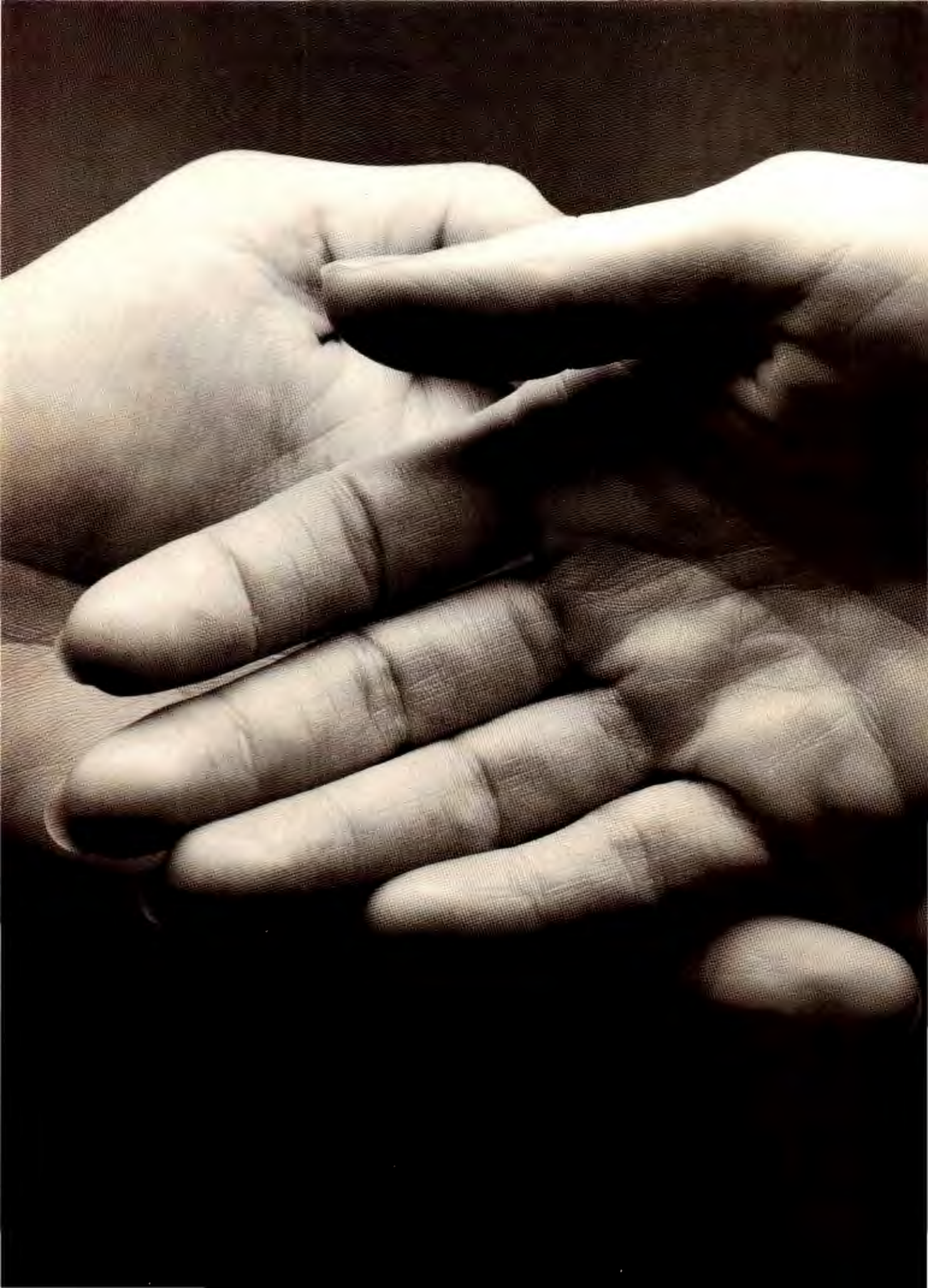

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The Promise of High-Tech

Exploitive promises only serve to confuse the ill-informed and artificially inflate market demand

Our generation always knew that video computing would happen, and we knew it long before personal computers even existed. We grew up believing in it like we believed in many other high-tech possibilities. The potential of technology seemed endless and so simple that our imaginations were easily ignited by "The Jetsons," *2001: A Space Odyssey*, a myriad of science fiction novels, and countless B-grade sci-fi movies.

The question has never been *if* the technology would be possible, but *when* it would become available. And therein lay the implicit promise that the general media so willfully and continually exploited, raising expectations of technology beyond what could actually be achieved.

So it was with a little tongue in cheek that we chose an image from "The Jetsons" for our cover art. No, I'm not suggesting that George Jetson's view of video computing is even close to today's video reality. However, the fine folks at Hanna-Barbera created a wonderful original illustration for BYTE that reminds me of how the general public perceives video computing. It also reminds me of the nearly three decades of raised expectations and undelivered promises that have confused computer illiterates. Is it any wonder that when it comes to video computing so many people are jaded?

Some folks will say that video computing is a solution looking for a problem. You and I, of course, know better. We know that while the enabling technology has finally arrived in the form of integrated, video-ready systems such as the Silicon Graphics Indy and the Apple AV Macs, the application of that technology must still be developed. That means a lot of hard work from folks like you, who choose to implement desktop video, and from folks in the computer industry, who should listen to your needs. I'm confident that work will be fruitful, and that it will take the next few years to be accomplished.

Meanwhile, it's time that we hold in check some of the high-tech promises being exploited by the general press and industry leaders who stand to gain from that exploitation. Take, for example, John Sculley's promises for Apple's PDA (Personal Digital Assistant), the Newton. Over a year ago, Mr. Sculley—back when he was running the show at Apple—started his crusade about how the Newton, which is yet to become available, would do nearly everything that a secretary could do. Now *that* sounds like an idea right out of "The Jetsons." If you think for one minute that a hand-held computer is going to be anything nearly as effective as a real live assistant, then you're probably not a regular BYTE reader—BYTE readers know better.

The fact is that, since Mr. Sculley's first remarks about the Newton over a year ago, Apple has been doing some serious backpedaling about what the Newton might do. That's not to say that the Newton won't be a useful device; it may be, and we'll be the first to let you know one way or the other. To say the least, the Newton is very clever and interesting.

The point is just that I'm sick and tired of all the exploitive promises about high-tech that only serve to confuse the ill-informed while artificially inflating market demand. These promises also send other manufacturers on a wild-goose chase, and users down a primrose path loaded with more thorns than petals.

Sure, PDA technologies hold a great deal of potential, and there's nothing wrong with dreaming a little. To paraphrase Henry David Thoreau, we *should* build castles in the clouds. But we must also construct solid foundations to support them. For PDAs, though, the foundation, or enabling technologies—namely greater horsepower and miniaturization—are yet to come.

For the time being, these little hand-held computers will be cute and perhaps useful. But calling a tiny computer an "assistant" is stretching things a bit too much. Regrettably, though, these devices have already been christened, and BYTE will join the rest of the world in using the term *Personal Digital Assistant*. We do so under protest, however, because a tiny computer is no more an assistant than my lawnmower (or is that PMA—Personal Mower Assistant?) is. Hell's bells, my dog assists me better than the Newton ever will, and I don't call her a PDA (Personal Dog Assistant). At least my dog understands voice commands and can fetch things.

Please, let's spend less time perpetuating technology myths and more time creating and implementing enabling technologies that can do something useful.

DENNIS ALLEN, EDITOR IN CHIEF

THE WORLDWIDE STANDARD

"The new speed demon"

—*PC Magazine*, May 11, 1993

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*Usability Science Corporation, dBASE IV v2.0 vs. FoxPro v2.5, June 1993. †dBASE Compiler for DOS sold separately. Offer good in the United States and Canada only. Prices in U.S. dollars. Dealer prices may vary. BI 5750.1

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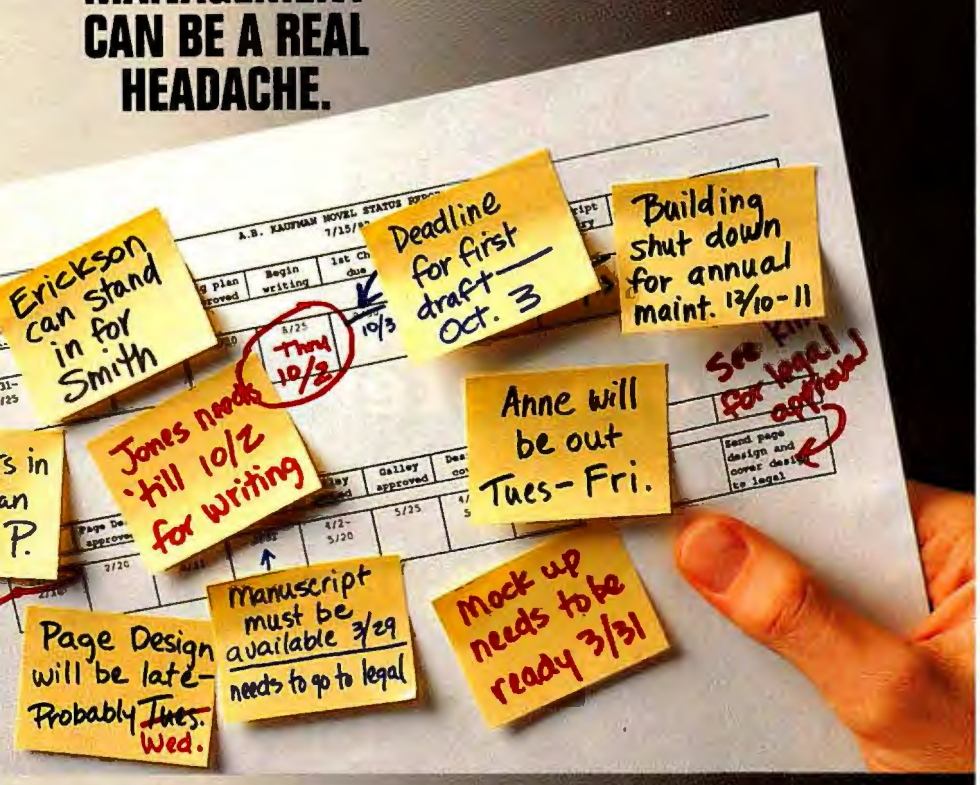

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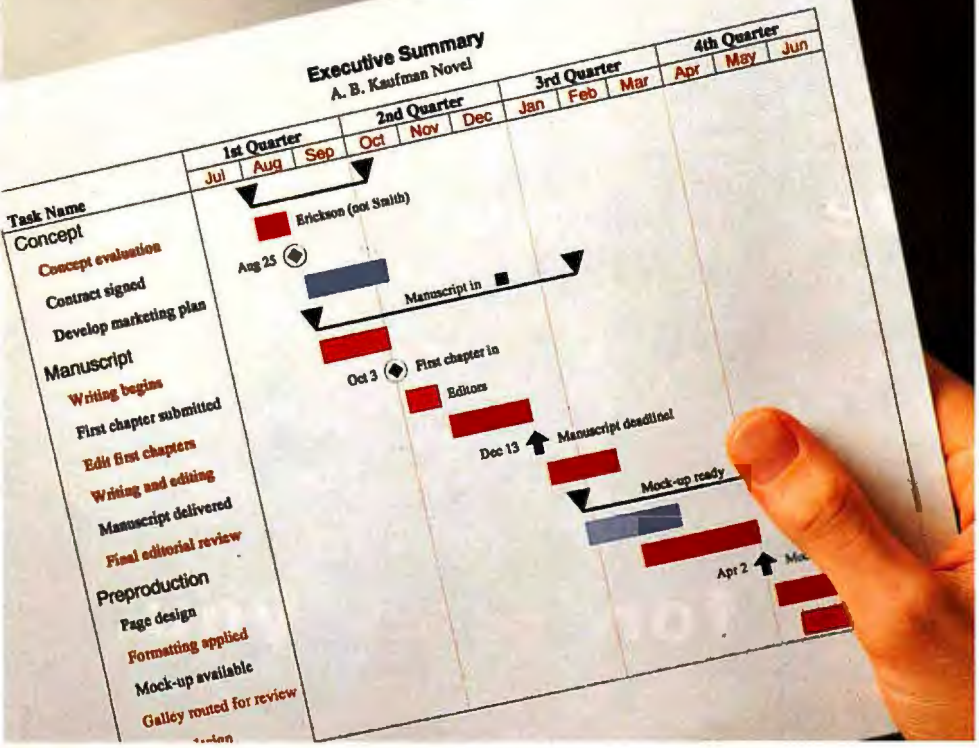

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Letters

A Better BYTE

The June issue of BYTE is the best one yet. Dennis Allen's editorial, an excellent article on OS/2 2.1 ("IBM Unleashes a New OS/2"), and a few objective criticisms of Windows ("Windows, Windows Everywhere?") indicate to me that BYTE does not intend to yield to the marketing pressures affecting most other publications.

Robert Simpson
Library, PA

Thank you for the new design of BYTE. I can't tell you how many times I have searched through a stack of magazines looking for an article that I remembered reading somewhere. It's truly amazing how a simple idea such as a better table of contents can reap great benefits.

J. R. Beecham
Lantana, FL

Windows Everywhere

In "Windows, Windows Everywhere?" (June BYTE), Jon Udell is correct to remind us of "software developers who were badly burned by Microsoft's handling of OS/2." Indeed, that should have been the theme of his entire article on the "Windows everywhere" strategy.

BYTE owes its readers more responsible reporting of computer technology. Udell raises important questions about the viability of "Windows everywhere," but the analysis of Windows NT and the "Windows everywhere" strategy is incredibly vacuous. After two years of hype, we are finally told that Windows NT will require too many resources and have too little downward compatibility for desktop systems.

Furthermore, NT's sparse graphics support limits its value as a graphics workstation, and its inability to support multiple terminals means it can't handle multiple users. The lack of global directory services gives pause to the question: How useful is NT as a network operating system? In view of these facts, the obvious question is: "Who needs NT?"

Remarkably, the credibility of this "Windows everywhere" strategy was never seriously questioned. Microsoft scarcely has a track record on multitasking systems. Yet we are supposed to believe that version 1.0 of one of the most complex systems Microsoft has ever designed will be a good candidate for a mission-critical server.

Udell recommends Win32s and suggests that Windows 4/DOS 7 is "lurking offstage." But he does not say when this may be available. The latest rumors seem to be late 1994. Given Microsoft's practice of missing shipping dates by more than a year, perhaps that means 1995. It might be more accurate to say Chicago isn't even on its way to the theater.

Richard E. Hodges
Los Angeles, CA

The opinions expressed are mine, but they are supported by interviews with dozens of software developers, system builders, and other industry experts. Most informed observers agree that the Windows API in its various forms is a force to be reckoned with, as is NT as the top tier of a layered operating-system strategy. Where there are holes in that strategy—advanced graphics, directory services, multiuser capability, and suitability for small and/or mobile devices—I called attention to them and discussed alternatives.

My assessment of NT is, indeed, strongly influenced by my own experience with the product. It has been, throughout its long beta-test cycle, as solid a system as I've ever seen. That robustness, coupled with strong device support, smooth application portability from 16-bit Windows, and the ability to leverage RISC and multiprocessing technologies, I find impressive.

Given the importance of the Windows 3.x software base—something that WinOS/2, WABI (Windows Application Binary Interface), and other initiatives clearly acknowledge—Microsoft's plan to carry Windows forward to the next generation of PCs is certainly a reasonable one. IBM, Sun, and some other companies have their own plans, which you'll read about here. But to have focused the whole piece on the IBM/Microsoft rift, as you suggest, would have been a peculiar way to do the "responsible reporting" you say the article lacked.—Jon Udell

OS/2 in Review

Kudos to BYTE for its fair review of OS/2 2.1 in the June issue (see "IBM Unleashes a New OS/2"). Although only two pages were devoted to OS/2, it was a remarkable divergence from the media's tendency to bash OS/2 in favor of the sacred cow, Windows NT. I hope that BYTE will not simply become another Microsoft lackey, as so many other publications have done.

Tim Tyler
Rockledge, FL

Thanks for printing Barry Nance's "IBM Unleashes a New OS/2." I've been critical of BYTE for its apparent Windows-centric orientation, but this article and your Contents by Platform index are very reassuring.

John Faughnan
Escanaba, MI

Stop the Whining

I wish you would cut down on the number of "what about us" letters from OS/2 users. It seems that a great deal of space is being devoted to diatribes complaining about how OS/2 is greatly superior to Windows, yet receives almost no coverage.

This is reminiscent of the old DOS versus Mac wars. Mac users complained that the superior Mac OS wasn't given a fair shot because of the immense sales and marketing muscle of IBM. Now OS/2 users are making the same complaints about Microsoft. Let's have more letters about real user issues.

Aaron F. McPherson
Allston, MA

Fix

Our July review of Lotus Notes release 3 ("One Thumb Up, One Thumb Down") contained incorrect pricing information. The Starter Pack ($995) and User license ($495) prices are correct, but the prices for other user levels are erroneous. Contact Lotus for quantity prices. ■

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; send BIX mail c/o "editors," or send Internet Mail to letters@bytepb.byte.com. Letters may be edited.*

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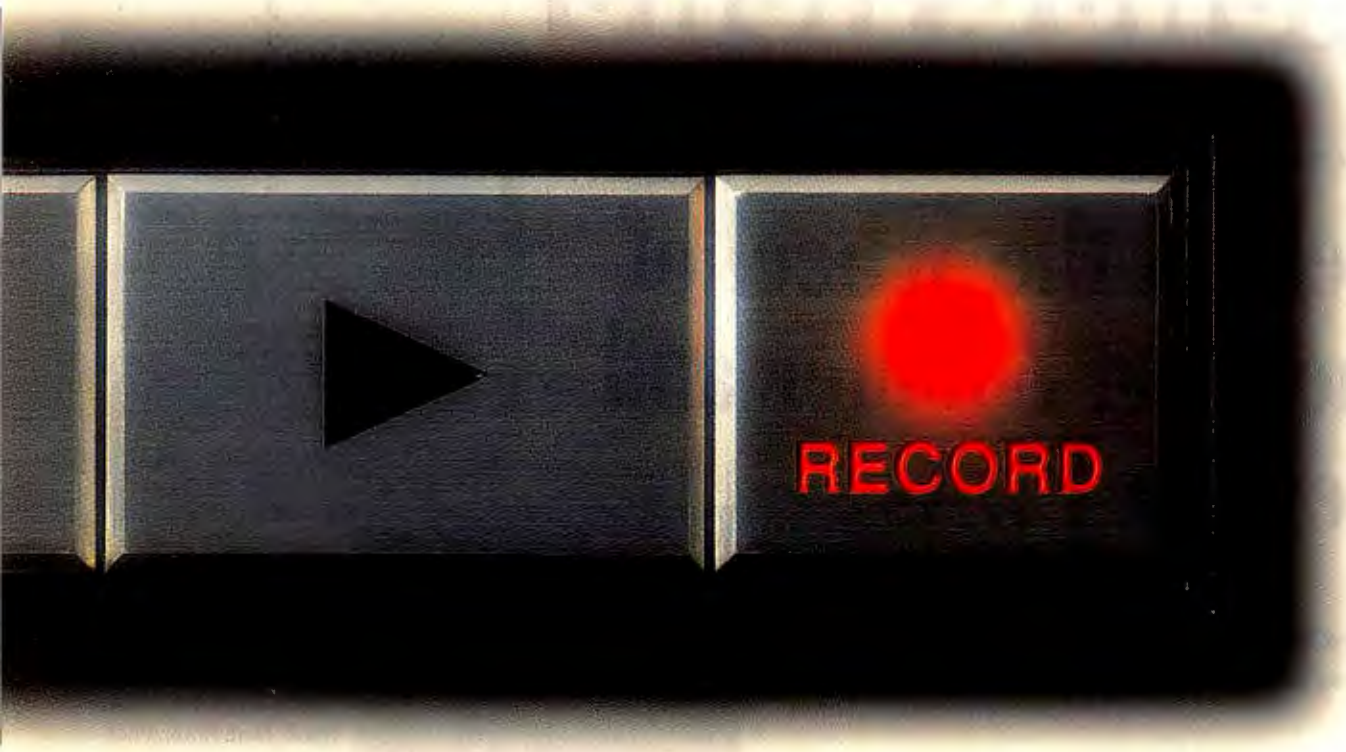

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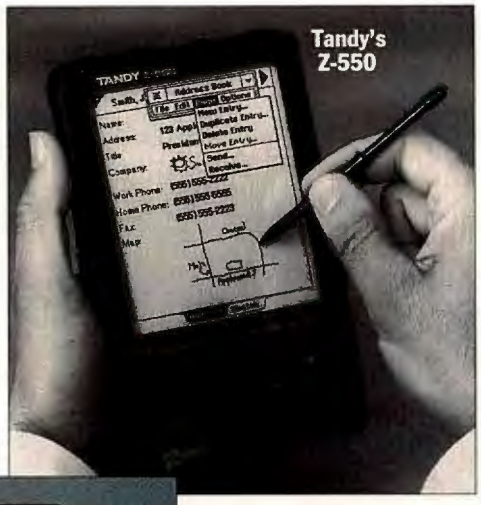
News & Views

PERSONAL DIGITAL ASSISTANTS

Behind the Wheel of the First Zoomer and Newton PDAs



The first Newton and Zoomer machines still have rough edges but show tremendous promise

DAVE ANDREWS

After months of anticipation, the first pen-based PDAs (Personal Digital Assistants) are finally nearing commercial release. In recent months, that statement has carried about as much weight as "the check is in the mail." However, Zoomer and Newton PDAs are now scheduled for release in October or earlier. In evaluating prerelease versions of both systems, I found that they resemble each other in size and weight. But the underlying software, processor, and handwriting-recognition engines are quite different.

Zooming In On the Zoomer

The Zoomer label indicates software compatibility: Applications will run on both Casio and Tandy systems, as well as other Zoomer PDAs that will be announced later this year. AST Research's recent purchase of portions of Tandy manufacturing facilities and its Grid division will not affect the Zoomer rollout, according to Tony Magoulas, spokesman for Tandy. The Zoomer will remain a Tandy/Casio joint venture, he said. Tandy says it will sell its Z-550 for $699. Casio will sell its XL7000 in different retail channels than Tandy, but the two systems are essentially the same.

The Z-550 runs for a claimed 100 hours on three AA alkaline batteries. You work with the Zoomer by flipping its cover up and over the back of the unit, which exposes the unit's 320- by 256-pixel, 3.2- by 4-inch monochrome LCD. The entire system measures 1 by 4.2 by 6.8 inches. Total system RAM is 1 MB, 640 KB of which is used by the operating system. Santa Clara–based SunDisk will offer a range of flash-memory PCMCIA cards (2 to 20 MB).

The Zoomer's GEOS is the latest in a family of graphical operating systems from GeoWorks. GEOS is both multithreaded and multitasking, yet its kernel requires just 60 KB. Library routines that are loaded as needed by applications total 180 KB.

The Zoomer will come with over 20 built-in applications. At the bottom of its screen, you will find several fixed icons, including the Launcher, Address Book, Date Book, Note Book, Pocket Quicken from Intuit, a world clock, calculator, menu, keyboard, and help. By tapping any icon with the plastic stylus pen, you execute the program. Tapping the Launcher icon (i.e., a rocket icon) gives you a menu of additional applications to choose, including a dictionary, a language translator, America Online, U.S. and world information, games, and others.

In its task switching and response to commands, the Zoomer's performance is fast. However, several BYTE editors who tried a beta system deemed the handwriting-recognition performance poky, requiring you to wait several seconds as the Zoomer attempts to convert your handwriting into text.

When you want to write notes and memos that will be recognized and converted into text, the PalmPrint handwriting-recognition engine (also developed by Palm Computing) works best when you print in block letters. You can write

in both uppercase and lowercase. The Notepad's recognizer doesn't like it when you mix cursive and printed characters; recognition accuracy declines when you do so. I found that, after a few minutes of practice, I could tailor my handwriting so that recognition accuracy went up from 50 percent to about 80 percent. Your mileage may vary.

The First Newton

Although Apple had not officially released details on the Newton and its Newton Intelligence operating system at press time, Sharp Electronics, which is manufacturing Newtons in partnership with Apple, let BYTE test its first Newton PDA, called the Expert Pad, which was running a beta version of Newton Intelligence. (The October BYTE will have in-depth coverage of Apple's Newton.)

Physically, the Expert Pad resembles the Zoomer—it has a reflective monochrome LCD and a flip-top cover—but it's quite different under the hood. Sharp officials said that the Expert Pad has a battery life of about 24 hours, which is much less than the Zoomer's claimed 100-hour battery life. Also, the Newton takes a different approach to recognizing your handwriting.

One of the benefits of Newton Intelligence is that every entry you make during the day is stored in Newton's object database. Thus, if you made an entry several days ago referring to "Bob," you can use the Find feature to search through all the applications for every occurrence of the word *Bob*. The system presents you with an indexed list of every hit that occurs.

A key part of the Newton will be its ability to take actions that you normally do manually and do them for you. The Intelligent Assistant accomplishes this. For example, if you write a reminder like "fax this document to Bob" and tap the proper icon, the Intelligent Assistant pops up a dialog box asking if you mean the Bob at 555-5555. If you indicate yes, it places the document in the in/out communications box.

Like the Zoomer, Sharp's Newton will come bundled with several applications. The first one you see when you turn on the Expert Pad is the Newton NotePad, within which you can enter text for recognition or ink drawings and handwritten notes. Other applications include a To-Do list and a Scheduler that are tightly integrated, a telephone directory, a filer for categorizing entries made in the NotePad, and an Extras icon.

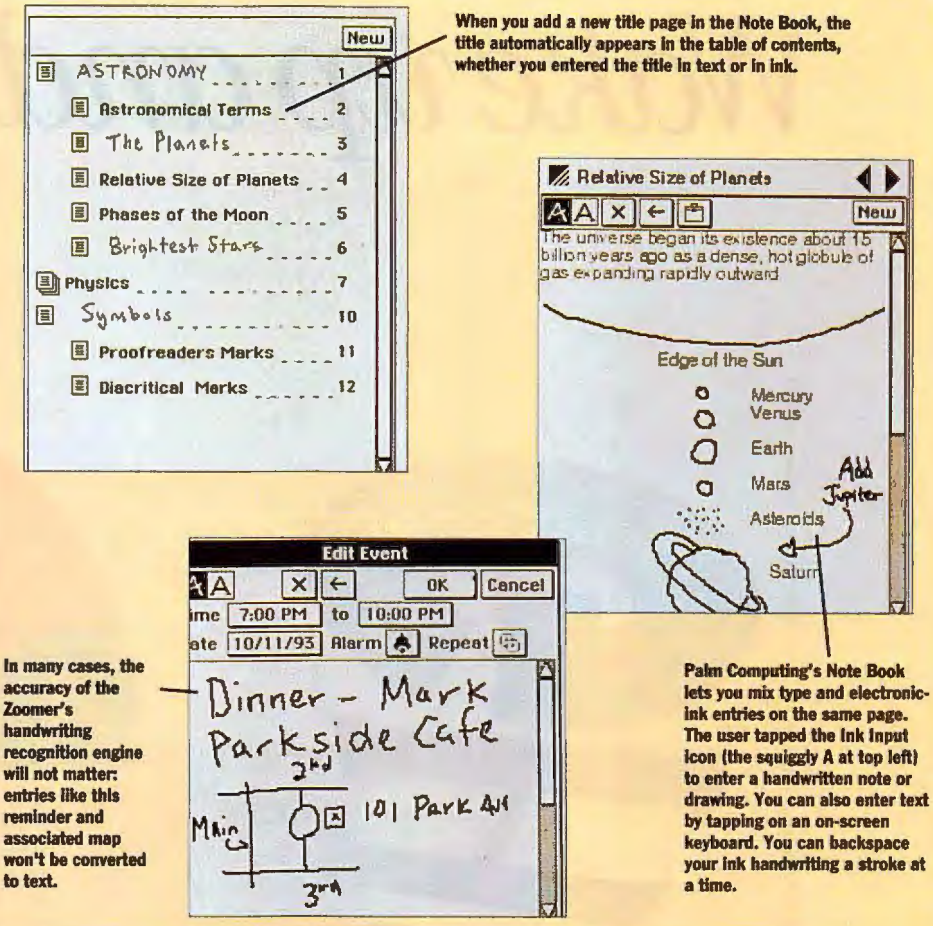
By tapping the Extras icon, you can access a universal in/out mailbox that supports deferred E-mail and fax transmission (the Expert Pad has a LocalTalk-compatible serial port) and other goodies (e.g., a calculator, metric conversion tables, time-zone information, a virtual keyboard, and possibly games).

The Expert Pad recognizes words by comparing what you write to words in a dictionary. Handwriting-recognition performance is snappy. However, the downside to the Newton's handwriting recognizer is that if you write a word that it cannot match to the dictionary, its best guess at what you were writing may prove to be wildly inaccurate. You have to train it on the spot by correcting the software using the on-screen keyboard. Luckily, the Newton's system software tracks these corrections transparently, without requiring any input on your part. Sharp officials claim that the Expert Pad's handwriting recognition accuracy improves with continued use.

Sharp says the final version of the Newton will let you set up a guest preferences profile. Thus, if someone else uses your Newton, it won't confuse

ZOOMER PROGRAMS MIX TEXT AND INK SEAMLESSLY

Palm Computing designed its applications to let you create documents that mix and match text and ink data types. The benefit: You don't always have to rely on the text recognizer to correctly interpret your handwriting.



HANDWRITING RECOGNITION AT A GLANCE

Newton	Zoomer
• Defaults to dictionary-based word comparison: its best guess can be wildly inaccurate	• Recognizes on a character-by-character basis: words can be partially correct
• It learns how you write	• You learn how it recognizes
• Has handwriting training module	• No training module
• Guest preference recommended for secondary user	• Anyone can pick it up and use it

Wake up and smell

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The Connectivity Issue

In their initial releases, neither the Zoomer nor the Newton will include a built-in modem. Instead, the companies are working with third-party vendors to develop external data/fax serial modems. America Online (Vienna, VA) will offer Zoomer users access to E-mail, a gateway to Internet, ASCII text fax and U.S. Mail gateways, access to wire services, and other services like stock quotes and travel brokers. Motorola (Boynton Beach, FL) says it will make its Embarc wireless data service compatible with the Zoomer PDA, so that Zoomer users can receive wireless E-mail and access electronic news summaries.

No third-party vendor has announced a general communications program for the Zoomer. Connecting it to desktop PCs will be done through the serial port or the infrared transceiver. Joe Ratner, product manager for personal information processors at Tandy, said the company is evaluating PCMCIA modems for compatibility with the Zoomer.

Newton PDAs will support infrared data exchange. Mac and Windows versions of the Newton Connection Kit will let you transfer, synchronize, back up, and update information via the Newton's serial port with a desktop computer.

Remember the Original PC

Based on my initial trials of both PDA machines, it appears that the Newton offers faster handwriting recognition than the Zoomer. I wasn't able to verify either company's battery-life claims. My emotions in testing both PDAs ran from awe to exasperation, especially when they did not correctly recognize my handwriting.

These are the first devices in a totally new category of computing. As with the first Mac and IBM PC, the first PDAs will not likely be as capable as their successors. But I think many people will find them useful. The situation can only get better, as handwriting recognition improves and applications, peripherals, and content are released to the market.

—Dave Andrews

INTEROPERABILITY

A Unified Ink Standard

Digital ink, the most useful data type for mobile applications, is ironically one of the least portable data types for sharing information between machines, operating systems, and applications. Effectively sharing ink requires more than a common bit map; unfortunately, a shareable ink data format that captures stroke order and other key attributes of ink hasn't emerged.

Six heavyweights in the mobile- and pen-computing arena—Slate, Apple, General Magic, Go Corp., Lotus, and Microsoft—are currently developing what they hope will be a long-term solution to the problem of shareable ink. Jot 1.0, the result of collaboration between these six players and a few others, is a specification for a standard, comprehensive ink format that each company has pledged to support.

Jot is a platform-independent format definition for captured ink. It includes properties like timing, pressure, stylus angle, and bounding coordinates, plus more esoteric attributes like color and type of nib. Software using Jot can choose only the properties it requires and ignore nonessential information. Jot is designed to be complete and extensible as other required qualities of ink are uncovered.

Captured ink stored in Jot format maintains all the attributes of "fresh" ink. As a result, it can be scaled, fed to recognizers that require information about how the ink was created, and processed by systems that don't include a stylus. Jot-format ink can be stored in shared databases, processed off-line, or incorporated into keyboard-oriented applications. Because storing the information required by Jot can consume a lot of space, Jot includes an optional provision for compression and stroke information reduction. Slate's Dan Bricklin said Jot would likely be an interchange format only, and most ink-based applications would continue to use smaller custom data formats internally.

Slate plans to incorporate Jot into PenApps; General Magic will include Jot in Telescript; Microsoft offered a long-term goal of rendering ink on every Windows desktop, and it will provide an OLE object with Windows for Pen Computing that will support Jot; and Go announced the integration of Jot into the next release of PenPoint, scheduled for late this year.

Lotus and Apple will also support Jot-format Ink, but Apple's Rick Spitz noted that Jot will not be built into the initial release of the Newton. Brian Dougherty, chairman and CEO of GeoWorks, said that his company is currently evaluating the Jot 1.0 specification and will likely support it in the next release of GEOS. "The only reason we wouldn't support it would be if we saw some performance problem with it," Dougherty said.

Jot offers a great deal of promise, not hindered by its solid support among ink-software vendors. But its timing may be the real key. Microsoft's Pradeep Singh praised the definition of the format "at the outset of the data type." Jot has its best chance for universal acceptance now, before the mobile/pen industry is well off the ground.

—Steve Apiki

PSION SPEAKS OUT ON PDAS

Because of their heavy reliance on pen-based input, the first prospective buyers of the Newton and Zoomer PDAs (Personal Digital Assistants) will look closely at these systems' ability to recognize individual handwriting. But Psion (Concord, MA), developer of the popular Psion Series III keyboard-based pocket computers, says the future of PDAs isn't the pen. Instead, it's voice.

Psion plans to announce later this month a new version of the Series III that for the first time will include a DSP (digital signal processor) that will let you record digital voice messages and attach them to application reminders and alarms. Although the new Psion will not support more advanced technologies like voice recognition (i.e., the ability to parse and act on a recorded voice message), Barry Balcourt, vice president of Psion, predicts that these capabilities will be available within two years from Psion. "The first step is voice recording," Balcourt said, noting that the new Psions will compress voice messages to just 8 KBps. "Then, we are going toward voice recognition. Two years from now, we'll be there."

—D. A.

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C32 for DOS is a professional, low cost 32-bit C compiler and tools package enabling development, debugging, performance profiling and royalty-free distribution of 32-bit applications for extended DOS. **Suggested retail price: $199*.**

WATCOM C/C++32 has a suggested retail price of **$599***. For additional information or to order direct call 1-800-265-4555. Call our FAX Back system at 1-519-747-2693 from your fax machine for immediate product information.

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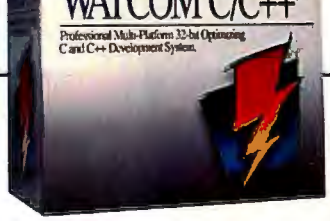

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DATA ANALYSIS

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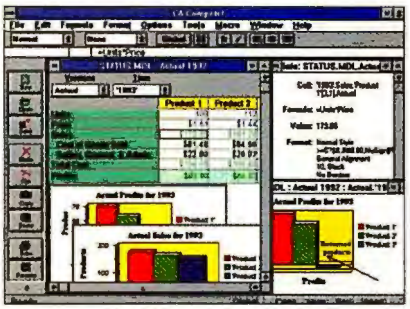
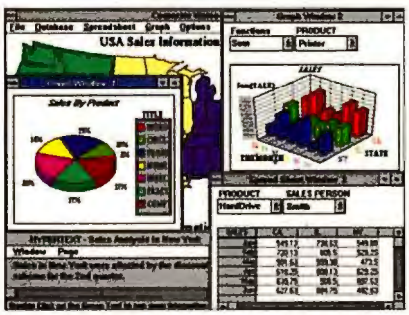


CA-Compete, like Lotus Improv, offers English-language-like formulas.

Watch the demonstrations, and multidimensional data-analysis products like Lotus Improv and CA-Compete seem to have lifted their promotional style from the old Ginsu knife commercials—take your spreadsheet data and "slice, dice, rotate, twist, turn, and pivot it." At the very least, this software has the best verbs.

Although the ads for these data-analysis programs may smack of superficiality, the challenge of this type of software in business today is a daunting one: to help strategists glean the most meaning from the immense storehouses of data their organizations have collected. In doing so, these products have created a product category all their own—one that, under their spreadsheet and graphing front ends, more closely resembles databases than the traditional spreadsheets from which this category has evolved.



Corporate Vision boasts a high degree of linking among table, text, and chart data.

Rubik's Cube Viewing

Michael Kornspan of Computer Associates compares the concept of multidimensional data-analysis software to a Rubik's Cube. Think of a single side of the cube and its nine squares arranged in three rows and three columns. This is the typical spreadsheet. And while that spreadsheet may have 3-D capability, true data-analysis software lets you take any row or column of that cube face and rotate it in either direction, for a possible total (differing by product) of 12 or more alternate views.

Answers to questions about why sales were down in the third quarter, after all, will not be found in a row-and-column display of sales by region. You may also need to view additional dimensions (e.g., quarterly sales by product type, sales by sales representative, year-by-year third-quarter sales per region, forecasted versus actual sales, and even product allocation by region). With a data-analysis product, you can point and click your way to viewing—in tabular or graphical form—the necessary data and forecast the effects of your decisions.

The missing link in all this is the grunt work required to establish direct and timely feeds from your dBase, Oracle, DB2, Sybase, or other databases to the data model you have created. Each program differs in the file formats it will import and export. Beyond that, it's up to someone to categorize the data that will be coming in and, in doing so, determine and configure the relationships among data fields. The latter process gives you the chance to think about how a data model can best be structured to be of the most use.

The English-language item names that are used in programs like Improv are beneficial in that they are not tied to cell references like A7. Instead, they're tied to understandable concepts (e.g., Total Cost) that make for easier reference and

SPREADSHEET WARS TO HEAT UP IN FALL

With Lotus 1-2-3 for Windows release 4's improved database access, Scenario Manager, new @ functions, and other features, Lotus Development finally delivered a worthy competitor to Borland and Microsoft Windows spreadsheets. This fall, Lotus's chief competitors are expected to strike back with new feature-laden versions of their Windows spreadsheets.

Are all these new features necessary? "That's a tough question," said Nicholas Delonas, a consultant and coeditor of the Spreadsheet Consultant (Allston, MA) newsletter. "I have yet to find an accounting department that enthusiastically moved from DOS to Windows. Most people, all they want to do is add up numbers." However, Delonas said that on another level, the trend in MIS appears to be a standardization on Windows and a move toward suites of products that work well together and share a common macro language. Microsoft says Visual Basic, Applications edition will let its Windows and Mac applications control each other. Meanwhile, Lotus plans to include its LotusScript macro facility in upcoming releases of its Mac, Windows, DOS, and Unix applications. —D. A.

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- **Data Modeling Desktop adds Lotus Improv–like data viewing**
- **Consolidator lets you merge and combine data across multiple sheets**
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- **More than 360 additional mathematical and other @functions**
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- **Shared spreadsheet notebooks over LAN and E-mail connections**

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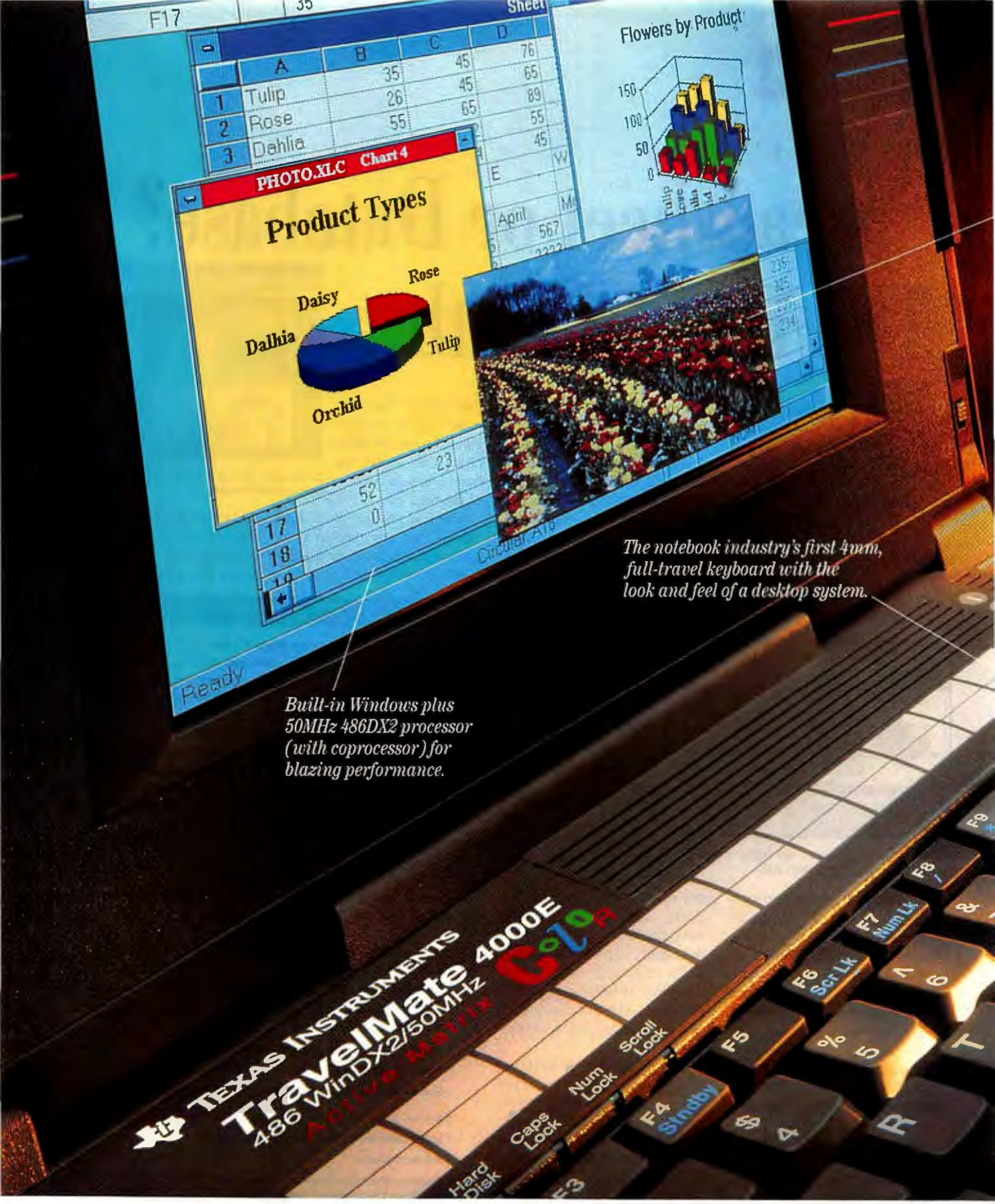
- **Lotus Improv–like pivoting views of data**
- **3-D worksheets**
- **Built-in version of Access database query interface for ODBC (Open Database Connectivity) applications**
- **Support for OLE 2.0**
- **Enhanced Scenario Manager**
- **Tighter integration with Word for Windows and Project through Visual Basic, Applications edition**



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Built-in Windows plus 50MHz 486DX2 processor (with coprocessor) for blazing performance.

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New brilliant Active Matrix display – 640 x 480 VGA with high-speed video system for lightning fast graphics.

New TI TravelMate 4000E WinDX2™/50 Active Matrix Color

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If you've been waiting for an active matrix color notebook with true desktop power, your wait is over. Thanks to the new TravelMate 4000E WinDX2/50 Active Matrix Color notebook from Texas Instruments.

With 256 brilliant, simultaneous colors and a 50MHz 486DX2 processor, this powerhouse doesn't just whisper color, it screams it.

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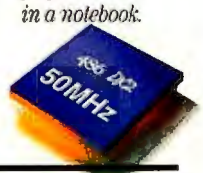
If you work on the go, you'll also go for the rugged 200MB hard disk drive, the high-speed video bus and 1MB of video RAM, as well as the full range of connectivity options – snap-on modules for Ethernet® LANs, SCSI-compatible devices and an internal 14,400 bps V.32 bis modem with 9,600 bps send/receive fax capability.

50MHz DX2 processor with coprocessor provides desktop performance in a notebook.



Of the leading active matrix color notebook manufacturers, only TI offers the desktop performance of a 50MHz DX2 processor.

Active Color Notebook	*Weight (lbs.)*	*486 Processor*	*Speed*	*Coprocessor*
TravelMate 4000E	**6.2**	**DX2**	**50MHz**	**Yes**
Toshiba T4600C	6.9	SL	33MHz	Yes
Compaq LTE Lite 4/33c	6.5	SL	33MHz	Yes
IBM ThinkPad 720C	7.6	SLC2	50MHz	No

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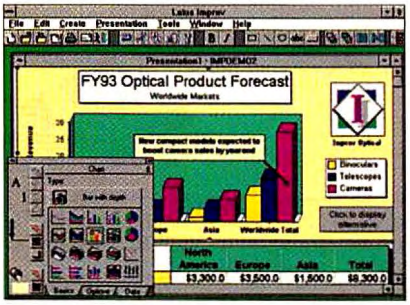
modification. In other words, you can refer to Total Cost from anywhere in the model or often from other models. The English-language naming convention for spreadsheet items also helps to make sense of a model's structure when you first view it.

Formulas, global and cell-specific, also become easier to write, use, and modify. For the above Total Cost in a sample CA-Compete model, the governing formula is "=Cost of Goods Sold+Selling, General, & Admin." This adds the two preceding cells in the column. In Improv, one formula might be "CurrentAssets.Total = groupsum(CurrentAssets)," which is also easily understood by anyone viewing the model.



The latest version of Lotus Improv for Windows includes five drivers for retrieving database data.

In many cases, you may need to customize views of data to present just the right type of information for an individual to make an informed decision. Higher-level staff, for example, might need only totals of various item groups; with Improv, you can collapse levels to summarize the report. Other personnel may need or should see only certain data.

The extensive graphing functions that are part and parcel of this hybrid software class also help in analysis and overall presentation. Graphing is typically easy and on-the-fly, and a few packages like CA-Compete let you embed the graph directly into the model. From there, it transforms as needed when you change from one view to another.

The newest product of the bunch, Corporate Vision from IntelligenceWare, goes a step further by making each data point itself an icon on which you can click for more detail. For example, you might want to get a monthly breakdown of a charted year's profits figure on a bar or pie chart. It applies the same concept to hypertext links you can make to textual data in a bulleted list. Click on the phrase "printer sales" in a bulleted chart, and the program can pop up a bar chart of sales by region.

Deceptive Learning Curve

Because multidimensional data-analysis software looks like a spreadsheet—in fact, CA-Compete includes most of CA-SuperCalc's code to give that program a dual nature—it can initially look easy to maneuver data views and arrive at what you need to make a solid decision. In fact, these products can pose a formidable and deceptive learning curve. It's not for lack of effort on the part of vendors, though. The problem is a result of the very concept of multidimensional analysis and the fact that spreadsheet users, before trying one of these products, have typically not had to think this way.

Strategic decisions, however, can still be made far more quickly using products like Improv or Corporate Vision than they have been in the past. To solve the problem of why expenses are up, for instance, a manager may have previously had the MIS department write a 4GL (fourth-generation language), SQL, or other type of query to produce a report that subsequently requires a rephrasing of the question or further information to get anything useful in solving the problem. This spiraling toward answers could take weeks. With data-analysis software properly set up and maintained, it takes only seconds.

—Ed Perratore

A SAMPLING OF DATA-ANALYSIS SOLUTIONS

Because multidimensional data-analysis software inherently defies classification—a challenge for its marketers, to say the least—products that fall loosely into the category vary widely in their capabilities, pricing, and target markets.

CA-Compete 5.0 (Computer Associates, Islandia, NY), $495: Expected to ship in the third quarter, this complete revamp of the Windows-based product that CA bought from ManageWare matches Lotus Improv on several fronts. Improvements include speed enhancements, an unlimited number of named views stored with each model, and the integration of CA-Ble, CA-Realizer's extended BASIC macro language, which lets users make C or DLL calls.

Corporate Vision 1.0 (IntelligenceWare, Los Angeles, CA), $690: Expected to be announced in late August, this product accesses data from Paradox, dBase, Oracle, Sybase, DB2, and SQL Server to combine spreadsheets with EISes (executive information systems) for a Windows-based system with linking among table, text, and chart data.

Diver for Windows, Diver for Macintosh 2.0 (Dimensional Insight, Burlington, MA), $750 per station: GUIs to the company's client/server CrossTarget product, both versions of Diver permit dive-downs (with multiple data models) into cross-tabular data sets as large as 32,000 rows by 32,000 columns. CrossTarget compresses, indexes, and stores data from dissimilar sources (via comma-delimited format) into a proprietary structure that serves for easy access and reporting of otherwise raw data.

ESSBase 2.2 (Arbor Software, Santa Clara, CA), $27,000 for a server plus a five-user license: This client/server package extends the capabilities of Lotus 1-2-3 and Excel to allow analysis of a claimed unlimited number of dimensions. Designed initially for Windows clients connected to OS/2 servers over major network operating systems, it includes an API for third-party customers using Visual Basic, C, and C++ to build custom applications (e.g., an EIS).

Improv for Windows 2.1 (Lotus Development, Cambridge, MA), $495: The latest version of this popular product includes network installation, .WK4 file support, integration with Lotus Notes, and a scaled-down version of Q+E Software's Q+E Extend for Improv 1.0. Five Q+E drivers let you build models using data from dBase and compatible formats, Btrieve, Paradox, Excel .XLS, and text files.

Muse 1.1 (Occam Research, Watertown, MA), $695: This Mac-based search-and-analysis product includes five environments—spreadsheet, database, scriptwriting, dictionary, and charting windows—for analyzing multidimensional data. The scriptwriting window accepts English-language queries; the dictionary interprets them. (A Windows version is expected this fall.)

SpreadBase 1.1 (Objective Software, Redwood City, CA), $695: Mac-based but with a Windows version in the works, this client/server product uses English-language cell references and offers three main view types: table (resembling a relational database table), graph, and matrix—a table in which each cell represents a database record. You can expand or collapse models.

TM/1 Perspectives 1.0 (Sinper, Warren, NJ), $495 for Professional Version, $795 for Corporate Version: Derived from TM/1, a data-analysis product dating back to the mid-1980s, this Windows-based tool is a client/server add-on to Excel or Lotus 1-2-3 (both ship together) that lets you analyze 2-D slices of data derived from comma-delimited files or data entered directly into the program. Not intending to compete against Lotus Improv, Sinper calls it a "database for spreadsheet users" rather than a modeling product. —E. P.

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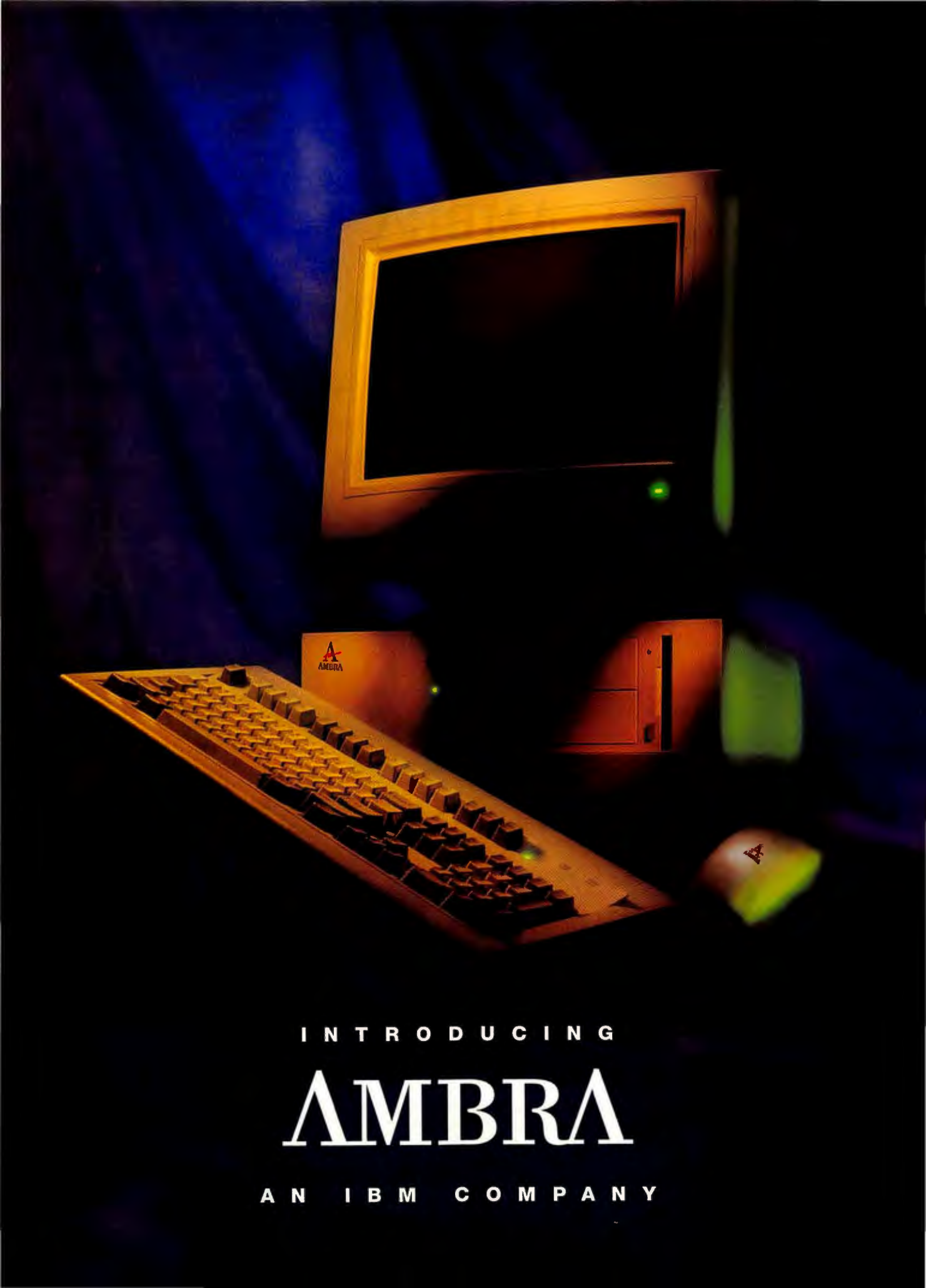

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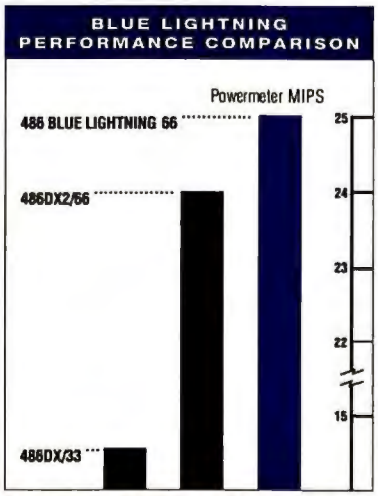

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External clock	33 MHz	33 MHz	33 MHz
System case	Desktop	Desktop	Desktop
RAM	8MB	8MB	8MB
Cache	**256KB**	128KB	—
Floppy	One	One	One
Hard disk	340MB	340MB	340MB
Onboard SCSI	✔	—	—
Local bus	✔VESA	✔VESA	✔
Video	Win accel w/1MB	Win accel w/1MB	Win accel w/512KB
Color monitor	15" FST*	15" FST	15" FST
Pentium-ready	✔	✔	✔
DOS 6.0, Windows 3.1, mouse	✔	✔MS Works for Windows	✔
Network-ready	**Ethernet (10BaseT)**	—	—
Tech support	24 hours, 7 days/week from **IBM**	Mon-Fri, 6 am to midnight Sat., 9am-4 pm	24 hours, 7 days/week
Warranty/Service	1 year **IBM onsite**	1 year onsite	1 year onsite
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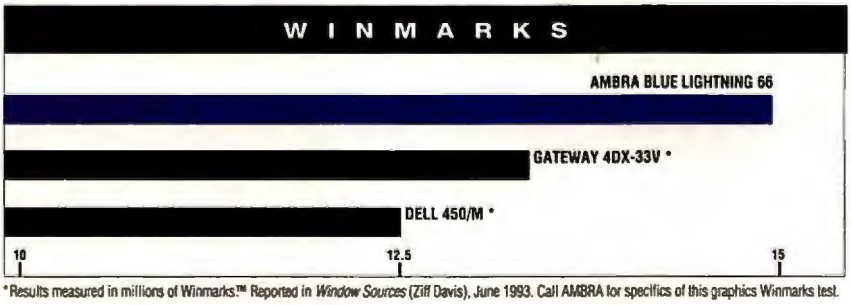
RAM	8MB	8MB
Cache	256KB	256KB
Floppy	One	Two
Hard disk	**540MB SCSI**	500MB IDE
Onboard SCSI	✔**Dual 32-bit**	—
Local bus	✔VESA	✔
Video	**ATI™ Ultra Pro w/2MB DRAM**	Win accel w/512KB
Color monitor	15" FST*	15" FST
DOS 6.0, Windows 3.1, mouse	✔	✔
Tech support	24 hours, 7 days/week from **IBM**	24 hours, 7 days/ week
Warranty/Service	1 year **IBM onsite**	1 year onsite
Price	**$4,259**	$7,566

*Upgraded from 14" SVGA at no extra cost. See special offer.



*Results measured in millions of Winmarks™ Reported in *Window Sources* (Ziff Davis), June 1993. Call AMBRA for specifics of this graphics Winmarks test.

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Model S450SL
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- 64KB processor cache
- 3.5" floppy
- 125MB (14ms) hard disk
- Windows accelerator with 1MB video memory
- 14" VGA color monitor
- Slimline case
- 3 16-bit ISA slots
- MS-DOS 6.0, Windows, mouse

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Model S425SX
- 486SX, 25 MHz
- Intel Pentium-ready
- 4MB RAM max: 36MB
- 128KB processor cache
- 3.5" floppy
- 170MB (17ms) hard disk
- 2 VESA local bus slots
- Windows accelerator with 1MB video memory
- 14" SVGA LR color monitor
- Slimline case
- 3 16-bit ISA slots
- MS-DOS 6.0, Windows, mouse

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Model S433DX
- 486DX, 33 MHz
- Intel Pentium-ready
- 4MB RAM max: 36MB
- 128KB processor cache
- 3.5" floppy
- 240MB (15ms) hard disk
- 2 VESA local bus slots
- Windows accelerator with 1MB video memory
- 14" SVGA LR color monitor
- Slimline case
- 3 16-bit ISA slots
- MS-DOS 6.0, Windows, mouse

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NC425 SL Notebook
- 486SX, 25 MHz, SL-enhanced
- Dual-scan STN color screen (640 x 480 x 256)
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- 9.5" screen
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- Intel Pentium-ready
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- 256KB processor cache
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- Stereo speakers
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- Network-ready (Ethernet 10BaseT)
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- MS-DOS 6.0, Windows, mouse

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- 256KB processor cache
- 3.5" floppy
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- Onboard SCSI
- 2 VESA local bus slots
- Windows accelerator with 1MB video memory
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- Network-ready (Ethernet 10BaseT)
- Desktop case
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- MS-DOS 6.0, Windows, mouse

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- Windows accelerator with 1MB video memory
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- Desktop case
- 5 16-bit ISA slots
- MS-DOS 6.0, Windows, mouse

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- 256KB processor cache
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- 2 VESA local bus slots
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- Desktop case
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DESKTOP PUBLISHING

Windows No Mac at DTP

Although Windows desktop publishing applications outsold such Mac programs by $8.4 million in the first quarter, the high-end world of professional, four-color desktop publishing has traditionally been a stronghold of the Mac. But with the release of Adobe Systems' high-end Photoshop for Windows image-editing program bolstering Windows stalwarts like Adobe Illustrator, QuarkXPress, and Aldus PageMaker, the PC is now a viable platform for high-end desktop publishing. Programs like FrameMaker, Interleaf, and Island Write, Draw & Paint offer viable desktop publishing on the Unix platform. But Craig Yappert, product manager of new products and technologies at Frame Technology, says users of the Unix versions of FrameMaker occupy a different space of desktop publishing than users of PageMaker or QuarkXPress, by typically creating technical documents that are hundreds or thousands of pages long.

The Windows-based Power Publishing PCs come preconfigured with Adobe Illustrator, Photoshop, and either PageMaker or QuarkXPress.

Three companies—Adobe, Dell Computer, and SuperMac Technology—have combined marketing resources and products to promote Windows-based PCs as an effective platform for high-end desktop publishing and prepress work. As part of this initiative, the companies have delivered two 486-based Power Publishing Alliance PCs that offer plug-and-play desktop publishing.

Officials of the Alliance member companies said that taking on Apple is not their main intention. Their target market consists of PC users who have been waiting to do color desktop publishing on the PC rather than on the Mac. Several desktop publishing experts agreed that these Power Publishing systems and their applications could satisfy the pent-up demand for color prepress on the PC. "Windows users who are in it [desktop publishing] haven't been in color desktop publishing," said Pauline Ores, director of editorial services at New World Information Trading in New York City. "It's a new market."

Nevertheless, the Power Publishing systems will inevitably be compared to what's available on the Mac, and in the opinion of several prepress experts, Windows as a high-end desktop publishing platform is not nearly as mature as the Mac. "The [Windows] PC world, in terms of desktop publishing, has a way to go," said Ira Fuchs, president of Digital Pre-Press, a New York–based company that runs three daily 8-hour shifts servicing magazines by generating four-color prepress output on both Windows and the Mac.

According to Fuchs, one problem his company often encounters in Windows—and not on the Mac—is an inconsistent implementation of PostScript drivers among Windows applications. He said that this is a major reason that whenever his company gets a request for a job under Windows, "We approach it with trepidation."

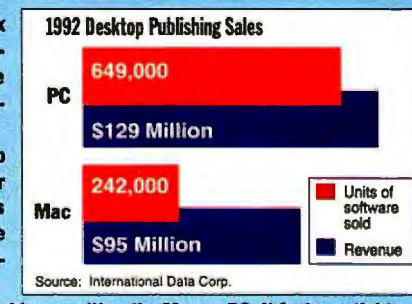
Victor Beitner, owner of Victor Beitner Systems, a service bureau in Toronto, said that corporations are now doing high-end publishing on PCs but agreed that the PostScript issue is slowing acceptance. "Once it's as easy to print from Windows as from the Mac, you'll see service bureaus accept Windows desktop publishing more readily," he said.

—Anne Fischer Lent

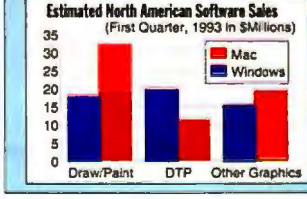
OUT-OF-THE-BOX WINDOWS DTP SYSTEMS

The Power Publishing Alliance has spawned two out-of-the-box solutions for graphic designers and color prepress professionals. The systems come loaded with software that has set the standards in the industry and are priced at $6695 for the Power Publishing Workstation and $8995 for the Superstation.

Both systems are based around a Dell 486DX2 EISA desktop computer with a SuperMac SuperMatch 17-inch color monitor and Spectrum/24 EISA video card. Preloaded software includes Illustrator 4.0, Photoshop 2.5, 200 typefaces from the Adobe Type Library, Adobe Streamline, Adobe Type Manager, Adobe TypeAlign, and either PageMaker or QuarkXPress.



SuperMac designed the SuperMatch monitor for color publishing on either the Mac or PC. It features tight corner focus and digital controls. The video card supports 1152- by 910-pixel resolution. The system targeted for graphic designers, the Power Publishing Workstation 433/ME, runs at 33 MHz with 16 MB of RAM and a 230-MB hard drive. The prepress system, the Power Publishing Superstation 466/ME, runs at 66 MHz with 32 MB of RAM and a 535-MB hard drive. The Superstation also includes calibration software and a color calibrator.



I took a look at the Superstation 466/ME, which had both QuarkXPress and PageMaker loaded. I was amazed that those two behemoths could coexist without any speed degradation. If the Superstation I tested is any indication of the quality of the Power Publishing systems, you get a host of desktop publishing power for a relatively low cost. The peripherals I'd add right off the bat include a CD-ROM drive and a network card, both of which are optional add-ons.

—A. F. L

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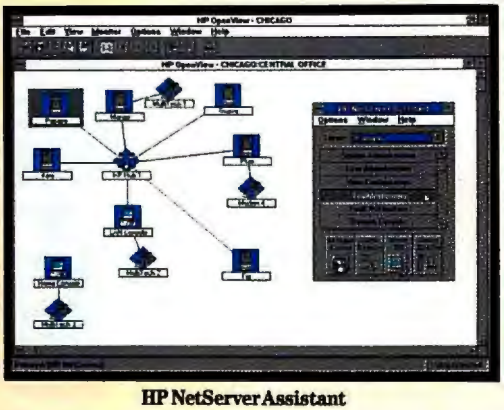

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- HP NetServer Assistant software included
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*U.S. list price for HP NetServer LM Model 530, including 486/33DX processor, 16-MB RAM and 535-MB SCSI hard drive.**U.S. list price for HP NetServer LE Model 240, including 486/33SX processor, 4-MB RAM and 240-MB IDE hard drive. Prices subject to change without notice. Pentium and the Intel Inside logo are U.S. trademarks of Intel Corporation. ©1993 Hewlett-Packard Company PPG686

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AFFORDABLE PERSONAL LASER PRINTERS

COMPANY	PRINTER	PRICE
Hewlett-Packard	LaserJet 4L	$849
Texas Instruments	microWriter	$729
Okidata	OL400e	$699

Listed printers differ in terms of features, drivers, and rated print speed. Suggested retail prices are listed; actual selling prices are almost always lower. For more information, see BYTE's Buyer's Guide to Printers (Summer 1993).

Okidata's OL400e printer, expected to have a street price of $499, may remove the last obstacle for true laser quality to permeate the budget-mindful small business. Okidata is marketing the 300-dot-per-inch OL400e, an upgrade to the OL400, at potential Hewlett-Packard LaserJet 4L users who would trade in a few features for a rock-bottom price.

The Okidata OL400e

The big sacrifice is scalable fonts: The OL400e's HP IIp+ emulation permits bit-mapped fonts only. Forty-four fonts (four typefaces) come standard, plus two USPS PostNet bar code faces. Okidata built in a PCMCIA Type II slot that accepts four cards for tax-preparation forms, bar codes, typewriter-style fonts, and symbols.

Despite its low price, buying the 17-pound OL400e is not a total exercise in feature denial. It lets you add 4 MB onto the standard 512 KB of RAM. A Mips 3000 RISC processor and a high-speed, parallel interface help keep things moving for the 4-page-per-minute engine. Okidata's 6000-copies-per-month duty cycle rating indicates the printer is best for light to moderate traffic. Okidata uses a solid-state LED print head in the OL400e. The printer comes with serial and parallel interfaces, and the printer can autosense between the two.

Unlike the LaserJet 4L, which forgoes the usual front-panel control in favor of a set of software utilities, Okidata's OL400e comes with a 16-character LCD control panel. The printer includes drivers for Windows 3.0 and 3.1, Microsoft Works, Microsoft Word 5, WordPerfect 5.0 and 5.1, and other programs.

The small-footprint (6.3 by 12.6 by 14.2 inches) model meets the U.S. Environmental Protection Agency's Energy Star guidelines for peripherals, using only 15 W during sleep mode. For savings beyond that during inactivity, you can go a step further than the LaserJet 4L's 5-W sleep mode: the power switch. The LaserJet 4L doesn't include one of those.

HP declined to comment on whether Okidata's printer will result in a laser printer price war. But TI peripheral spokesman Jerry Rycaj said his company intends to remain competitive. "If a price move is called for," he said, "we certainly won't shy away from a price move."

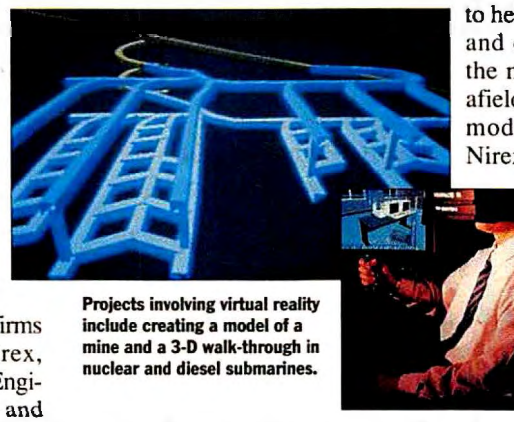
—Ed Perratore

Okidata, (609) 235-2600; fax (609) 778-4184.

SIMULATION

Industry Uses Virtual Reality

LONDON—Twelve firms have formed an initiative with one of Europe's leading virtual-reality research centers to apply computer-based simulation and advanced visualization in complex industrial design and 3-D modeling projects. Under the VRS (Virtual Reality and Simulation) initiative, major industrial firms such as Rolls-Royce, Nirex, Vickers Shipbuilding and Engineering, ICI Chemicals and Polymers, and British Nuclear Fuels will pool their engineering talents with the Salford-based Advanced Robotics Research (ARR) center at several levels.



Projects involving virtual reality include creating a model of a mine and a 3-D walk-through in nuclear and diesel submarines.

Movies like *The Lawnmower Man* have glamorized the more advanced aspects of virtual reality, where subjects don special helmets and gloves to enter exotic and futuristic worlds. However, the companies participating in the VRS initiative will use virtual reality in nuts-and-bolts projects ranging from environmental impact studies to 3-D walk-through models of nuclear and diesel submarines. The first three projects should achieve tangible results within the next 18 months, says Bob Stone, who is ARR's technical manager.

The three projects are a 300-acre mine model for Nirex, an engine simulation for Rolls-Royce, and a submarine compartment program for Vickers. ARR is providing consultancy to help Nirex benchmark and convert data about the mine, based at Sellafield, into virtual-reality models. ARR will use Nirex AutoCAD files to create a surface model of the mine and then develop further models for sections underground. The hardware for the Nirex project has yet to be chosen, although the two likely candidates are Silicon Graphics platforms and the high-end 3-D graphics Freedom workstation sold by Sun Microsystems and Evans & Sutherland.

ARR will also be helping Rolls-Royce develop a model of its Trent 800 aero engine's fan casing and other features. The ARR contract with Vickers will eventually result in models to test new submarine designs.

—Dom Pancucci

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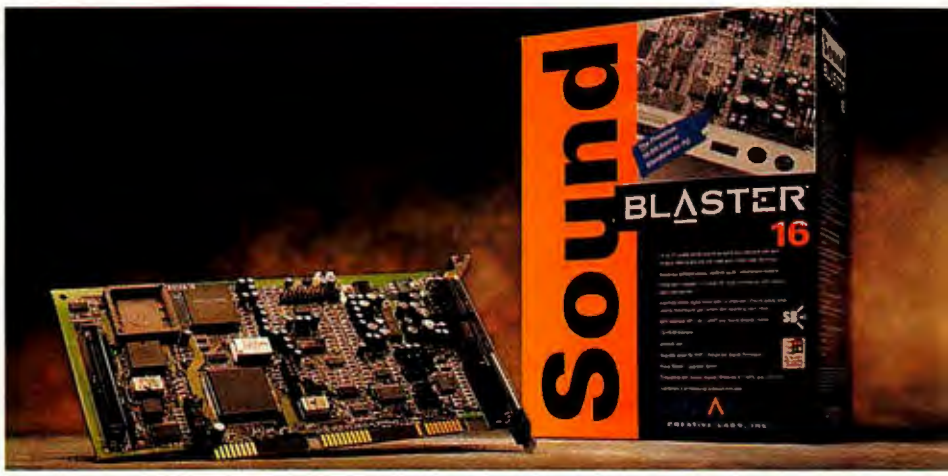

The new 16-bit PC audio standard: Includes programmable mixer, microphone, VoiceAssist speech recognition software, plus more than $1000 in software applications.

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ON-LINE GRAPHICS

Fractal Compression Goes On-Line

Imagen hopes that one day, instead of looking for a good buy on a house or automobile in your local newspaper, you will be able to access classified ads on nationwide BBSes that use the company's fractal-compression product.

Perhaps the biggest obstacle to the electronic information highway is the problem of sending graphics images across telephone lines. Millions of people are already sending and receiving text-based E-mail and messages downloaded from on-line services. But graphics are another story. Because graphics images are often several megabytes in size, they take a long time to transmit across telephone lines, and they require a lot of disk space once they get there.

A small start-up company called Imagen (604) 266-2240), based in Vancouver, has an answer for DOS and Windows users. Imagen's Fracterm, which is based on fractal-compression technology developed by Iterated Systems (Norcross, GA), compresses images that will later be transmitted from BBSes. Using Fracterm (starts at $350), BBSes can offer electronic information delivery consisting of full-color images along with text to their subscribers.

Fractal-compression algorithms are based on a mathematical description of the image and are resolution-independent: A compressed fractal image requires the same number of bytes whether it is displayed on a 640- by 480-pixel VGA screen or on a 1024- by 768-pixel high-resolution monitor. According to Imagen's CEO, Dwight Jones, the resolution independence of fractal compression offers a major advantage over the JPEG compression scheme, which is dependent on the resolution, thus requiring larger files for higher-resolution images. (For more information, see "Compressing with Fractals," BYTE's *Essential Guide to Windows*, Spring.)

Fracterm is offered as a host system for BBS operators with an unlimited license to distribute the user software to its subscribers. Any image compressed at the BBS end can be downloaded by users with this software. To the user, it appears that the image is being transmitted in real time, but in fact, the compressed image is first transmitted and then decompressed by the user software. In testing Imagen's system, full-color images I downloaded took less than a minute to decompress.

Fracterm seems to be an elegant solution for image compression, but it is not likely to become widely adopted by major on-line services such as CompuServe. Jones admits that on-line services have given his product a lukewarm reception because they're more committed to JPEG. CompuServe even has its own compression system called GIF. Debra Young, CompuServe PR representative, says, "We look into all kinds [of technologies], but right now we're focused on JPEG and GIF."

Jones says that Fracterm will support JPEG in a release called Fracterm Pro, to be released later this year. Some other drawbacks of Fracterm are that it doesn't support the Mac and works with a limited number of video adapters. But if you're running a BBS and want to provide graphics images, Fracterm is worth looking into.

—Nicholas Baran

ELECTRONIC PUBLISHING

Electronic Newspaper Offers Color Pictures

It's a vision as old as the PC itself: electronic delivery of newspapers and magazines directly into your computer. On-line services and CD-ROMs let you retrieve the text of articles that appear in dozens of sources—but all you get is text. Photos, charts, and other graphics never make it off the printed page.

A new service from start-up WalkSoft (Rochester, NY) takes electronic publishing a step further, delivering once a week via modem or disk a formatted "newspaper" that includes color pictures and animations. WalkSoft's News In Motion costs $250 for 52 issues—including telephone charges to download the data files, if you use a 9600-bps or faster modem.

Each week, News In Motion includes roughly four animations, 10 photos, and 50 to 60 articles culled from such diverse sources as the *Economist*, the *Financial Times*, and the *International Herald Tribune*; translated material from *Le Monde*, *Der Spiegel*, *Asahi Shimbun*, and others; news photos from Agence France-Press and Reuters; and op/ed pieces and the crossword puzzle from the *New York Times*.

When you subscribe to News In Motion, WalkSoft provides software that includes everything you need to download, read, and search articles. It includes the Newsstand user interface, communications software, a run-time version of Apple's QuickTime for Windows, and PKUnzip and JPEG utilities for decompressing text and images. One remarkable aspect of News In Motion is that to download the newspaper, which takes less than 10 minutes, you dial a toll-free 800 number. Each issue is 700 KB compressed or 1.4 MB uncompressed, which means it fits on a single disk.

The key technology breakthrough in News In Motion is that the layout templates are predefined and reside at the user's PC, rather than being transmitted with each issue. Thus, only the text and photos need to be sent, and the layout occurs on-the-fly using codes embedded in the text.

—Andy Reinhardt

"Raima Database Server's performance is roughly equivalent to hitting the afterburner." – *John Michelsen, Millennium Software*

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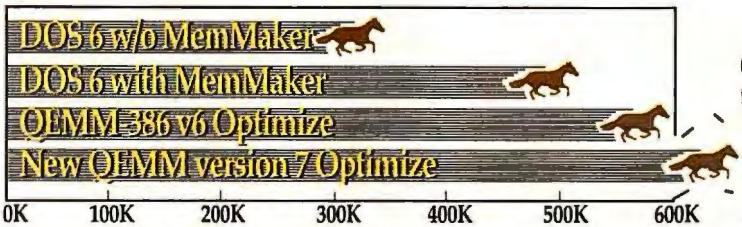
Introducing QEMM 7
The Memory Manager Worth Paying For

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

Instant Riches

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

How to Look a Gift Horse in the Mouth



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

DOS 6 Giveth; DOS 6 Taketh Away

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

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

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

Page Frame: the Key to Your Future

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

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

There's lots more to QEMM 7:

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

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

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

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

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

Quarterdeck

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QEMM Users: upgrades are available from dealers.

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

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

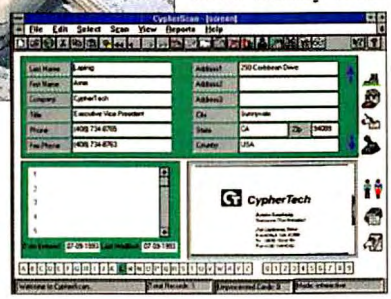
Circle 136 on Inquiry Card.

CONTACT MANAGEMENT

Scanners Turn Business Cards into Database Records

If your desk is piled with stacks of business cards and you dread the prospect of laboriously entering all those names into a database, technology has come to the rescue. A pair of new products will let you scan business cards, convert their images to text, and pump the names, titles, addresses, and phone numbers into appropriate database fields.

Microtek's $399 Scan-in-Dex weighs less than 2 pounds.



CypherScan shows a business card image and completed database fields.

The first of these nifty gadgets is the Scan-in-Dex from Microtek (Hsinchu, Taiwan, and Torrance, CA), which consists of a small scanner (6.4 by 5.8 by 2 inches) designed specifically for reading business cards and a Windows software package that performs OCR, extracts the data, and puts it into a proprietary database. Scan-in-Dex is being sold as an integrated one-button solution that is easy enough for any user.

A more recent arrival is the CypherScan family from CypherTech (Sunnyvale, CA), consisting of two software-only products. The first is for users with a flatbed or hand scanner ($245 and $145, respectively). The other product costs $395 and includes the same diminutive card scanner as the Scan-in-Dex. The flatbed version includes a cardholder template that lets you read in up to eight cards in a single swipe. The software runs in Windows.

Both companies use AI to parse out the name-and-address information and assign it to the proper fields. Microtek's OCR software (licensed from Ocron) routes the converted text to a rules engine that searches for keywords and character patterns. Thus, if a line of text includes the words Street or Avenue, the software assumes this is the address. Five digits in a row—or five plus four—are likely to be the ZIP code. Job titles are identified through a lookup table of likely candidates (e.g., president).

CypherTech's technology, built on the Calera OCR engine, is more sophisticated, using a combination of positioning, relative font sizes, word lookups, and other rules to determine where text should go. Thus, it might be able to successfully identify an odd job title because it is located on the line between the name and the address. However, both companies' products can be fooled by unusual business-card designs. To facilitate fixes, both put text that can't be placed into a "comments" box.

Both packages include a simple database that stores card data, but CypherScan offers more flexibility: Records can be stored natively in dBase or Paradox formats or exported directly into Lotus Organizer or Contact Software's Act. Scan-in-Dex exports only ASCII. CypherScan also recognizes E-mail addresses, and reads Canadian postal codes. Both companies plan Mac versions, but neither company has announced expected Mac shipping dates.

—Andy Reinhardt

BUSINESS-CARD SCANNING ON THE ROAD

Pacific Crest Technologies ((714) 261-6444) will release this fall a business-card scanner that will compete in the same category as CypherTech's and Microtek's products, yet in a much smaller size. The company's business-card scanner will be about the size of a portable cassette player and will connect to your desktop or notebook PC through the parallel port. It will weigh less than a pound without the AC power adapter.

Rich Sondheimer, president of the company, said the business-card scanner's small size and parallel-port connectivity make it an ideal solution for portable computers. "We're targeting it for professionals and salespeople who don't want to have to open their computer or laptop to install a new product," he said.

The hardware/software unit will include Windows-based software that automatically identifies names, titles, company addresses, and other information and put it in the proper fields in the included stand-alone database. The program will offer the ability to import and export data from Paradox, dBase, Lotus 1-2-3, Packrat, Act, Organizer, Ascend, and Franklin. It will also have a universal import/export function that lets you create your own import or export format for any Windows- or DOS-based address database. Pricing on the system isn't finalized. —D. A.

WORD PROCESSING

Next Word for Windows to Work Better with Other Applications

A preview of the next version of Word for Windows indicates Microsoft has improved the word processor's ability to share documents with other Windows programs in a number of areas. Word 6.0 for Windows (the current version number is 2.0, but the company wants to synchronize the Windows version with the DOS version number) will offer an enhanced interface, drag-and-drop text editing among applications, and in-place editing through its support of OLE 2.0. Version 6.0 will not ship initially with Microsoft's Visual Basic, Applications edition (VBA), but other VBA-enabled programs like the next releases of Excel and Project will be able to control the word processor.

VBA, which Microsoft says will eventually appear in all its major office productivity programs, will provide a way for developers to write agent programs that perform tasks across the company's Mac and Windows programs.

Microsoft says it is also improving Word for Windows' ability to convert WordPerfect files into Word files. The program will likely ship by year end. —D. A.

POOR OLD MOUSE.

Most of the time all mice are nice and fine for pointing around. But when it comes to inputting graphics or logos into any application or any CAD package, they are hopeless. They just can't – and so you can't. No way.
Problem? Yes and no. It depends – you may shrug your shoulders and say "Well, I'll never do CAD and I just never want to input any sketches, logos, or photos into my computer anyway." Or – you feel that isn't good enough after all the money you have invested and all the nice things you know you could do today with your own graphics once they were in the computer.

PROBLEM SOLVED.

Here comes the mouse that lets you input all your graphics as well. How?: That's what they all want to know, but we're not telling. Its a new invention. It's a universal combination of a true mouse and an independent manual drawing board that becomes a precision full-featured digitizer tablet once you just place the mouse onto the board. It's all in one or all separate as required. Simply unplug your poor old mouse, plug in our mouse and have the real all purpose input device to your PC always at hand. At a price poor mice can afford too.

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OPERATING SYSTEMS

IBM Announces "Better" DOS Than MS-DOS

Compatibility used to be the name of the game. In past releases of their respective versions of DOS, IBM and Microsoft consistently released products that were almost identical to each other. Those days of product uniformity have apparently ended with IBM's announcement of PC-DOS 6.1, which was expected to ship at the end of July.

The new game is MBD (More, Better, Different) marketing, and IBM has come out swinging. IBM says PC-DOS 6.1 is smaller and faster than MS-DOS 6.0. The company demonstrated speed improvements in video updates, batch processing, and the execution of ANSI commands. UMB (upper memory block) support was improved to decrease DOS's memory requirements by using extra video memory as UMBs and adding UMB support for 286-based systems.

The major area of product differentiation is in the included utility programs. IBM responded to Microsoft's DoubleSpace disk compression by announcing that Addstor's SuperStor disk doubler will be bundled this fall. Early purchasers of PC-DOS 6.1 will receive a coupon they can use to upgrade at no cost when the SuperStor version is released. This new version will provide full support for the Microsoft Real-Time Compression Interface.

Central Point Software's Backup program supports archival storage on floppy disk, minitape, or SCSI tape. This program is augmented by RAMBoost, a memory optimizer, Undelete, and Scheduler, a program that can run Backup unattended at periodic intervals.

The included AntiVirus program is a product of IBM's own Thomas Watson Research Center. It's claimed to detect and correct over 1400 viruses. Fuzzy-logic technology is used to find mutating strains of known viruses.

—Matt Trask

PROCESSORS

AMD Declares Independence

Late this summer, Advanced Micro Devices (Sunnyvale, CA) will start shipping a new series of 80x86-compatible processors that it says are not based on Intel microcode. AMD's strategy is not only to free itself from costly legal entanglements with Intel but also to attract new customers by offering chips that fill perceived gaps in Intel's product line. For instance, among the first three new processors is a 40-MHz 486SX. Intel's fastest 486SX runs at only 33 MHz.

AMD also introduced a pair of 33-MHz 486SX chips: One is a 5-V part for desktop systems, and the other is a 3.3-V part with SMM (System Management Mode) for mobile computers. First shipments were slated for August and September.

All the chips are based on clean-room microcode developed by engineers who did not copy Intel's 80x86 microcode, according to AMD. Until now, AMD's 80x86-compatible chips used Intel microcode obtained through licensing agreements dating back to the 1970s—the source of a long-running court battle between AMD and Intel.

The new processors have fully static cores and are manufactured in Sunnyvale using a 0.7-micron, triple-layer CMOS process technology. They will cost $185 each in 1000-unit quantities. That's comparable to Intel's prices for similar parts, indicating AMD is not interested in starting the kind of price war that eroded the price of 386-compatible chips in 1991 and 1992.

"We're capacity-constrained with our 486 production right now," said Dirk Heinen, a program manager at AMD. "There's no point in driving the price down, when we've already got more orders than we can handle and we're still trying to ramp up production."

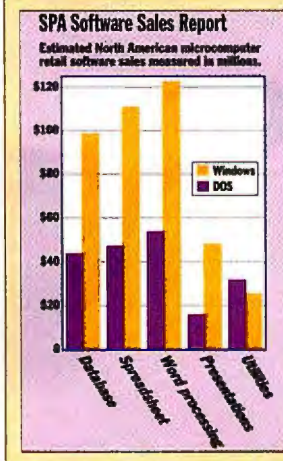
Heinen said AMD will probably ship only a few hundred thousand of the new processors this year—a minuscule fraction of the total 486 market, that is estimated at 25 to 30 million chips this year.

—Tom R. Halfhill

AMD AND INTEL 486 MICROPROCESSORS

Intel 5-V	AMD 5-V
486DX 25, 33, 50	486DX 33, 40
486SX 16, 20, 25, 33	486SX 33*, 40*
486DX2 40, 50, 66	486DX2 50
Intel 3.3-V	**AMD 3.3-V**
486DX 33	486SXLV 33*
486SX 20, 25, 33	
486SL 25, 33	(* = AMD microcode)

WINDOWS OUTSELLS DOS



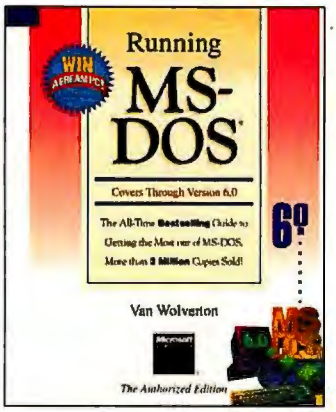
In the first three months of this year, sales of Windows-based applications surpassed sales of DOS-based applications in North America, for the first time, according to the Software Publishers Association, a trade association of the PC software industry. The SPA reports that the Windows sales growth was fueled by the 112 percent increase in the sales of Windows databases over the previous quarter, a sales growth driven primarily by the success of Borland's Paradox for Windows and Microsoft's Access. The popularity of Windows databases no doubt contributed to Lotus Development's acquisition of Approach Software's Approach database for Windows.

In all four of the major business-oriented categories (i.e., word processing, spreadsheets, databases, and presentation graphics), Windows programs outsold DOS applications. DOS continued to hold the lead in home education, finance, and utilities. In the area of entertainment, DOS whomped Windows by generating $60.1 million in sales, compared to $3.1 million for Windows.

Trends in Europe were similar to North America's in the first quarter of this year, according to SPA Europe. Revenues generated by Windows products accounted for 70 percent ($338.1 million) of the 41 software firms participating in the SPA's data program.

—D. A.

Six Bucks Back on MS-DOS® 6 Books



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by Van Wolverton

The All-Time Bestselling Guide to MS-DOS—More Than 3 Million Copies Sold!

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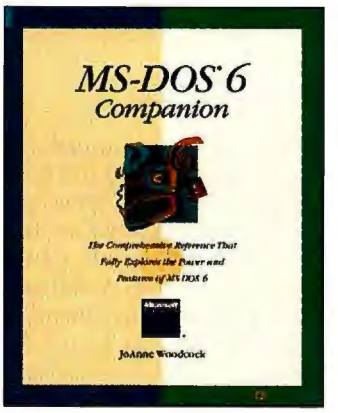
PC Week

Van Wolverton gently teaches beginners the basics and offers more experienced computer users a solid grounding in computer fundamentals. Includes coverage of MS-DOS back to version 3.3 and a complete command reference.
Suggested retail price $24.95.



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by JoAnne Woodcock

The Comprehensive Reference That Fully Explores the Power and Features of MS-DOS 6.

The first easy-to-understand look under the hood at MS-DOS 6. A powerful tool for support professionals who provide assistance to coworkers and business associates. It's the ultimate nonprogrammer power user's guide!
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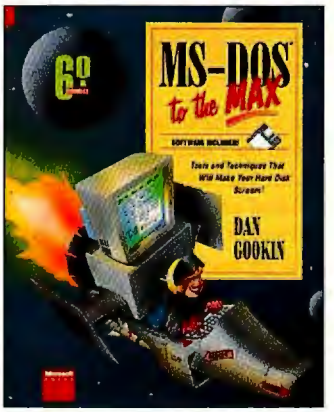

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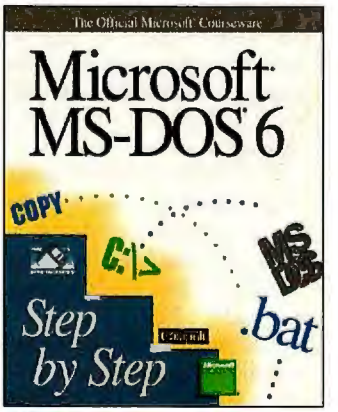

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JANET WANG

From Manufacturing to Design

Taiwan, long known for making products for American and European computer vendors, is now having to reengineer itself. As labor rates rise here, vendors in Europe and North America who must compete in markets defined by low profit margins are moving their manufacturing to countries like Thailand, Malaysia, and even mainland China, where the average labor rates are about one-fourth Taiwan's.

In the last few years, Taiwan's computer industry has been trying hard to change its image of being only manufacturing oriented. Through intensive upgrading within the industry, products designed in Taiwan are no longer the exception. The government is taking an active part in helping companies break out of the manufacturing mold and move into product engineering; one way is through the establishment of research centers, such as the science-based industrial park located in Hsinchu.

Hsinchu, the Taiwanese equivalent of the legendary Silicon Valley region in California, is just far enough from Taipei (90 minutes by car) to avoid the expensive rent districts of the capital city, yet it's still close to major airports. In fact, companies are increasingly keeping their corporate and sales offices in Taipei while setting up their research centers so that they are a relatively short commute on the Chung Shan freeway.

Many companies exhibiting at Computex, Taiwan's largest computer show, exemplified the new focus on product engineering. For the second consecutive year, *0 & 1 BYTE*, an affiliate of BYTE, sponsored the Best of Computex awards.

The AcerFormula 64-bit Windows PC from Acer (based in Taipei) was the winner of the Best System award. Its PICA (performance-enhanced I/O and CPU architecture) exhibited outstanding design in a competitive product category.

PhotoStacker, an image-compression program from Ultima Electronics (Taipei), was the winner in this year's Best Software category. Compressing a 512-KB by 512-KB color image on a 386-based PC with PhotoStacker takes just 6 to 8 seconds.

WalkieFax 200 from Archtek Telecom (Taipei) won the Best Peripheral award with its versatile functions, including laser fax, copier, A4 hand scanner, and PC-Fax.

The winner of the Best Multimedia award was the VGA-AVer Pro from ADDA Technologies (Taipei). This product bridges VGA capabilities with video devices. It synchronizes VGA display with standard composite video and Super-VHS video in either NTSC or PAL format.

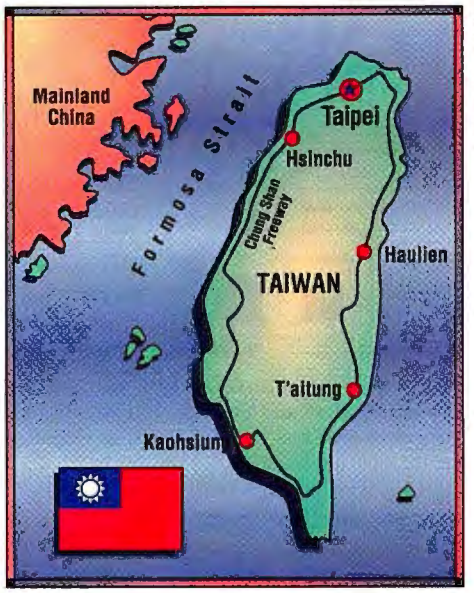
Zyxel, based in Hsinchu, displayed its U-14496EPlus high-speed modem. Providing speeds of up to 19.2 Kbps and universal fax with voice capability, this product won the Best of Connectivity award. The company developed its own ASICs (application-specific ICs) and firmware for the winning product.

A lot of companies exhibiting at the show have incorporated the world's latest design trends. For example, a number of "green" monitors were shown at Computex. One such monitor, the ViewSonic 15G from ViewSonic International (Taipei), has four power-saving modes. It won the Best Display award.

The winner of the Best of Input award was Dextrareader, from Taipei-based Dextra Technology. Dextrareader is a 600-dpi gray-scale sheet-fed scanner, supporting the TWAIN standard. It lets users scan up to 12 pages at a time.

The Best of International award is a category for products from companies based outside of Taiwan. This award went to the Lexicomp LC-8600 Palmtop PC, designed by Abstract Research & Development (Orinda, CA). This system included a 16-bit F8680 PC/Chip, 1 MB of RAM, three AA alkaline or rechargeable nickel-cadmium batteries, a 640- by 200-pixel-resolution screen, an optional 2 MB of internal RAM, and an internal 9600-/2400-bps fax modem.

You can expect to see more PC innovations from Taiwan as more companies take the giant step from product manufacturing to product design. ■

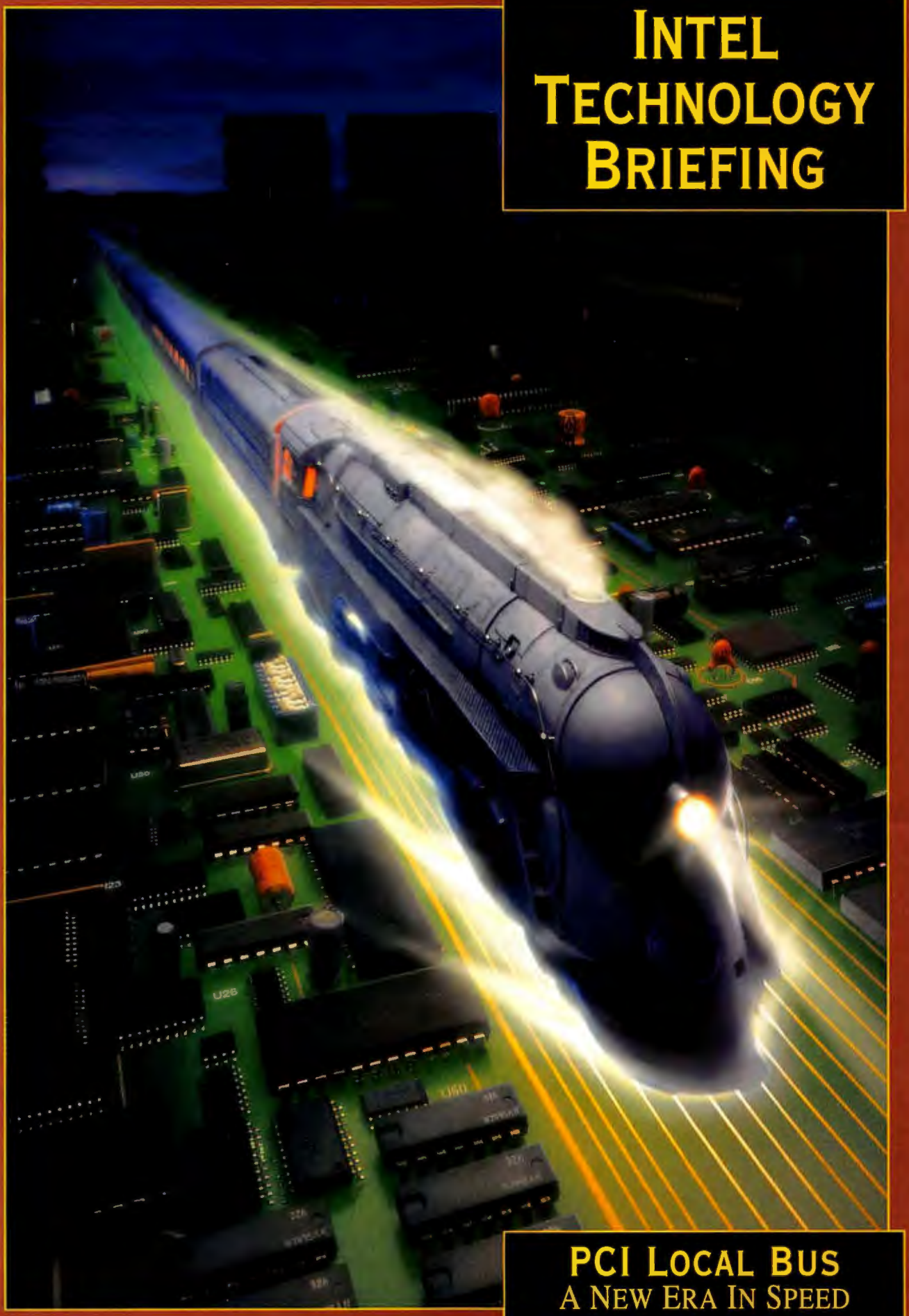


MANUEL KING © 1993

Taiwan can no longer depend on a large pool of labor that's both educated and inexpensive. The ability to design innovative products has become the key to the survival of its information industry.

Janet Wang is the editor in chief of 0 & 1 BYTE, *a Chinese-language affiliate of BYTE. You can reach her on BIX c/o "editors."*

Intel Technology Briefing



PCI Local Bus
A New Era In Speed

PCI: LAYING THE TRACKS FOR TODAY'S TECHNOLOGY.

This third Technology Briefing will tell you about a new local bus technology–PCI. Jointly developed by Intel and other industry leaders, it's designed for current and next-generation PCs. PCI picks up where today's bus architectures leave off, providing greater system performance via a wider data path and increased expandability.

HOW TO BREAK THE BOTTLENECK.

The I/O bus most people use today, ISA, was specified for the original 286 computer. Its 16-bit data path and 8 MHz clock speed provided satisfactory performance for moving CGA graphic images of 150-thousand bytes and DOS applications limited to several hundred-thousand kilobytes. But with current generation Super VGA images requiring 750 KBytes and Windows* applications weighing in at several megabytes, traditional I/O buses are unable to transfer the information quickly enough. The solution? A local bus system capable of moving 32 bits of data at 33 MHz.

LOCAL BUS IN A NUTSHELL.

Simply put, a local bus takes peripherals off the I/O bus and connects them, together with the CPU and the memory subsystem, to a wider, faster pathway for data. The result is faster data transfer between the CPU and the peripherals. That's especially important for servers and graphic-intensive software like Windows and OS/2.*

PCI: WHERE LOCAL BUS IS GOING.

PCI is the best local bus implementation.

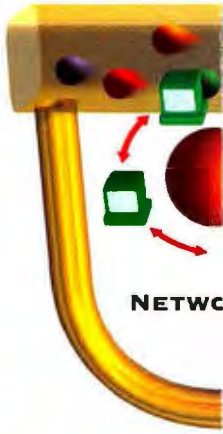
- Highest performing bus today (refer to back page).
- Pathway to new capabilities like plug and play.
- Offers the best expandability for high performance peripheral devices.

ROOM TO GROW.

Most PCI systems will support three to five performance-critical peripherals. These peripherals will be either integrated directly onto the motherboard or can be added via PCI expansion cards, such as multimedia, graphics, disk drives and LAN cards. Of course, you can still use existing ISA, EISA or Microchannel add-in cards because PCI is designed to supplement, not replace, the traditional I/O bus.

INDUSTRY-WIDE SUPPORT.

It was in 1991 that Intel's Architecture Lab, along with leading computer vendors, began work on a design specification for PCI. The PCI specification has now been adopted by 168 companies including OEMs like Compaq, Dell, DEC, Gateway 2000, IBM, NCR and NEC; and add-in card vendors like Adaptec, ATI Technologies, Diamond Computers, STB, Tseng Labs and Matrox. As a result of this alliance, PCI chipsets, systems, and add-in cards for graphics, multimedia and LANs are now being introduced.



PCI LOCAL BUS

Burst Mode Data Transfer.

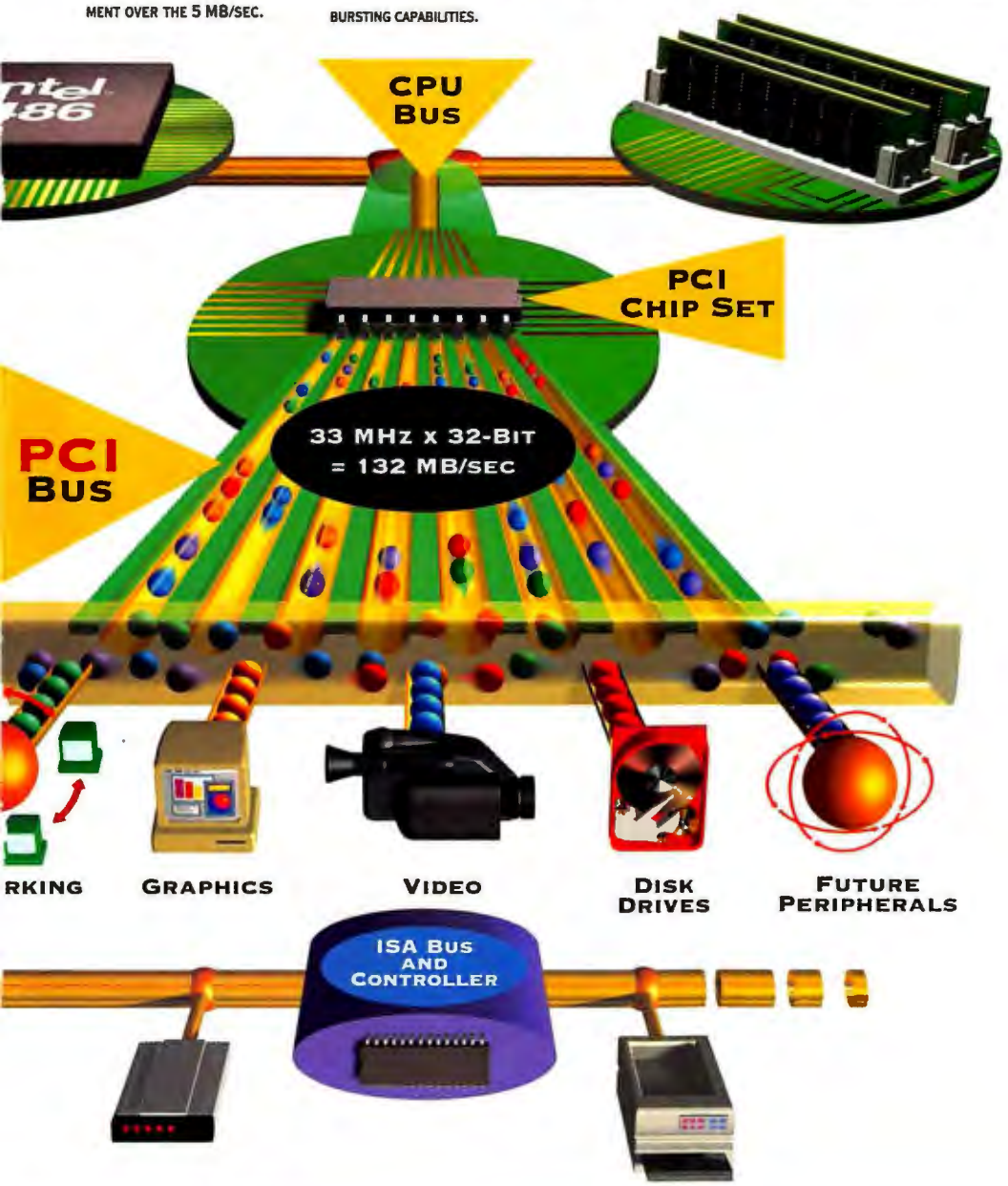
PCI boasts a 32-bit data path and a 33 MHz clock speed. This yields a maximum data transfer rate of 132 megabytes per second, a marked improvement over the 5 MB/sec. for a standard ISA bus. And with PCI, data is written to and read from the peripherals through linear bursts. This means the data is transferred every clock cycle, doubling PCI's throughput over buses without linear bursting capabilities.

PCI Buffered Expansion Architecture.

PCI's architecture features a buffer design between the CPU and peripherals that amplifies the signal, allowing multiple high-speed peripherals to be attached to the same PCI local bus. Buffering also isolates the peripherals from the CPU, reducing noise and increasing reliability. And because PCI interfaces with ISA, EISA and Microchannel buses, you can continue to use existing add-in cards.

A Jumperless Future.

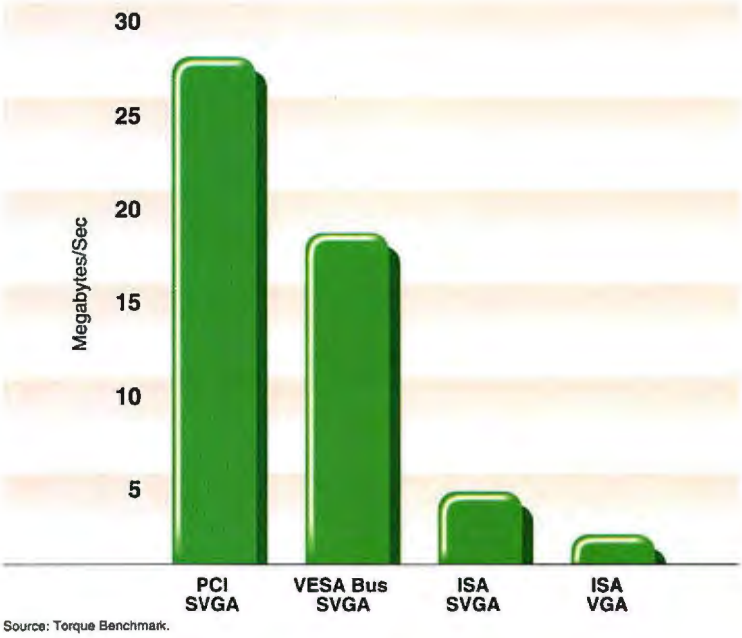
Through PCI, Intel is working to make auto-configuration a practical reality. At the heart of PCI's design, built-in configuration registers and software will automatically keep track of every interrupt being used in the system. When a new PCI peripheral is added, the PCI chipset will simply select an unused interrupt. No more changing jumpers. No more keeping track of IRQs.



PCI PERFORMANCE

BUS THROUGHPUT

THE TORQUE BENCHMARK ILLUSTRATES PCI'S BUS THROUGHPUT FOR GRAPHICS OPERATIONS. IT MEASURES THE RATE AT WHICH BYTES ARE TRANSFERRED FROM MAIN MEMORY TO SCREEN.



Source: Torque Benchmark.

THIS BENCHMARK WAS RUN ON IDENTICALLY CONFIGURED i486™ DX2-66 CPU-BASED SYSTEMS. ONLY THE BUS ARCHITECTURE, AND THEREFORE THE GRAPHICS CARD, WAS CHANGED. ALL SVGA GRAPHICS CARDS USED VERSIONS OF ATI'S MACH32* GRAPHICS ACCELERATOR FAMILY.

PCI: A BUS WITH A FUTURE.

The Intel Architecture Lab was instrumental in establishing the industry's PCI Special Interest Group (SIG). The PCI SIG was responsible for defining and establishing the PCI specification as a standard. In fact, it has already defined a new specification to support 64-bit extensions and 3.3 volt systems.

IS THERE A PCI LOCAL BUS IN YOUR FUTURE?

Yes, especially if you're interested in maximum performance and functionality from today's demanding peripherals like full-motion video and graphics. And there certainly is if your outlook is long-term, since Intel and its partners designed PCI to also be the architecture for the next generation of technology. Users of i486 processor-based and Intel Pentium™ processor-based systems will be the real beneficiaries of PCI's greater bandwidths and clock speeds. So when buying your next system be sure to specify PCI local bus.

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Cyber Worlds

HUGH KENNER

Here's a sampling from the opening page of *Virtual Light*:

> The courier presses his forehead against layers of glass, argon, high-impact plastic. He watches a gunship traverse the city's middle distance like a hunting wasp, death slung beneath its thorax in a smooth black pod.... The air beyond the window touches each source of light with a faint hepatic corona, a tint of jaundice edging imperceptibly into brownish translucence. Fine dry flakes of fecal snow, billowing in from the sewage flats, have lodged in the lens of night.

Like the worlds he presents, William Gibson's way with words can take some getting used to, if only because word and world are aspects of one another. He writes from *within* the dystopia he's presenting, and the language he puts on the page is different from today's American for the same reason today's American is different from 1770's American ("When in the course of human events..."). Bill Clinton's way with idiom would have broken Thomas Jefferson's heart, but then so would have Bill Buckley's.

We feel at home, it may be, in our grandparents' nightmares. And very likely we should all be unhappy in any future to which we could be suddenly transported. What has always made real futures habitable is their way of coming about in tiny increments, and what makes fictive ones like Gibson's unsettling is the *Blade Runner* effect: our total immersion as early as page 1.

So novel is the language, it's not always quite clear what he's saying. Look back three paragraphs. What about that "hepatic corona"? Hepatic in a visual context means liver-colored, which the *OED* specifies as dark brownish-red. But "a tint of jaundice"? Jaundice—true, a liver disorder—does tint the skin, though not dark brownish-red but yellowish. So what does Gibson mean us to see? I'd call that a naive 1990's question. He means us to receive the sickly impact of a word-string, *hepatic-jaundice-brownish-fecal-sewage*. Not a nice place, Mexico City, 2005.

Yes, as near as 2005. The writer who coined the word *cyberspace*, and a decade ago took every science fiction award in sight with the dystopia of the decade, *Neuromancer*, now ventures a future just 10 years away, when, in his words, "All the technology we read about today like virtual reality and telepresence has come to pass, but otherwise it's business as usual."

And if you think I'm not telling you what the book's "about," you're right. Reviewers of *Neuromancer* ran up against the difficulty of saying what "happens" in a mental space where such once-firm counters as "character" have fallen victim to virtuality. There are "characters" in *Neuromancer* whom you could neither sue nor shoot, existing as they do solely as binary trees of interactive cognitive attributes. Hence, no way to paraphrase that book's last 20 pages.

But *Virtual Light*? It turns on the theft of a pair of virtual-reality glasses that an ex-cop named Berry Rydell is supposed to retrieve. ("Ex-" is a trademark of the Gibson cosmos, where people get demoted, disgraced.) But something not quite human has an interest in what those glasses show....

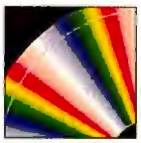
Don't worry. Just absorb the prose texture. It'll carry you through a reality every bit as absorbing as *Blade Runner*'s. ■

VIRTUAL LIGHT

William Gibson
Bantam Books
ISBN 0-553-07499-7

$21.95

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times *to* Art & Antiques. *You can contact him on BIX as "hkenner."*



COMPUTER FUNDAMENTALS

HOW COMPUTERS WORK

Warner New Media, 3500 Olive Ave., Burbank, CA 91505, (800) 593-6334 or (818) 955-9999, $79.99

How Computers Work is an interactive CD-ROM for the Mac that explains in layperson's terms the fundamentals of computer hardware. While this title won't help the experienced computer user, it's a great way to introduce new users to computer technology basics.

Based on Time-Life's *Understanding Computers* and *How Things Work* series of books, it uses rich graphics, animation, and QuickTime movies to illustrate the fundamentals of computer hardware and software. This complex topic is broken down into categories such as input, output, memory and storage, processing, programming, applications, and a time line.

In one topic, a QuickTime movie shows a diagram of a color monitor with red, green, and blue electron-gun beams sweeping across the monitor's face. It clearly demonstrates how the beam strikes the surface, thereby energizing the screen phosphors, which glow to form the image. Icons supply access to a notepad, a bookmark function, a glossary/index, and a navigation aid that helps steer you through the reams of information.

Both male and female voices provide a sonorous voice-over for these sections. The time line provides a comprehensive history of the computer's evolution, yet there are curious omissions. For example, the Macintosh appears several times, but the only processor mentioned is the Intel 80x86 series, which isn't found in that computer.

The average BYTE reader probably won't find much new in this material. But if you're training new users, or you have a child starting an introductory computer course, How Computers Work might be a great help.

—Tom Thompson

NETWARE FOR THE FUN OF IT

HOW TO KEEP YOUR NOVELL NETWORK ALIVE By James Nadler and Don Guarnieri Random House Electronic Publishing (formerly Bantam Computer Books), ISBN 0679-79109-4, $26.95

The opening Hunter S. Thompson quote announces that this gonzo guide to Novell networking won't take the dry, plodding approach typical of the genre. Humorously messy cartoons by Steve Marcus confirm that this is a hip computer book with an attitude. It's also informative. Chapters on subjects such as cabling, internetworking, tape backup, storage subsystems, communications, printing, and workstation/server hardware deliver a healthy mixture of technical reference, product description, troubleshooting procedures, and general advice all focused on what you need to know to run Novell LANs.

The advice rings true: Divide and conquer, do with few and simple tools, be religious about backups, and respect users. The technical, product, and troubleshooting material springs from a vast reservoir. Nadler and Guarnieri are working consultants, not theoreticians. You won't find answers to every conceivable question about source routing, X.25 gateways, or DAT (digital audiotape) backup products—that wouldn't be possible—but you will find a number of highly specific nuggets on these and many other subjects. If one of those tips solves a problem of yours, the book will have paid for itself. If not, you will still have been entertained, enlightened, and reassured. "Remember," the authors point out, "that none of this stuff really works."

—Jon Udell

RELATIONAL DIFFERENCES

UNDERSTANDING RELATIONAL DATABASES by Fabian Pascal
John Wiley & Sons, ISBN 0471-585-386, $29.95

You don't have to get far into Fabian Pascal's *Understanding Relational Databases* before you're struck by the uneasy feeling that (a) you thought you understood what it meant for a DBMS to be a relational DBMS, but you were wrong, and (b) many people writing and selling DBMS packages (as well as computer publications reviewing the software) were equally ill-informed.

Not only is the book a tutorial, it also points a harsh finger at an industry that, in its rush to build database software, has forgotten (or possibly ignored) many of the fundamental requirements of the relational technology. The yield is a crop of file management packages with "sort of relational" outer husks passing themselves off as true RDBMSes.

The author's sharp elbow in our ribs reminds us that there's no such thing as "sort of relational." Worse, many DBMS products have—with the help of nonlogic from their designers—changed from "sort of relational" to simply relational. The ultimate losers

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are you and I, since a DBMS that's not relational is unable to incorporate all the safeguards and optimizations that relational technology sought to install in the first place.

It is Pascal's well-meaning intention to introduce the reader to enough relational theory so that he can proceed to eliminate much of the confusion that has arisen about it over the past two decades. We are reminded that an RDBMS is not just a mathematical plaything, but a concept that yields practical results. Thanks to the author's gift of clear writing, even a moderately determined reader stands a good chance of realizing the title's promise by the last page.

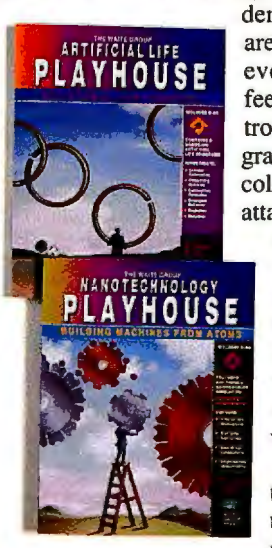
—Rick Grehan

CASUAL TECHNOLOGY

ARTIFICIAL LIFE PLAYHOUSE By Steven Prata The Waite Group Press, ISBN 1-878739-32-8, $23.95
NANOTECHNOLOGY PLAYHOUSE By Christopher Lampton The Waite Group Press, ISBN 1-878739-33-6, $23.95

When the rush of technology seems too much, it's useful to sit back and simply take a casual, lighthearted look at the oncoming wave. *Artificial Life Playhouse* and *Nanotechnology Playhouse* take this approach. Both are informative, and they include demonstration programs on disk. Neither will tax your technical skills.

Artificial Life Playhouse provides a quick overview of various artificial-life topics, such as cellular automatons and genetic algorithms, and then plunges you into a delightful collection of demonstration programs. My favorites are a pair of programs that simulate the evolution of antlike creatures as they feed and reproduce. One version controls a single ant colony; the other program provides competition between two colonies. It is incredibly easy to become attached to these little critters as you design a better bug.



Most of the provided software is in the public domain and available through a variety of on-line systems. You'll appreciate having them all in one place, along with design hints and problem-solving exercises to provide a little challenge.

If you've spent any time reading in the field of nanotechnology, you know that most of it is highly technical—articles describing the bonding mechanism between atoms and proving you can make mechanical dolls that will fit on the head of a pin. *Nanotechnology Playhouse* is more of a light stroll through the nano landscape—from roving factories able to manufacture your heart's desires to machines surfing through your bloodstream looking for hostile cells. All this, of course, is fictional; some of it absurdly so. However, this material is a look into the eyes of some modern dreamers who claim we have yet to begin making *really* microminiaturized systems. ■

—Raymond GA Côté

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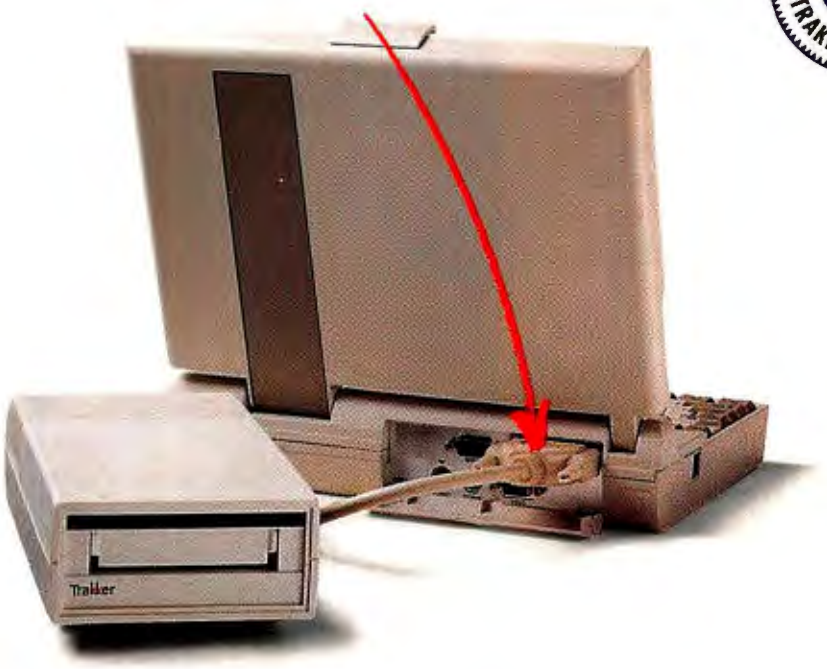

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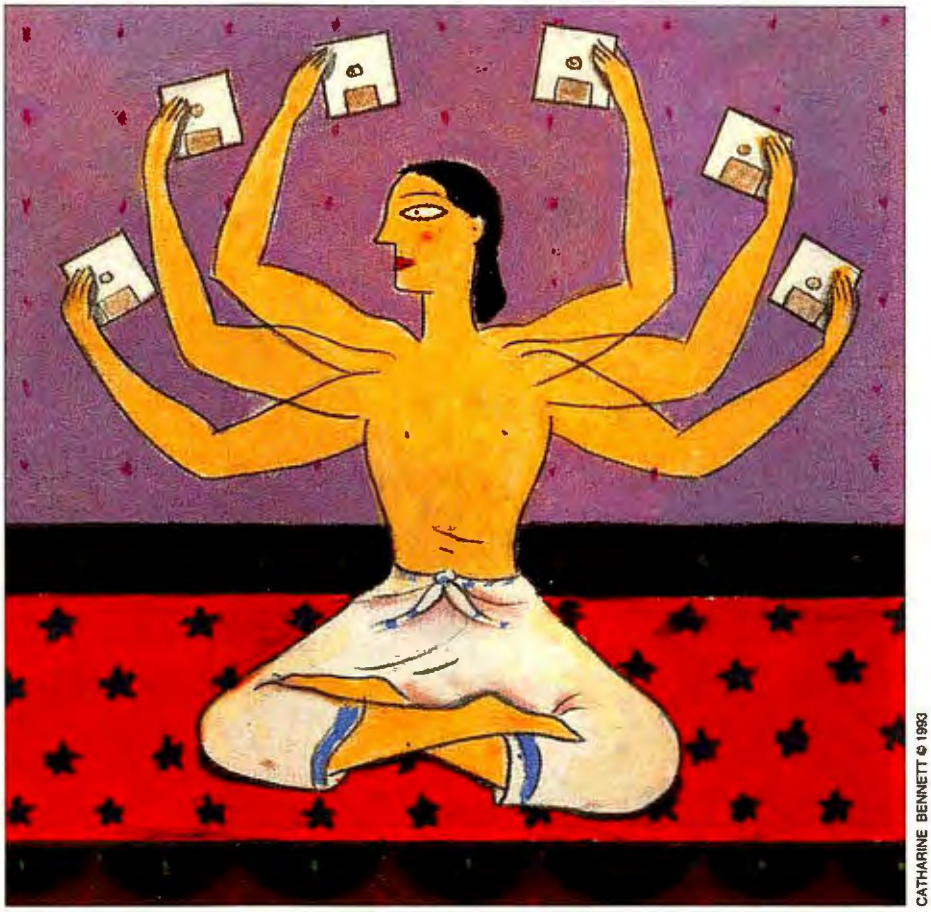

CATHARINE BENNETT © 1993

Small-systems thinking makes India a strategic software partner

Recently, I saw a demonstration of a new Motif-based programmer's tool called Sextant. It's a source code analyzer that converts C programs into labeled graphs that you navigate interactively. The demonstration was impressive. What made it unique for me was that it took place in the offices of Softek, a software company in New Delhi, India.

It's well known that Indian engineering talent pervades every level of the microcomputer industry. But what's happening in India? On a recent tour of the country, I visited several high-tech companies and discovered that India is evolving rapidly from an exporter of computer engineering talent into an exporter of computer products and services. Software exports, in particular, dominate the agenda. A 1992 World Bank study of eight nations rated India as the most attractive nation for U.S., European, and Japanese companies seeking offshore software-development partners.

The World Bank study was conducted by Infotech Consulting (Parsippany, NJ). When the opportunity arose to visit India, I contacted Infotech's president, Jack Epstein, for advice on planning my trip. He referred me to Pradeep Gupta, an entrepreneur in New Delhi who publishes two of India's leading computer magazines, *PC Quest* and *DataQuest*. Gupta also runs market-research and conference businesses. He orchestrated a whirlwind week of visits to companies in New Delhi and Bombay and generously took time to acquaint me with the Indian high-tech scene.

A Nation of Small Systems

Even among Indians, there's a tendency to attribute India's emerging software prowess to the innate mathematical abilities of its people. "After all, we invented zero," says Dewang Mehta, an internationally known computer graphics expert. He is also executive director of the National Association of Software and Service Companies (NASSCOM) in New Delhi.

While this cultural stereotype may hold more than a grain of truth, it's not the whole story. As NASSCOM's 1992 report on the state of the Indian software industry notes, India has the world's second-largest English-speaking technical work force. Consequently, Indian programmers are in tune with the international language of computing, as well as the language spoken in the U.S., the world's largest market.

Furthermore, India's data-communications infrastructure is rapidly modernizing. And the Indian government has begun an aggressive program of cutting taxes and lifting import restrictions for export-oriented Indian software businesses while simultaneously clearing the way for foreign companies to set up operations in India.

Other countries share many of these advantages, but India holds an ace. It is a nation of small systems. For U.S. and European companies that are right-sizing mainframe- and minicomputer-based information systems, the switch to PC-based

of India's 50,000 branches aren't linked electronically.

Nevertheless, the die was cast, and India entered the 1990s in possession of a special advantage. Indian programmers are not only well educated and English-speaking, but out of necessity they're keenly focused on client/server or multiuser solutions for PCs running DOS (with NetWare) or Unix—just the kinds of solutions that U.S. and European companies are rushing to embrace. India finds itself uniquely positioned to help foreign partners right-size legacy applications.

The small-systems mind-set also guides India's fledgling supercomputer industry. Denied permission by the U.S. government to import a Cray supercomputer, the Indian government's Center for the Development of Advanced Computers built its own—very different—sort of supercomputer. Called PARAM, it gangs Inmos T800 transputers in parallel and can also harness Intel 860 processors for vector work. Related developments include a transputer-based neural-network engine intended to run process-control applications. The designers of this system impressed me with their clear grasp of the way in which inexpensive transputers can yield superior performance, scalability, modularity, and fault tolerance.

client/server alternatives can be wrenching. Dumping the conceptual baggage of legacy systems isn't a problem for India, however, because, in general, those systems simply don't exist. "India's mainframe era never happened," says Gupta.

When Europe, Japan, and the U.S. were buying mainframes left and right, few Indian companies could afford their high prices, which were made even more costly by 150 percent import duties. Also, a government policy limiting foreign investors to a 40 percent equity stake in Indian manufacturing operations drove companies like IBM away, and the Indian mainframe industry never got off the ground.

But what did develop was an indigenous microcomputer industry. In the early 1980s, Indian companies began to import components and to assemble and sell PC clones that ran DOS. This trend quickened in 1984, when the late Rajiv Gandhi, prime minister and an avid computer enthusiast, lifted licensing restrictions that had prevented clone makers from selling at full capacity.

In the latter half of the 1980s, a computerization initiative in the banking industry shifted the focus to Unix. Front offices would run DOS applications, but behind the scenes, a new breed of Indian-made PCs—Motorola- and Intel-based machines running Unix—would handle the processing chores. Unfortunately, that effort stalled when the banks ran afoul of the unions; even today, many of the Bank

India's mainframe era never happened.

— Pradeep Gupta, entrepreneur and publisher of *PC Quest* and *DataQuest*

Software Products and Services

Many of the companies I visited produce comparable offerings for LAN or Unix environments. In the realm of packaged software, Oberoi Software in New Delhi sells a high-end hotel management application using Sybase 4.2 that runs on Hewlett-Packard, DEC, and Sun workstations. A low-end version uses Btrieve for DOS LANs. Softek offers 1-2-3, dBase, and WordStar work-alikes for DOS and Unix.

Shrink-wrapped products, however, aren't India's strong suit at the moment. PCs remain scarce and expensive commodities. According to *DataQuest*, fewer than 500,000 PCs can be found in this nation of 875 million people. To a U.S. software engineer, a $3000 PC might represent a month's wages. An equivalently prosperous Indian professional would have to work a full year to pay for the same system. To put this in perspective, the average per capita wage in India is about $320, and the government caps the monthly

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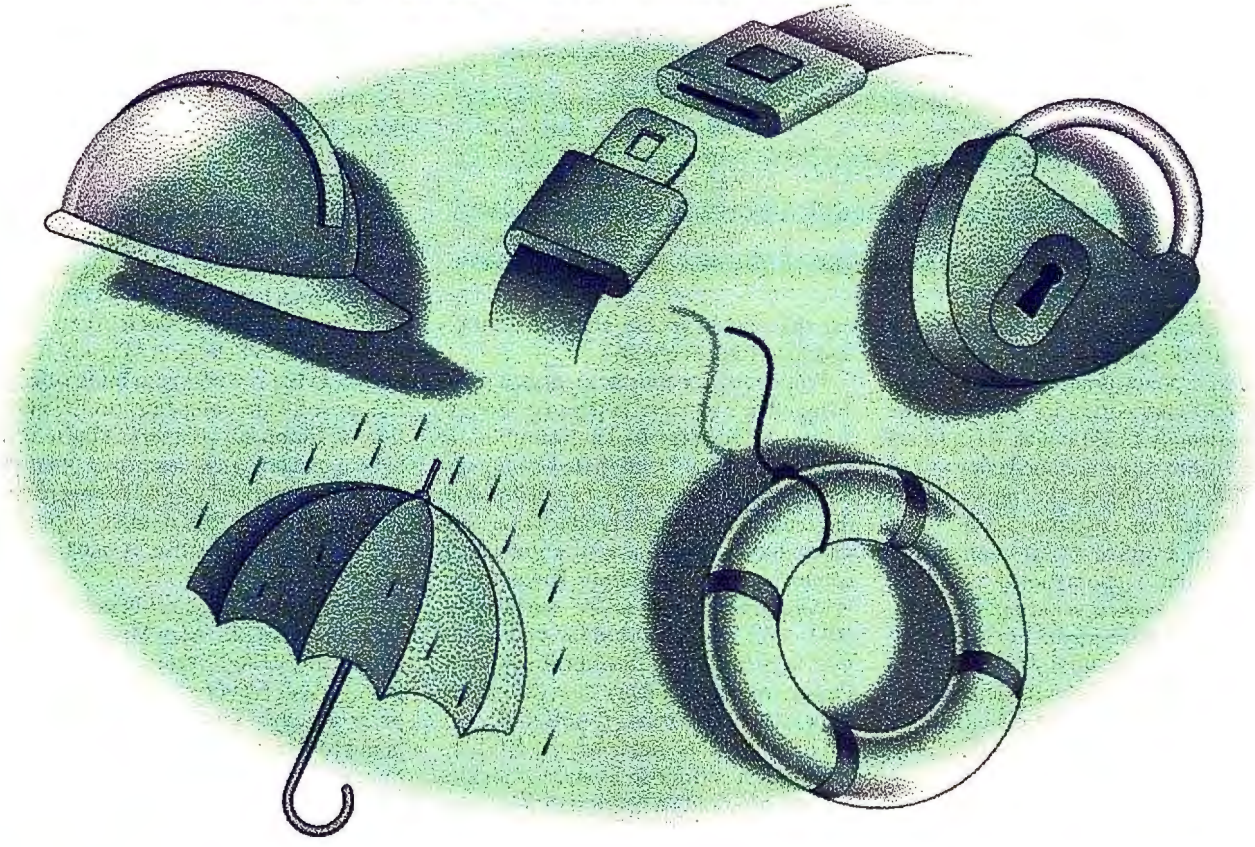

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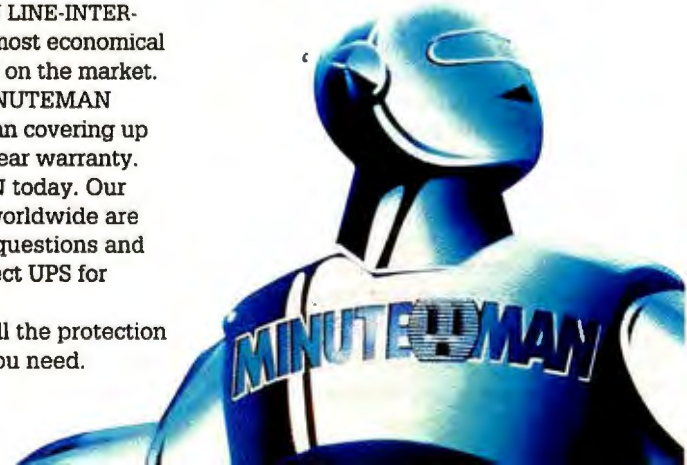

Circle 125 on Inquiry Card.

INDIAN/U.S. PARTNERSHIPS

A growing trend among Indian computer companies is to work with U.S. companies.

INDIAN COMPANY	U.S. PARTNER	PRODUCTS
Citicorp Overseas Software	Citicorp	Software services
HCL-HP	Hewlett-Packard	Workstations, PCs, software
ITC	Lotus Development	Software services
Mastek	Ingres	Software services
Onward Computer Technologies	Novell	Software services, maintenance
Pertech Computers	Dell Computer	Motherboards, PCs
Rolta India	Intergraph	CAD workstations, services
Tata Information Systems	IBM	PS/2, PS/VP, software services
Tata Unisys	Unisys	Workstations, software services
Wipro Infotech	Sun Microsystems	Workstations, software services

salary of Indian corporate executives at around $1600 per month.

Software piracy is another vexing problem. "The competition for a 5000-rupee [approximately $165] Indian spreadsheet isn't a 15,000-rupee imported copy of Lotus 1-2-3," says Gupta, "but rather a zero-rupee pirated copy of Lotus 1-2-3."

Painfully aware of the effect piracy has on the country's international reputation as a software power, government and industry leaders have joined forces to combat it. The Department of Electronics (DoE), for example, has funded an anti-piracy campaign, and Lotus has a $69 amnesty program that enables users of illegal copies of 1-2-3 to come clean.

Reengineering Is a National Strength

The real action in Indian software isn't in products. It's in reengineering services. A typical project, for example, might involve re-creating an IBM AS/400-type application for a LAN or Unix environment. A few years ago, Indian programmers almost invariably would perform such work on location in the U.S. or Europe, a practice called "body shopping." This was convenient for clients, but it wasn't very beneficial to India because the tools and the knowledge spun off from reengineering projects tended to stay overseas.

More recently, the trend is to carry out such projects on Indian soil. Softek, for example, used a contract to build a law-office automation system for a Canadian firm as an opportunity to weld a number of its own products into a powerful, general-purpose client/server development toolkit. Softek engineers showed me how that toolkit supports single-source development of GUI software for DOS or Unix (in character mode) as well as Windows. They explained that client programs can connect to Softek's own RDBMS (relational DBMS) or to servers from Gupta, Ingres, Oracle, or Sybase. That's an impressive achievement matched by few companies anywhere in the world, and it's one that should greatly enhance Softek's appeal to foreign clients.

While reengineering often means rightsizing, that's not always the case. For example, the National Indian Institution for Training, a New Delhi–based computer-training institute rapidly expanding into the realm of software products and services, has rewritten a well-known U.S. commercial word processor. Rigorous development techniques are the watchword at NIIT. "We have a passion for methodology," says managing director Rajendra S. Pawar, whose company also distributes Excelerator, Intersolv's CASE tool.

Other projects under way at NIIT include an X Window System interface builder, Mac and DOS tutorials to accompany the Streeter series of math textbooks (for McGraw-Hill), a simple but effective multimedia authoring tool called Imaginet, a word processor for special-needs users that exploits an NIIT-designed motion- and sound-sensitive input device, and an instructional video system.

Although services outweigh products for now, and the Indian trade press has complained that no indigenous software product has yet made a splash on the world scene, the situation could well change. Indian programmers are talented, and they're up-to-date with database, GUI, network, and object-oriented technologies. These skills, along with wages 10 or more times less than U.S. programmers, make Indian programming a force to be reckoned with. Software development is a failure-prone endeavor; many products never see the light of day. But, as Tata Unisys (Bombay) assistant vice president Vijay Srirangan points out, "The cost of experimentation in India is low." Of the many software experiments under way in India today, some will surely bear fruit.

We want to create many Hong Kongs and Singapores in India.

— N. Vittal, Secretary to the Government of India, Department of Electronics

A major obstacle blocking the path to commercial success is the lack of international marketing, but some help has been forthcoming. Under contract to the U.K.'s Developing Countries Trade Agency, the marketing firm Schofield Maguire (Cambridge, U.K.) is working to bring selected Indian software companies to the attention of European partners. "India does have a technological lead over other developing countries," says managing partner Alison Maguire. "But to really capitalize on its software expertise, it must project a better image."

Some companies have heard the message. For example, Ajay Madhok, a principal with AmSoft Systems (New Delhi), parlayed his firm's expertise with computer graphics and digital video into a high-profile assignment at the 1992 Olympics. On a recent U.S. tour, he visited the National Association of Broadcasters show in Las Vegas. Then he flew to Atlanta for Comdex. While there, he bid for a video production job at the 1996 Olympics.

Incentives for Exporters

According to NASSCOM, in 1987, more than 90 percent of the Indian software industry's $52 million in earnings came from "on-site services" (or body shopping). By 1991, on-site services accounted for a thinner 61 percent slice of a fatter $179 million pie. Reengineering services (and, to a lesser extent, packaged products) fueled this growth, with help from Indian and U.S. government policies.

On the U.S. side, visa restrictions have made it harder to import Indian software labor. India, meanwhile, has developed a range of incentives to stimulate the software and electronics industries. Government-sponsored technology parks in Noida (near New Delhi), Pune (near Bombay), Bangalore, Hyderabad, and several other locations support export-oriented software development. Companies that locate in these parks share common computing and telecommunications facilities (including leased-line access to satellite links), and they can import duty-free the equipment they need for software development.

The Indian government has established

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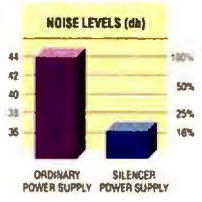

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Cooling Fan Capacity:	2	3	6
Filtered Air Inlet:	Yes	Yes	Yes
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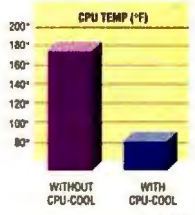

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export processing zones in which foreign companies can set up subsidiaries that enjoy similar advantages and receive a five-year tax exemption. Outside these protected areas, companies can get comparable tax and licensing benefits by declaring themselves fully export-oriented.

Finally, the government is working to establish a number of hardware technology parks to complement the initiative in software. "We want to create many Hong Kongs and Singapores," says N. Vittal, Secretary of the DoE and a tireless reformer of bureaucracy, alluding to the economic powerhouses of the Pacific Rim.

The Indian high-tech entrepreneurs I met all agreed that Vittal's tenacious slashing of government red tape has blazed the trail they now follow. How serious is the problem of government red tape? When the government recently approved a joint-venture license application in four days, the action made headlines in both the general and trade press. Such matters more typically take months to grind their way through the Indian bureaucracy.

The evolution of India's telecommunications infrastructure shows that progress has been dramatic, though uneven. In a country where only 5 percent of the homes have telephone service, high-tech companies increasingly rely on leased lines, packet-switched data networks, and satellite links. The DoE works with the Department of Telecommunication (DoT) to ensure that software export businesses get priority access to high-bandwidth services.

But the slow pace of progress at the DoT remains a major frustration. For example, faxing can be problematic in India, because the DoT expects you to apply for permission to transmit data. And despite widespread Unix literacy, only a few of the dozens of business cards I received during my tour carried Internet addresses. Why? DoT regulations have retarded what would have been the natural evolution of Unix networking in India. I did send mail home using ERNET, the educational resource network headquartered in the DoE building in New Delhi that links universities throughout the country. Unfortunately, ERNET isn't available to India's high-tech businesses.

Vittal recognizes the critical need to modernize India's telecommunications. Given the scarcity of an existing telecommunications infrastructure, he boldly suggests that for many scattered population centers, the solution may be to completely pass over long-haul copper and vault directly into the satellite era. In the meantime, India remains in this area, as in so many others, a land of extreme contrasts.

Our multiprocessing implementation of Unix System V has been used since 1988 by companies such as Pyramid and NCR.

—Arjun Malhotra, director HCL-HP, Noida, India

While most people lack basic telephone service, workers in strategic high-tech industries now take global voice and data services for granted.

Powerful Partners

When Kamal K. Singh, chairman and managing director of Rolta India, picks up his phone, Rolta's U.S. partner, Intergraph, is just three digits away. A 64-Kbps leased line carries voice and data traffic from Rolta's offices, located in the Santacruz Electronics Export Processing Zone (SEEPZ) near Bombay, to an earth station in the city's center. Thence, such traffic travels via satellite and T1 lines in the U.S. to Intergraph's offices in Huntsville, Alabama.

Rolta builds Intel- and RISC-based Intergraph workstations for sale in India; I saw employees doing everything from surface-mount to over-the-network software installation. At the same time, Rolta does facilities mapping for a U.S. telephone company through its subsidiary in Huntsville. Every night, scanned maps flow through the satellite link to Bombay. Operators running 386-based RoltaStations retrieve the maps from a Unix server, digitize them using Intergraph's MicroStation CAD software, and relay the converted files back to Huntsville.

Many Indian companies have partnerships with U.S. firms. India's top computer company, HCL, joined forces with Hewlett-Packard to form HCL-HP. HCL's roots were in multiprocessor Unix. "Our fine-grained multiprocessing implementation of Unix System V has been used since 1988 by companies such as Pyramid and NCR," says director Arjun Malhotra.

HCL's joint venture enables it to build and sell HP workstations and PCs in India. "People appreciate HP quality," says marketing chief Ajai Chowdhry. But since Vectra PCs are premium products in the price-sensitive Indian market, HCL-HP also plans to leverage its newly acquired HP design and manufacturing technology to build indigenous PCs that deliver "good value for money," according to Malhotra.

Pertech Computers, a system maker in New Delhi, recently struck a $50 million deal to supply Dell Computer with 240,000 motherboards. Currently, trade regulations generally prohibit the import of certain items, such as finished PCs. However, exporters can use up to 25 percent of the foreign exchange they earn to import and sell such items. Pertech director Bikram Dasgupta plans to use his "forex" money to buy Dell systems for resale in India and to buy surface-mount equipment so that the company can build work-alikes.

IBM returned to India last year, after leaving in 1978, to join forces with the Tatas, a family of Indian industrialists. The joint venture, Tata Information Systems, will manufacture PS/2 and PS/VP systems and develop software exports.

Citicorp Overseas Software, a Citicorp subsidiary, typifies a growing trend to locate software-development units in India. "Our charter is first and foremost to meet Citicorp's internal requirements," says CEO S. Viswanathan, "but we are a profit center and can market our services and products." On a tour of its SEEPZ facility in Bombay, I saw MVS, Unix, VMS, and Windows programmers at work on a variety of projects. In addition to reengineering work for Citicorp and other clients, the company markets banking products called Finware and MicroBanker.

ITC (Bangalore) supplements its Oracle, Ingres, and AS/400 consulting work by selling the full range of Lotus products. "Because we have the rights to manufacture Lotus software locally," says vice president Shyamal Desai, "1-2-3 release 2.4 was available here within a week of its U.S. release." Other distributors of foreign software include Onward Computer Technologies in Bombay (NetWare) and Bombay-based Mastek (Ingres).

India's ambitious goal is to quadruple software exports from $225 million in 1992 to $1 billion in 1996. To achieve that, everything will have to fall into place. It would be a just reward. India gave much to the international microcomputer industry in the 1980s. In the 1990s, the industry just might return the favor. ■

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

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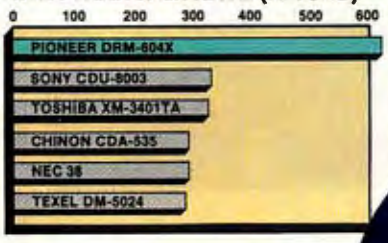

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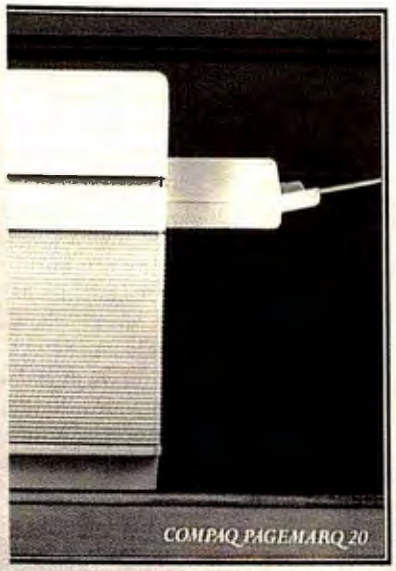

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Cover Story

VIDEO CONQUERS

The integration of full-motion video on desktop computers has begun. Out of the box, your system will soon allow you to have live videoconferences, attach video clips to your data files, and view video files from your desk. Leading the way are Apple with its new AV Macintosh series and Silicon Graphics with its Indy workstation.

ANDY REINHARDT

Once only a fantasy of world's fairs and Jetsons cartoons, video communication is finally arriving as a serious business tool. But instead of being packaged in a stand-alone, phone-like device, it is riding into the workplace on the back of personal computers. The integration of video into PCs offers much more than the ability to see the person on the other end of the line: Content-rich video will enable new kinds of collaborative work.

New products from Apple and Silicon Graphics exemplify the trend to support motion video in desktop systems. Just as computer makers earlier added color, bit-mapped graphics, and audio to PCs, now they are building in video. The Silicon Graphics Indy and two new Apple Macs—the Centris 660AV and the Quadra 840AV—include hardware for input and output of analog video, video digitization, digital signal processing for image manipulation and compression, and software support for handling video data. The Indy even includes a tiny video camera as standard equipment (see "Apple, SGI Blaze Video Trail" on page 81).

Such capabilities have been available from third-party vendors such as SuperMac, RasterOps, and Creative Labs at considerable cost to purchase, install, and integrate. Apple's QuickTime and Microsoft's Video for Windows added system-level software support for handling synchronized digital-video data, but hardware was still extra. Now, with starting prices as low as $2500 for the Centris 660AV and $5000 for the Indy workstation, you can buy a system ready to handle video right out of the box. In effect, video has become nearly free, and the implications for computer users are enormous.

PHOTOGRAPHY: MEL LINDSTROM © 1993

THE DESKTOP

"People are going to be really surprised at how powerful [video] is," says multimedia analyst Denise Caruso, editor of the *Digital Media* newsletter (San Francisco, CA). When video becomes standard, programmers will write software that takes advantage of it and users will treat it like just another data type, such as text, graphics, or audio.

This will open up new, more effective channels of communication among individuals and workgroups. Presentation packages, word processors, databases, and even spreadsheets will support video clips and annotations. E-mail packages will add support for video attachments to messages. Multimedia titles will become richer, more dynamic, and more widely distributed.

Perhaps the most significant potential lies with desktop videoconferencing. You can, in effect, turn your PC into a videophone by sending pictures captured with your computer's camera in real time across high-speed telephone lines or over a LAN. Or you could employ a store-and-forward architecture, sending those pictures to a central repository for delivery at a later time.

Sarah Dickinson, an analyst at Personal Technology Research (Waltham, MA), has monitored the migration of videoconferencing technology from large room-size systems to the desktop. "When you put this technology on the motherboard," Dickenson says, "it changes everything."

Both real-time videoconferencing and store-and-forward video mail present technical, cultural, and economic hurdles. Each puts stress on the existing communications infrastructure and forces the user to work in new ways. And, as with any emerging technology, the cost of successfully applying video throughout the enterprise is high.

New Media

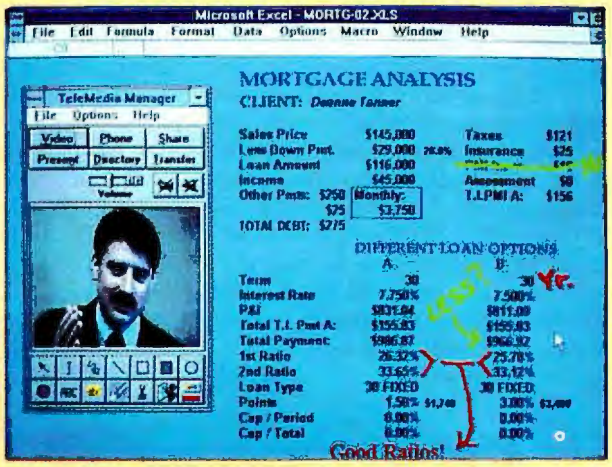
Built-in video capabilities will be harnessed in a number of ways. Foremost among them is delivery of prepared content in either analog or digital form. Thus, the new Apple and SGI systems can accept analog video signals (NTSC or PAL) directly from cable, a VCR, or a laser videodisc and display the picture in a window. This means that you could watch CNN while you work on a spreadsheet, or view a training videotape for a new software package while using the program in a separate window.

Likewise, digital video, delivered on a CD-ROM or across a network, can be displayed on-screen or merged with other video sources and graphics. A company with networked, video-equipped computers can use this infrastructure to deliver informational or motivational videos. For example, Sun Microsystems sent its employees a digital-video holiday greeting from chairman and CEO Scott McNealy last December, and SGI distributed to its staff a digital video of the visit earlier this year by President Bill Clinton and Vice President Al Gore.

continued

Document Conferencing Keeps Your Data Close-By

One of the main advantages of a desktop system is that the video communication occurs on the same machine where you keep your electronic documents. "You're closer to your data," says Chris Herot, director of advanced technology for Lotus Development (Cambridge, MA). "You don't have to bring it with you down the hall." Compression Labs' Cameo, PictureTel's Live PCS 100, and other desktop systems thus typically offer the ability to send—and in most cases to work collaboratively on—documents. Because document conferencing can be done over conventional phone lines without expensive hardware add-ins, it's likely to become prevalent far sooner than desktop video. Consequently, many desktop videoconferencing systems give equal weight to document conferencing.



A Cadillac among desktop video *and document conferencing systems, NCR's TeleMedia Connection is a hardware and software package that supports collaborative document mark-up and real-time video-in-a-window. It uses H.261-standard compression and requires dual ISDN channels for quarter-screen video throughput of 15 fps.*

Document conferencing is typically designed much like a two-way version of remote-control software packages, such as pcAnywhere or Timbuktu. The "master" user owns the document and runs the application that created it, while one or more "slave" users see a bit-mapped image of the document that they can mark up and annotate in real time. Document images can be saved at all locations, but the original is usually modified only if the master gives keyboard or mouse control to remote users. Files can also be sent among users, often in the background.

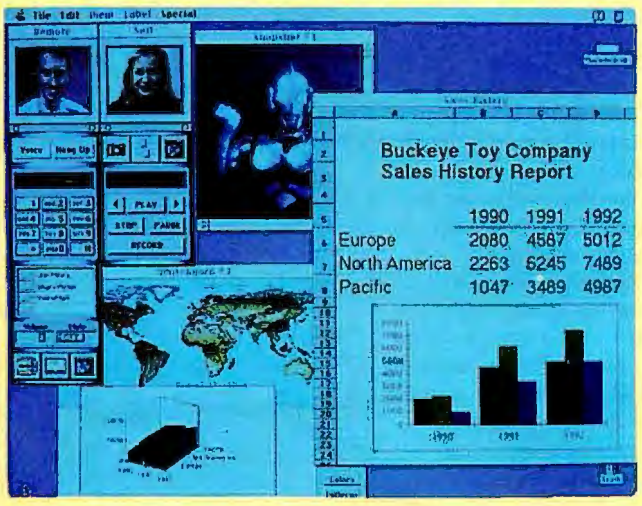
Many of these packages also support *whiteboarding*, or the ability to draw or type on a blank white window, usually in "ink" color-coded by user. The more sophisticated products also permit multiple simultaneous masters and slaves; i.e., I share my Excel spreadsheet with you while you share your Ami Pro report with me. Some offer better performance by trapping GDI (Graphical Device Interface) calls and keyboard/mouse inputs instead of transmitting compressed bit maps. But at this point, none of the packages permit actual application sharing, where the same document is loaded up on both sides and collaboratively modified, although several vendors say that they are working toward this capability.

Visit, from Northern Telecom (Nashville, TN), was an early entrant in the desktop market. The $3899 product (not including telecom interface) has the distinction of being the only system that now runs on both the Mac and Windows and can interoperate between them. Its video, however, is limited to gray scale. Visit requires digital or leased lines but uses only one 64-Kbps ISDN channel or 56-Kbps switched line (Switched-56) to deliver 10 to 15 frames per second (fps) of video. Northern Telecom plans to enhance the system this year with support for color, H.261 compression, and multipoint bridges, says Jeff Berman, manager of market development for the company.

NCR's TeleMedia Connection is a similar system, but it supports 15-fps quarter-screen color video over dual ISDN channels—i.e., 128 Kbps. NCR sells the product primarily as a document-sharing system for Windows, with H.261 videoconferencing as a bonus. TeleMedia Connection sells for between $5000 and $7000, depending on whether you already have an AT&T 8510 ISDN phone (to which you run an interface cable) or need to add an ISDN card to your PC. Neil Whittington, assistant vice president of NCR's workstation products division, multimedia business unit, says support for Switched-56 and analog lines (for document sharing only, not video) will be added later.

Another Windows video/document conferencing system is DVTS from GTE (Chantilly, VA). It offers H.261 compression, frame rates of from 7.5 to 30 fps, and a whiteboard feature. It supports ISDN and Switched-56, or you can use it over a high-speed modem.

Creative Technologies, the parent company of Creative Labs (best known for the SoundBlaster and VideoBlaster), has recently acquired the Mac-based ShareView and ShareView Plus, products that set new standards in this category



Creative Technologies' ShareView Plus *is now available only for the Mac but is slated for other platforms. This groundbreaking package offers document sharing and videoconferencing over a standard analog phone line, using proprietary compression. The video rate can be as low as 5 fps, so Creative plans to add support for digital telephony and standard codecs.*

because they were designed to run over analog lines. ShareView, which sells for $1195, includes a NuBus board, a 14.4-Kbps modem, a handset, and software that permits audio communications, whiteboarding, and collaborative document sharing. The $4499 Plus version of the product adds a video camera and a second NuBus card that uses a proprietary compression scheme capable of sending images ranging from 80 by 96 pixels up to 160 by 190 pixels at rates of 5 to 12 fps. Creative's plans for the product include expanding to Windows, and supporting digital telephony and standards-based codecs.

Nuts Technologies, a San Jose, CA, based start-up, has announced but not yet shipped a product called Hello 918 that reportedly supports analog and ISDN with video rates of 5 to 30 fps. Eye-Tel Communications (North Vancouver, BC, Canada) recently acquired Tel-America Video Conferencing of Syracuse, IN, and sells a line of products called Tel-Eye-Vision that range from low-cost graphics file transfer and document-sharing tools to a $10,000 conferencing system based on H.261 and digital lines.

For OS/2, IBM sells Person-to-Person/2, a whiteboarding and document-sharing package that also supports live videoconferencing via IBM's ActionMedia II card. Versions of the software for Windows and AIX are planned for later this year, with Mac support in 1994. The $280 package ($1875 for a 10-user license) lets up to five users at a time share a common chalkboard or mark up documents. The package runs now over Token Ring and Ethernet LANs using NetBIOS, with native IPX support slated soon, and requires ISDN for WAN (wide-area network) connections.

In what may augur a future trend, Peregrine Software (Carlsbad, CA) has developed a software-only networked videoconferencing product that runs on off-the-shelf video hardware. Instead of being sold as a turnkey or integrated solution, Peregrine's as-yet-unnamed package will run on any PC that is equipped with a video camera and a capture card supported by Microsoft Video for Windows. Features include shared documents and real-time video over NetWare or NetBIOS LANs (and over WAN links faster than 128 Kbps), and network software that manages the video streaming and frame rate.

REAL TIME VS. STORE-AND-FORWARD

Real-Time Video Conferencing	Store-and-Forward Video Mail
Live, interactive collaboration	Noninteractive
Parties must be present to use	Send and receive on your own schedule
Needs few system resources, since video is passed through	Needs more system resources, i.e., CPU, bus bandwidth, disk space
Needs expensive real-time compression technology	Video compression can be done off-line or in software
Supports real-time document conferencing as well	Not meant for real-time document conferencing
Hard for people who speak different languages	Can view video and respond at your own pace
Conveys innuendo and nonverbal information	Not much better than voice mail
Requires special LANs, i.e., synchronized, ATM	Operates over conventional LAN
Needs fast, expensive telecom services for WAN links	Operates over analog phones

Computer-based training is the most promising short-term application for desktop video, especially if the materials are interactive and customizable by the user—that is, if they take advantage of the computer rather than working in the linear fashion of videotape. For example, hypertext links can allow you to go through a lesson in the order and at the pace that suit you. "Every company is looking at how to train its people faster and faster," says Marika Ruumet, network manager for HP-TV, Hewlett-Packard's programming network for business partners.

In addition to playing prerecorded content, you can also capture still frames and video clips with the Indy and Mac AV systems. You just plug a camcorder into the video port; the hardware to digitize and compress video is built in. Once the video is digitized, you can attach it to a mail message and send it to a colleague. Or you can use an editing package such as Adobe Premiere 3.0 to alter images, rearrange frames and sequences, and add titles, music, and voice-overs. While this process will not produce professional-quality video, the resulting presentation can be output to analog video—using a so-called print-to-tape capability—for playback on any VCR.

Video Mail

Once you've got digital video inside your system, you gain the ability to send it to somebody else, assuming that you're on a LAN or connected to the phone system. Both real-time and store-and-forward video messaging will get a big boost from systems like the Mac AVs and the Indy.

The advantage of video mail, says Ann Earon, president of Telemanagement Resources International (TRI; Lake Wylie, SC), is that it lets you send and receive whenever you're ready. This is especially important when crossing time zones or dealing in foreign languages. Earon notes that Asian users haven't widely embraced real-time videoconferencing, not only because live sessions with the U.S. involve inconvenient hours, but also because of cultural reasons. "They'd rather receive a video transmission, discuss it, and then respond," she says. For international communications, Earon asserts, store-and-forward video is "very suitable."

Store-and-forward messaging is much easier to accommodate on networks than is real-time communication, because packets can be deferred for later delivery. Unlike videoconferencing, video mail doesn't require vast amounts of synchronous bandwidth. Videoconferencing can demand anywhere from 14.4 Kbps for low-quality analog transmissions to at least 128 Kbps for full-screen digital transmission. Traditional room-size systems use 384 Kbps or more.

However, because video is such a dense data type, mailing and storing it require large amounts of processing power and hard drive space on both ends of the communication link. Caruso dismisses store-and-forward video mail as "bull"; she doubts that users really want or need to send and receive video clips of "talking heads," which often convey little more than a voice-mail message. "I don't see the point of all that overhead for the problem you're trying to solve," Caruso says. Video files could also spell problems for networks: Frequent video-mail file transfers could clog LANs.

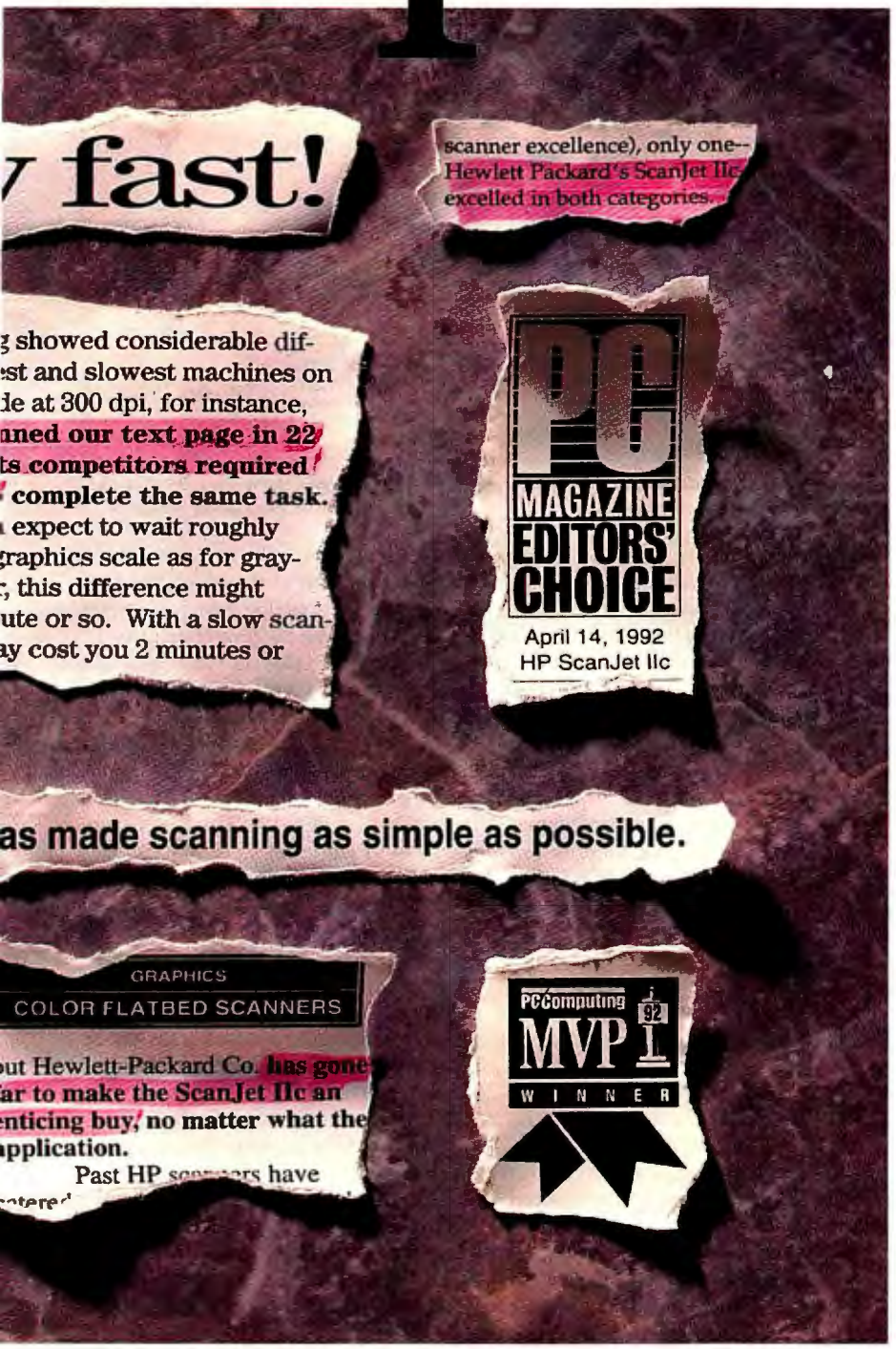
Conferencing

By contrast with video mail, real-time videoconferencing is less demanding of the host system, because the video typically passes through the machine without chewing up CPU resources or system-bus

Read my

clips.

HP ScanJet IIc



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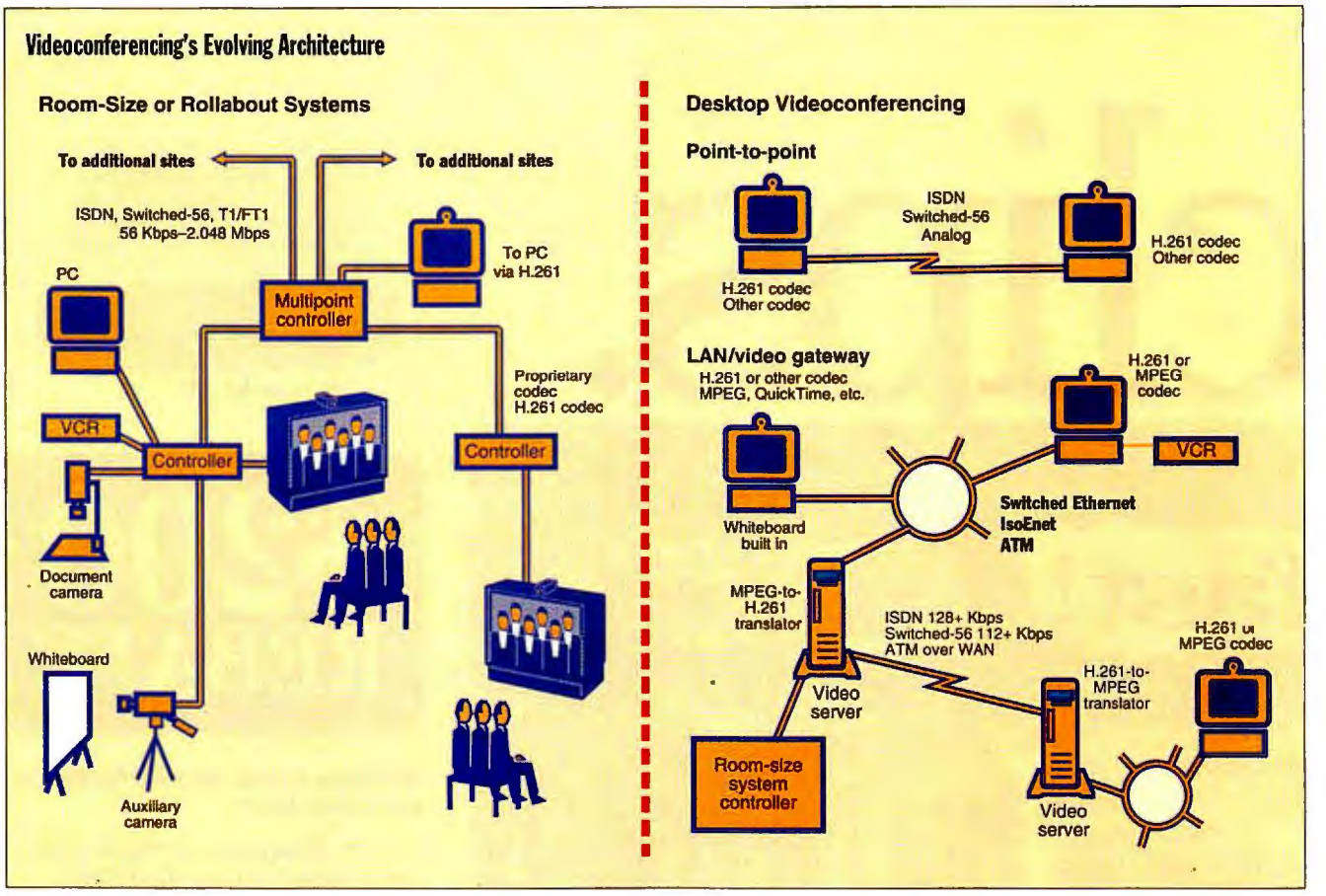

Traditional videoconferencing systems *use proprietary compression algorithms and rely on high-speed leased or switched phone lines. PCs running standards-based compression can sometimes attach to these systems. Desktop videoconferencing is less centralized and can't accommodate groups of users, but it may permit more spontaneous and intimate communication.*

bandwidth. Because it's live, the data neither comes from nor is saved to a hard drive; users who want to preserve video conferences for posterity usually output them to a VCR.

But the acceptance of traditional videoconferencing has been slow, so many industry observers are skeptical about its potential on the desktop. They argue that users need to share documents and graphics more than they need to view live movies of each other.

Vendors acknowledge this. According to Jeff Berman, manager of market development for Northern Telecom's (Nashville, TN) Visit desktop video system, "Our customers are using Visit as an interactive multimedia conferencing platform for collaborative work, not necessarily as a low-cost videoconferencing system replacement."

The Video Computer

- **Fast 32-bit processor**
- **Video input (NTSC/PAL to VGA or other display)**
- **Video output (VGA or other to NTSC/PAL)**
- **Video camera, analog or digital**
- **DSP or specialty chips for processing digital video**
- **Compression/decompression in silicon**
- **Fast path to memory and hard disk**
- **Access to digital communications (ISDN, Switched-56, LAN)**

The $3899 Visit, an early desktop videoconferencing product, has the distinction of being the only system that now runs on both the Mac and Windows (see "Document Conferencing Keeps Data Close-By" on page 66).

Established videoconferencing players, including such companies as Compression Labs, Inc. (CLI; San Jose, CA), PictureTel (Peabody, MA), Vtel (Austin, TX), and U.K.-based GPT Video Systems, are now bringing out desktop-based products. CLI got an early start in this category with its $4500 Macintosh-based Cameo Personal Video Conferencing System, announced in January 1992, which uses compression technology that was developed jointly by CLI and AT&T. Cameo is designed to work over ISDN lines only and employs a scaled-up version of the algorithm that AT&T uses in its analog-based consumer videophone. The system transmits 15 frames per second (fps) of video, or about half the rate of TV video, and requires an external phone to transmit audio.

PictureTel, which has struck joint development deals with IBM and Lotus, has recently announced the $6000 PC-based PictureTel Live PCS 100. This system supports both PictureTel's proprietary SG3 algorithm and industry standards. As with most of its competitors in this product class, the price of the PCS 100 reflects the cost of hardware-assisted video compression and interfacing to ISDN.

Personal Technology Research's Dickinson believes these systems "may not be the route to desktop videoconferencing." Instead, PC vendors may migrate up into the conferencing business by building in support for video compression and high-speed communications.

Larger videoconferencing systems will remain viable, however. According to Lung Yeh, vice president of technology for the video products group of Creative Technologies (Singapore), the systems will

Why do they call it a dongle?

He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.

It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

The Most Powerful Program in the World

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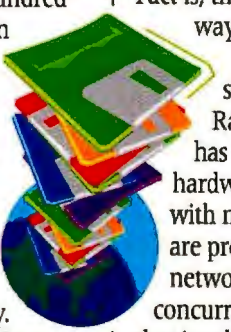
The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.



Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

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Video Compression Standards Vie for Acceptance

TOM R. HALFHILL

Imagine if you couldn't send a fax outside your company because the recipient's fax machine recognized a different transmission standard than yours. Or suppose the public telephone system lacked sufficient bandwidth to handle a fax transmission at all. Welcome to videoconferencing, 1993.

But there is hope. The CCITT, which established the Group 3 standard that lets fax machines communicate worldwide, is trying to bring the same order to videoconferencing. It is promoting a specification known as H.261 (pronounced "H-dot-261") or Px64 ("P times 64").

H.261 defines a scheme for sending video at speeds of from 64 Kbps to 2 Mbps. At the low end of the spectrum, H.261 fits into an ISDN channel; at the high end, it needs wider-bandwidth dedicated lines, such as T1. The standard defines a video window of 352 by 288 pixels, known as CIF (Common Intermediate Format). It also supports QCIF (Quarter CIF), a smaller window of 176 by 144 pixels. Related specifications cover still-frame graphics, call-setup protocols, and other issues.

Large conference-room video systems, such as those from PictureTel (Peabody, MA) and Compression Labs (San Jose, CA) , traditionally rely on their own proprietary codecs, although they offer H.261 as an option. In the desktop market, not everyone seems to be greeting H.261 with open arms. "The problem with H.261 is that it lends itself to very, very expensive hardware," says Paul Nahi, a product director at Media Vision (Fremont, CA). "Videoconferencing will become popular when, and only when, you can set up a node for under $200. That's $200 for the plug-in board, the software, and the camera."

Media Vision is pushing its own proprietary codecs known as MotiVE (Motion Video Engine) and Captain Crunch. MotiVE is a codec that's licensed to Microsoft for use with Video for Windows. Captain Crunch is a newer codec that will be available on a pair of chips for under $40 by the end of the year. Media Vision intends to sell the chip set to other vendors and use it in a line of desktop video products.

Weitek (Sunnyvale, CA) is developing a new family of chips that will improve playback in Video for Windows and eventually support the most popular codecs, including Captain Crunch, Cinepak, MPEG, and Intel's Indeo. Intel (Santa Clara, CA) and Microsoft (Redmond, WA) are backing Indeo for desktop video, although Microsoft has also licensed Cinepak for use with Video for Windows. Intel's Smart Video Recorder, an ISA board for PCs, uses the Intel 750 video processor and Indeo to capture and record live video onto a hard disk in real time.

Although Intel has alliances with Bell Atlantic and Ameritech and is known to be working on desktop videoconferencing products, it's not clear if it will implement Indeo, H.261, or some other codec. "Our policy is to follow existing standards when they make sense, and to introduce new standards if they don't already exist or [existing ones] don't offer a good solution," says Scott Darling, marketing director of Intel's business communications division.

AT&T Microelectronics' (Berkeley Heights, NJ) AVP-1000 chip set supports H.261/Px64 and MPEG for full-motion video, plus JPEG for still-image compression. Motorola (Austin, TX) and BT (London, U.K.) are also developing a chip set that supports H.261, MPEG, and JPEG. Those chips will appear on PC expansion boards from BT next year.

Nearly everyone is focusing on ISDN or LANs as the minimum requirement for acceptable video quality. But start-up company Knex (Fremont, CA) says it will soon introduce the Holy Grail of video codecs: a radical new compression scheme that can send 320- by 240-pixel color images at 15 frames per second over POTS (plain old telephone system) with a transmission delay of under 200 milliseconds. "Our goal is to make it possible for any two people on the face of the earth to communicate with each other visually over ordinary phone lines," says Steve Johnson, Knex's chief operating officer.

That goal has eluded everyone since the first prototype videophones drew curious crowds at the 1964 World's Fair in New York. But until the codec chaos is resolved, videoconferencing will be more local than global.

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

CODECS FOR DESKTOP VIDEOCONFERENCING

CODEC	SOURCE	APPLICATIONS	ADOPTERS
Captain Crunch	Media Vision	Video playback, videoconferencing, CD-ROM	Cirrus Logic, Weitek
Cinepak	SuperMac Technology	Video playback, videoconferencing, CD-ROM	Apple, Atari, Cirrus Logic, Creative Labs, Microsoft, Sega, 3DO
H.261/Px64	CCITT	Universal videoconferencing over digital phone lines and LANs	AT&T, British Telecom, CLI, Motorola, NEC, PictureTel, Video Telecom
Indeo	Intel	Video playback, CD-ROM	Apple, Microsoft
JPEG	Joint Photographic Experts Group	Still-image compression and transmission	Widespread
MotiVE	Media Vision	Video playback, videoconferencing, CD-ROM	Microsoft
MPEG	Moving Pictures Experts Group	Video playback, videoconferencing, CD-ROM	Philips, many others

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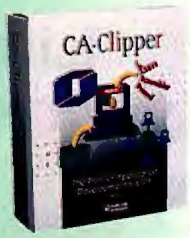

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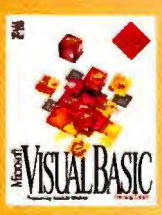

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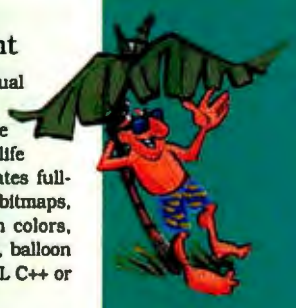

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be positioned to serve groups of people and to span multiple sites, whereas today's desktop systems are aimed at individuals doing point-to-point communications. However, TRI projects that unit sales of large-scale videoconferencing systems will remain relatively flat for the next four years, while sales of desktop-based systems will soar from about 10,000 this year to nearly 800,000 in 1997.

Although the first videoconference systems appeared in the 1970s, the technology is still bogged down by conflicting standards and constricted electronic pathways. Before desktop videoconferencing can be-

Pandora and the Active Office

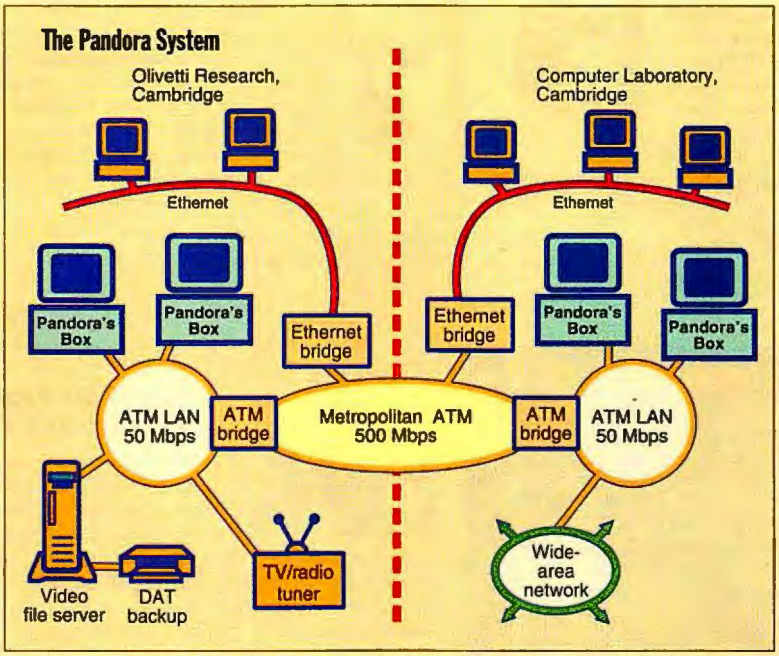
DICK POUNTAIN

CAMBRIDGE, U.K.—Europe's largest PC manufacturer, Olivetti, sees its future products converging into a system it calls the Active Office. With the Active Office, digital video and audio services will be able to follow individuals around from room to room via the *active badges* they wear. Not only will your videophone calls get routed to the workstation you're nearest to, but your whole desktop might follow, too, so that you're not forced to wrestle with Fred's purple-on-green windows and Albanian keyboard layout.

The components of this Active Office are being developed at Olivetti Research, Ltd. (ORL), in a joint venture between Olivetti and DEC that's sited in Cambridge, U.K. The key enabling technologies are high-speed ATM (Asynchronous Transfer Mode) networks, a distributed multimedia system called Pandora and its successor Medusa, and the active badges themselves. ORL presently runs a network of more than 40 Pandora workstations—spread over four separate sites a half-mile apart in central Cambridge—that provides videophone, video-mail, and conferencing services.

The Pandora System

Pandora is an all-digital multimedia system that transports multiple streams of "medium quality" video and audio to each workstation in a network. Every Pandora user gets a high-resolution Unix workstation connected to a video camera, telephone, microphone, and loudspeaker via a unit called Pandora's Box, which combines the functions of network interface, stream manager, and video mixer.



Pandora handles video via a subsystem approach, *with separate frame stores for the workstation's screen display and for incoming video streams. Pandora's Box acts as a pixel switch that merges video into the workstation's display, a design that yields high performance but makes it difficult for workstation software to access video data. In contrast, Medusa, the successor to Pandora, places raw video data directly onto the workstation bus, where it can be manipulated by software.*

Each Pandora's Box contains no less than six Inmos T45 transputers acting as embedded controllers: one to sample the video camera; one to manage an analog video mixer and combine incoming video with the workstation's X Window System display; one to handle audio, sampled at 8 kHz; one to switch data streams, say, to and from the compression and expansion hardware; and two to act as ATM network I/O processors.

Apart from the total bandwidth of the ATM network, there's no hard limit on the number of video streams or screen windows that a Pandora system can handle. For example, a four-party videoconference might use 28 simultaneous streams—12 video and 12 audio for two-way connection of all pairs of participants, plus four extra video streams to show participants their own local image.

Pandora is designed to degrade gracefully when it does eventually approach overload. Audio always takes priority, and video packets will be discarded first if the system can't cope, because users will tolerate degraded picture quality better than fuzzy sound. One of the audio transputer's duties is to apply echo and feedback cancellation, which ORL has found to be crucial to Pandora's acceptability in real office environments.

ATM Networking

ORL is a strong champion of ATM as the most suitable form of network for real-time multimedia systems. ATM is a variant of packet switching in which short, fixed-length data packets called *cells* are transmitted via "end-to-end" virtual circuits, rather than by destination or route addressing. Unlike many packet schemes, ATM always preserves the time ordering of its packets. ORL originally implemented 32-byte cells but has now moved to 48-byte cells (with 5-byte headers) for greater ease of interworking with broadband ISDN.

ATM has several advantages for multimedia applications, of which the most

come as effortless and ubiquitous as the videophones on *The Jetsons*, the problems of interconnectivity and bandwidth have to be solved. Unfortunately, transmitting a synchronized stream of audio and video in real time is much more difficult than, say, sending a fax, which consists of a black-and-white bit map of static words and pictures on a page.

Consider the volume of traffic required for a videoconference. Assuming a full-screen image of 640 by 480 pixels in true color (24 bits per pixel), and NTSC-standard 30 fps for full-motion video, you'd need to transmit almost 27 MBps for an uncompressed picture the quality of a TV broadcast. And that's just for a one-way hookup without sound. For a full-duplex, two-way conversation, you'd have to move an equivalent volume of data in both directions simultaneously, along with a pair of audio tracks.

Clearly, such a torrent of data would overwhelm any ordinary analog phone line, often referred to as POTS (for "plain old telephone system"). Even digital ISDN doesn't come close to offering that much bandwidth.

One answer is to simply increase the bandwidth of the pipeline by replacing copper wire with fiber-optic cable. However, that calls for an enormous investment in infrastructure.

Compression Critical

Compression is the obvious solution, but even the best of today's compression schemes aren't up to the challenge. To squeeze a TV-quality video signal through a 64-Kbps ISDN channel, you'd have to invent a codec algorithm that discards more than 99 percent of the data without seriously degrading the image.

As a result, desktop videoconferencing systems typically compromise by offering smaller windows (as tiny as 80 by 96 pixels), grainier color (8 bits per pixel instead of 24 bits), and lower frame rates (5 fps or less under certain conditions). These trade-offs reduce the bit stream to manageable levels.

Many codecs can achieve these levels of compression, but some require more time to compress than they do to decompress. MPEG, a standard fostered by the Moving Pictures Experts Group, and Cinepak, a proprietary but widely licensed codec from SuperMac Technology (Sunnyvale, CA), are examples of so-called asymmetrical codecs. They are better suited for store-and-forward applications or prerecorded video on CD-ROMs than for real-time videoconferencing. If an asymmetrical codec is implemented in high-speed silicon, however, it can effectively become symmetrical by supporting real-time conversion at both ends.

Even when a codec works in real time, the data pathway adds a certain amount of time lag. If the pathway is a LAN, the delay might be dependent on the size of the network and the volume of traffic. On a long-distance phone line, delays are inevitable as the signal is beamed from

important is predictability. Popular networks like Ethernet have sufficient capacity to carry small amounts of video (e.g., for video mail), but they impose unpredictably long transmission delays that greatly complicate the design of real-time multimedia systems; for example, data might have to be time-stamped to allow resynchronization on arrival. ATM's short cell size and virtual circuits guarantee a low upper bound on transmission delays, measurable in microseconds. Pandora can work without explicit synchronization between streams and needs to employ time stamping only when video-recording to a server's hard disk. Other advantages of ATM include scalability right up to global area networks using the same data format, and dynamic bandwidth sharing, which permits graceful degradation and efficient load balancing.

ORL's current ATM networks use a 500-Mbps fiber-optic backbone between remote sites, with 50-Mbps coaxial LANs connecting local workstations. A range of ATM switches and an ARM-based (Advanced RISC Machine) ATM protocol engine called ATMos have emerged from the Pandora project, along with bridges to Ethernet and WANs.

Medusa and Active Badge

ORL is now working on Medusa, the successor to Pandora. Medusa will support eight or 16 cameras per workstation, making possible applications like nondeskbound videophones or broadcasting lectures and meetings with viewer-selectable camera angles. It extends Pandora's use of time stamps to support more stream types, like infrared or sonar-depth information devices and very slow streams such as those produced by active badges sending location information.

Medusa separates devices into two classes: those that attach to a workstation cluster and those that attach directly to the ATM network. The former work with raw video data that can be manipulated by graphics software on the workstation, while the latter use JPEG compressed data to reduce data volumes.

Active badges are small clip-on devices that employ infrared signaling to send the wearer's location to a network of sensors once every 15 seconds. The badges are based on a commonly available 5-bit encoder chip designed for remote controllers and have a one-year battery life. They are never turned off, but they have a light sensor that switches them to a low-power state when they're put in a dark drawer or pocket.

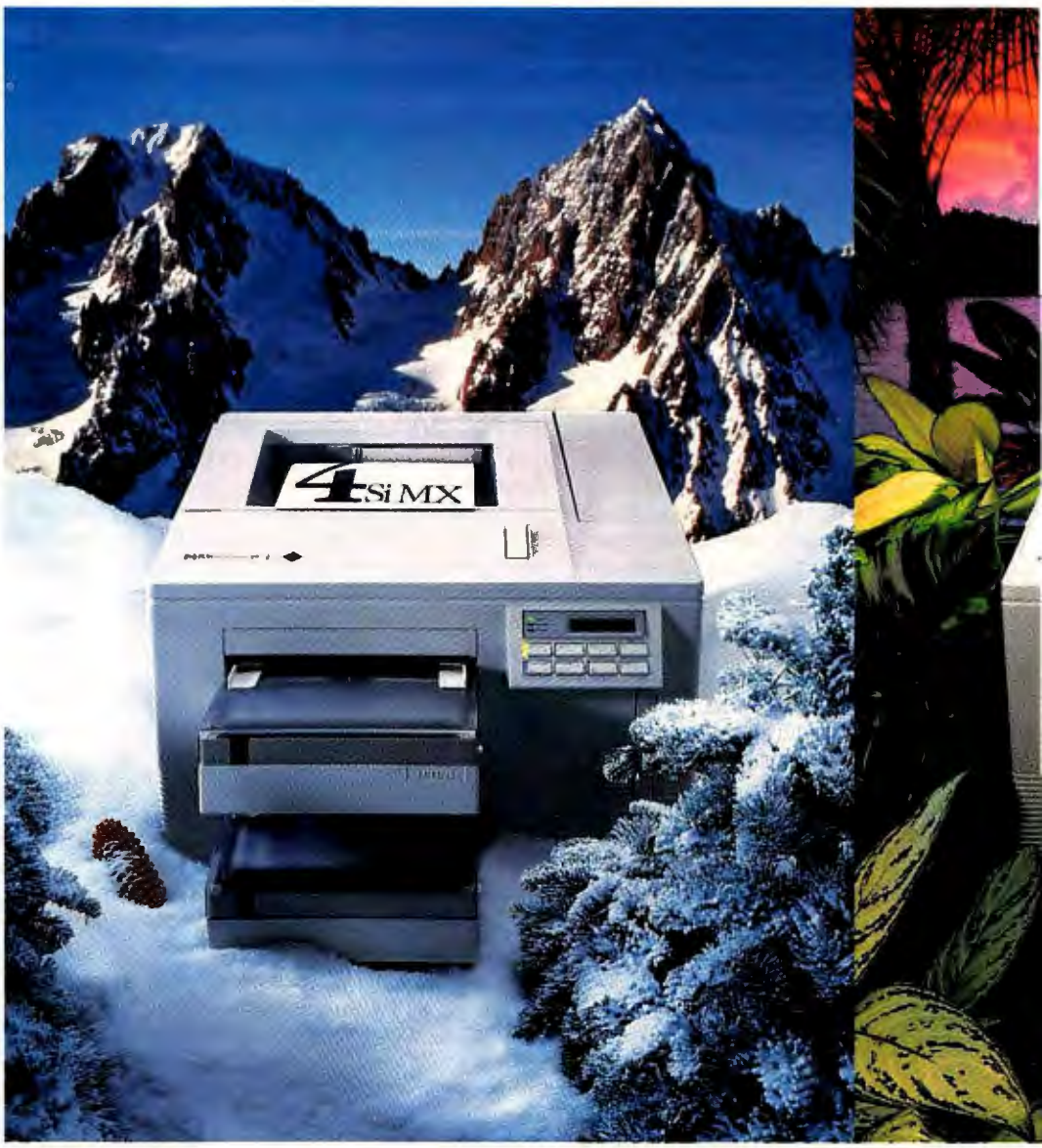
The current ORL implementation only allows a workstation user to locate and page any other badge wearers within the four sites spanned by the network, and to check their nearest phone extension and current status (e.g., "in a meeting," "do not disturb") by using commands like FIND, WITH, LOOK and NOTIFY. ORL has also created tiny active tags called PiCOs (Portable Interactive Computing Objects) that you can attach to equipment like printers, workstations, and phones to integrate these resources into the location map. In future, badge location will be used to route video mail and much more.

Despite initial misgivings about their Orwellian privacy implications, ORL people have taken to the badges well. During a year's noncompulsory trial, no one has stopped wearing the badge; the reduction in disruptive phone calls and fruitless trips to find colleagues seem to be adequate reward.

ORL's Pandora network has generated other useful data on the user acceptability of multimedia systems. Off-line video mail has proved far the most popular facility, followed by two-way live videophone. Videoconferencing is less popular, and least popular of all is the mixed text-and-video document; ORL's users seem to prefer to treat text and video mail as alternatives, with different applicability. Many people also like to use the videophone to greet colleagues by waving or nodding with the sound turned off.

Dick Pountain is a BYTE consulting editor based in London. You can reach him on BIX as "dickp."

Announcing the first network printer



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ground stations to satellites. The goal is to keep the total overhead below 250 milliseconds or so; otherwise, it interferes with spontaneous conversation. Overseas telephone calls usually limit the delay to 200 ms.

After solving all these problems, you've still got to make sure everyone is using the same compression and transmission standards. Otherwise, there's no guarantee you can make a connection with a person across the street, much less on another continent.

In late 1990, the CCITT adopted a worldwide specification for video compression called H.261 (see "Video Compression Standards Vie for Acceptance" on page 72) that made it possible for different systems to interoperate. Suppliers like CLI and PictureTel have added support for H.261, typically in the form of an upgrade option, but most suppliers argue that the specification suffers by comparison with their own proprietary algorithms.

> **The use of desktop videoconferencing is going to be a one-on-one kind of thing—just one or two people at [different] sites working together on a document.**
>
> **— Nick Odowick, videoconferencing specialist, Northrup Corp. (Los Angeles, CA)**

Networked Video

Networking with video raises problems that go beyond mere bandwidth. Today's office LANs usually use shared media and are non-real-time. Because video requires predictable delivery, sending it over all but the most lightly loaded LANs can be disastrous. Solutions such as switched Ethernet and FDDI (Fiber Distributed Data Interface) help provide more bandwidth, but they're still not deterministic. The ultimate solution has to be isochronous Ethernet or an entirely new protocol such as ATM (Asynchronous Transfer Mode; see "All-Terrain Networking," August BYTE).

A few companies are now addressing this problem in novel ways. For instance, Fluent (Natick, MA) sells an NLM (NetWare loadable module) that adds synchronization of video data to a conventional NetWare LAN. A combination of server- and client-based software modules dynamically tunes the video frame rate to accommodate the available network bandwidth. Starlight Networks (Mountain View, CA) has taken the different approach of developing a new media-transport network protocol that is optimized for video. And Fore Systems (Pittsburgh, PA) sells an ATM-based network switch that the company says is designed for multimedia. Olivetti is also developing Pandora, an ATM-based distributed multimedia system with videoconferencing capability (see "Pandora and the Active Office" on page 76).

Given the high cost of installing videoconferencing on every desktop, the following model may turn out to be a common architecture: PCs will run software compression such as Intel's Indeo to shrink video data sent over the LAN, and then a specialized video gateway server will cross-translate that video into H.261 or another communication-oriented protocol for transmission over WANs (wide-area networks). A model such as this distributes the cost of hardware compression over more users, and it also eliminates the need to bring ISDN-class telephony to every desktop.

What's Wrong

In the end, user needs and corporate culture will dictate how video technology is used. Mark Lowenstein, an analyst with the Yankee Group (Boston, MA), cites four issues: cost, quality, connectivity, and applications. Systems like CLI's Cameo and Northern Telecom's Visit are too pricey for PC owners, he says. A Yankee Group study found that 50 percent of respondents would consider buying desktop videoconferencing if it cost $1000 or less, but none of them would pay more than $5000.

Clearly, integrating video I/O on the desktop, as the AV Macs and the Indy do, greatly reduces its cost. But since the price of H.261-level compression will likely stay high, either new compression schemes will have to emerge or desktop systems will have to share compression services on a LAN through a video server.

Quality levels will also have to rise if desktop video is to prove useful. William Coggshall, president of New Media Research (Los Altos, CA), argues that what a user sees on-screen has to be "actionable"; that is, the quality has to be high enough that "you can tell whether their smiles are sincere." Otherwise, videoconferencing isn't an acceptable substitute for face-to-face meetings. To achieve this quality level, the frame rate has to be at least 10 fps, preferably 15 fps, and the window size needs to be a quarter of the screen or larger.

The problem with connectivity is simply that analog lines can't support effective videoconferencing given today's compression algorithms and modems. Barring breakthroughs in compression, the only solution is digital telephony services, but more than any other factor, this could be an impediment to acceptance. ISDN and Switched-56 are more expensive than analog and still not available in many places. Worse, the phone companies themselves still seem ambivalent about their commitment to ISDN. Says Lowenstein, "Connectivity is simply not there."

The last factor, applications, will be solved by a combination of developer and user ingenuity. Microsoft, for instance, is moving to provide APIs and back-end service interfaces that will let programmers write video-enabled applications without worrying about the underlying transport mechanisms. Capabilities like OLE 2.0 already permit video objects to be linked into compliant Windows applications.

For now, the question remains whether or not people really want their desktop systems to become videophones. Kenneth Bosomworth, president of International Resource Development (New Canaan, CT), cites studies that suggest people fundamentally don't enjoy videoconferencing—or at least the room-type systems prevalent up to now. Desktop conferencing could be a different story because it is more intimate.

Observers conclude that in the short term, document sharing may be the most easily applied and widely used component of desktop video communication. "Talking heads" video windows are a snazzy, if underpowered, option that will gain in usefulness as the information infrastructure develops. If real-time conferencing is only one of the video-related activities that people harness on their systems, users will eventually get used to it, in the same way that they acclimated to telephones and voice mail.

Video computing is the next major step in the evolution of the personal computer. As more media types are integrated into systems, the lines that have separated phones, PCs, TVs, and other consumer electronics will blur. And eventually, the world's-fair videophone fantasy will come true. ■

ACKNOWLEDGMENTS

News editor Ed Perratore and senior news editor Tom Halfhill also contributed to this story.

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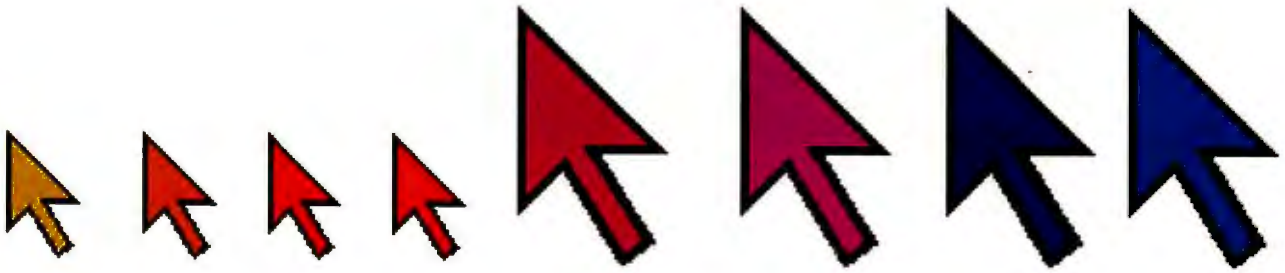

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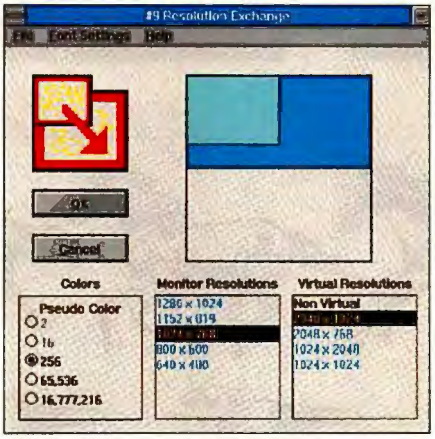

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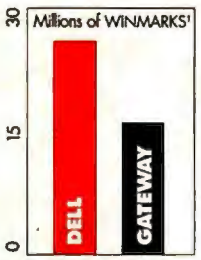

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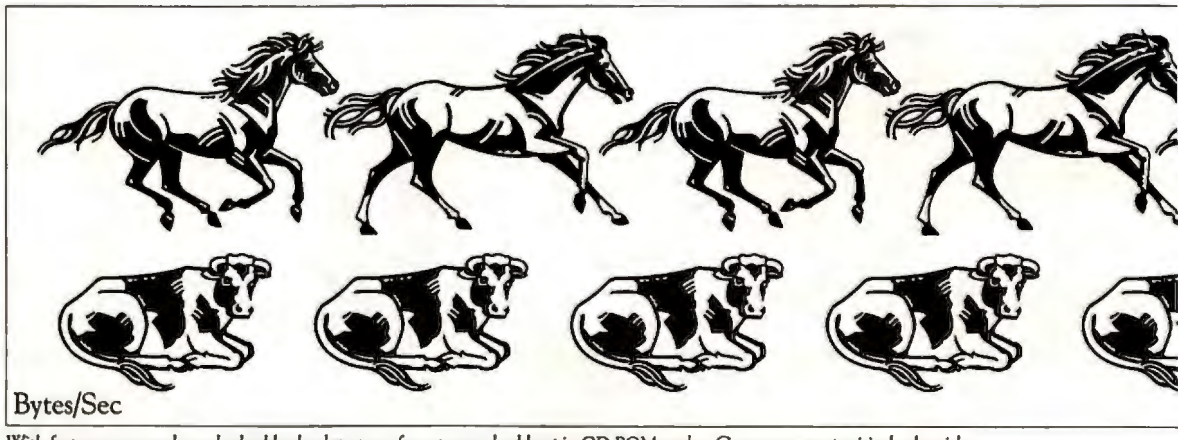

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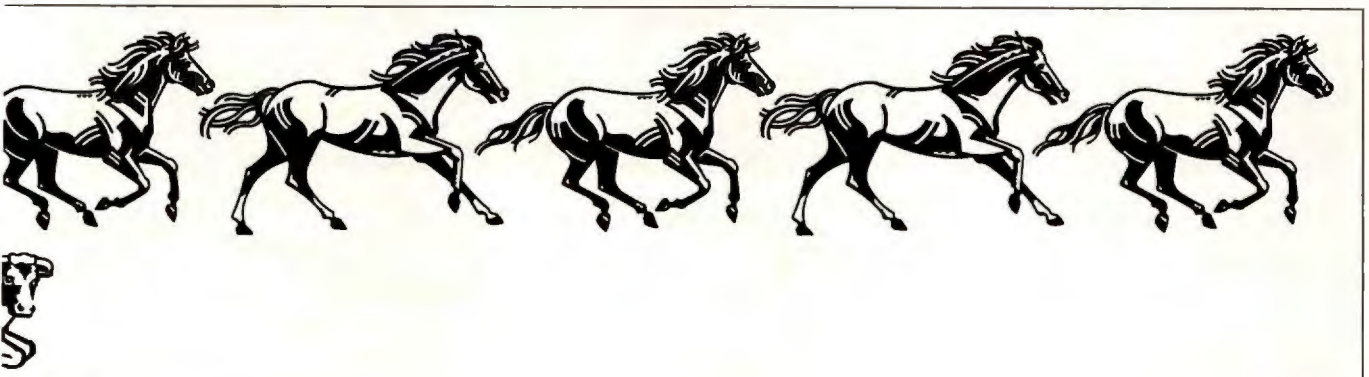

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Apple, SGI Blaze Video Trail

DANIEL PELAVIN © 1993

TOM THOMPSON AND BEN SMITH

New computers from Apple and Silicon Graphics signal the start of a new period for desktop systems: the era of video computing. Never before have video I/O and the processing of digital video been so tightly integrated into system hardware and software. By treating video like any other data type, such as text, graphics, or audio, these systems open up more effective channels of communication among individuals and workgroups.

In fact, both Apple and SGI are positioning their new systems primarily as aids to improved business communication. The two companies are also avoiding the word *multimedia*, the meaning of which has become blurred. SGI calls its new technology *digital media*, while Apple has apparently latched onto the long-established term *audio/visual*, or AV. No matter what you call them, these systems are delivering on a key promise of multimedia: the seamless integration of all media types into a single box.

By integrating video and audio into their latest workstations, Apple and Silicon Graphics will change the way businesspeople communicate

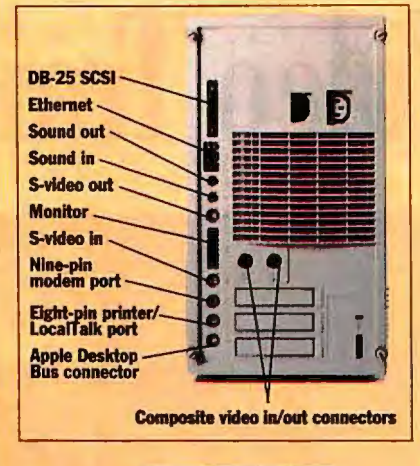
Mac Audio, Mac Video

The new breed of Mac not only consolidates new features into a desktop computer but also provides new ways for you to both work in the office and collaborate with other people, whether they're down the hall or across the country. Telephone services enable the Mac to call people, act as a speakerphone, send and receive faxes, and operate as a modem to access on-line services. Built-in live-video hardware lets you record and play back video and—with the telephone services—handle videoconferencing over a network or an ISDN line. Finally, sophisticated speech-recognition technology allows you to direct the Mac by voice command, while a text-to-speech engine enables documents to be read out loud with 16-bit CD-quality stereo sound, freeing you to do other tasks as you listen.

Two new Macs represent the vanguard of these integrated systems. The high-end system is the Quadra 840AV, which has a Quadra 800 chassis and a 40-MHz 68040 processor. Although Apple has not stated what the "AV" stands for, it's obvious that it implies audio/video enhancements. At the low end, the Centris 660AV uses a Centris 610 chassis with a 25-MHz 68040 processor. Both Macs use an AT&T 3210 DSP (digital signal processor) to handle most of the digital signal processing in the systems.

The Quadra 840AV's VRAM frame buffer for its built-in video can be expanded from 1 MB to 2 MB so that it supports 24-bit color on 16-inch monitors and 16-bit color on 19- and 21-inch (1152- by 870-pixel) monitors. This makes the Quadra 840AV better suited for high-end graphics work than is the

The Mac Quadra 840AV



The Apple PlainTalk microphone is designed to focus on an area 18 to 30 inches in front of it to help eliminate background noise.

The video application (upper left) displays live video and captured video images.
The Telephone application (right) uses the Telephone Manager to dial numbers and use the Mac as a full-duplex speakerphone.
The PlainTalk window (lower left) indicates speech recognition is active.

The modular design of the Telecom Adapter lets you connect the AV Macs to any phone system while reducing cost.

Quadra 800, whose 1 MB of VRAM limits it to 16-bit pixels for 16-inch monitors and 8-bit pixels for larger monitors. The Centris 660AV has the same frame-buffer size as the Quadra 800 and so supports the same video depths.

Prices were preliminary at press time, but a Quadra 840AV with a 230-MB hard drive will cost approximately $4500. A Centris 660AV with an 80-MB hard drive will cost about $2400. As usual, these prices don't include the cost of a monitor and keyboard, but you'll probably get away with a low-end Centris 660AV system with a 14-inch monitor for roughly $3000.

Video Is the Medium

These AV Macs treat live video as just another data type that's manipulated by the system and applications. Composite video and S-video input ports accept NTSC-, PAL-, or SECAM-format video signals from sources such as a video camera or VCR. Live 16-bit video at 30 frames per second (fps) appears in a draggable, resizable window on the Mac's screen. A menu selection allows you to set the size of the window to 160 by 120 pixels, 320 by 240 pixels, or full-screen (640 by 480 pixels maximum).

Off-the-shelf chips from Philips digitize the video, perform format conversions and color adjustments, and rescale the image. The video data travels through the computer on a separate 64-bit bus, so it doesn't tie up the main processor bus. When live video is active, the Mac's frame buffer is halved; the Mac's screen graphics are placed in one half and the digital video dropped into the other. An ASIC (application-specific IC) then melds the contents of both of the frame buffers into one screen image. A DAV (digital audio/video) connector provides access to the video bus's raw digital video and sound. This connector is mounted in-line with a NuBus slot so that a NuBus board can tap into the DAV to perform data compression/decompression, encryption, or other processing.

Issuing a Copy command from within a supplied Video Monitor application captures a single video frame as a PICT image that can be pasted into documents, and QuickTime-savvy applications can create QuickTime movies of the incoming stream of video and sound. To get you started with recording movies, Apple will provide a basic video/audio capture application called FusionRecorder (licensed from VideoFusion).

Apple's Centris 660AV is based on a 25-MHz 68040 CPU.

The capture rate and quality of the QuickTime movie depend on whether you're saving to memory or to a hard drive, what the image size is, and what the compression settings are. NTSC or PAL video can also be sent out S-video and composite video output ports. The Monitors Control Panel can redirect the video so that a TV connected to these video output connectors can act as a monitor; this way, you can use a large-screen TV as an inexpensive presentation device for a group. Or, by routing the video to a VCR, you can "print" a business presentation or an application demonstration to tape.

You can use the AV Macs' built-in video to have a face-to-face conference with another AV Mac user on an Ethernet LAN. To do this, however, the live-video image has to be small (typically 160 by 120 pixels), the frame rate needs to be reduced to about 10 to 15 fps (which is the low end of what's considered to be acceptable viewing quality),

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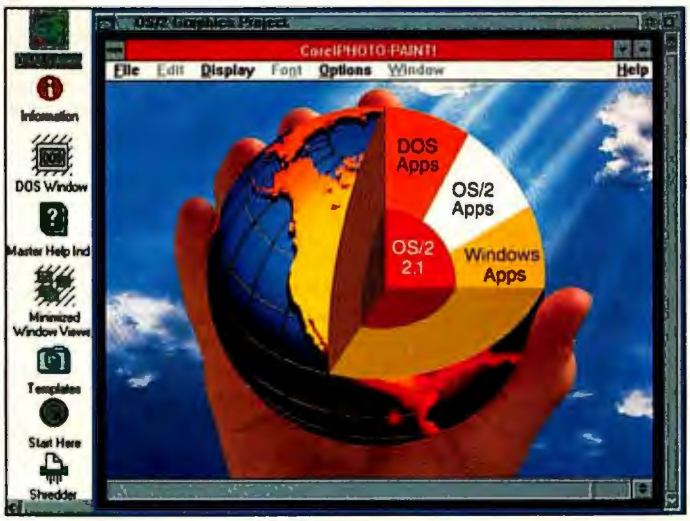

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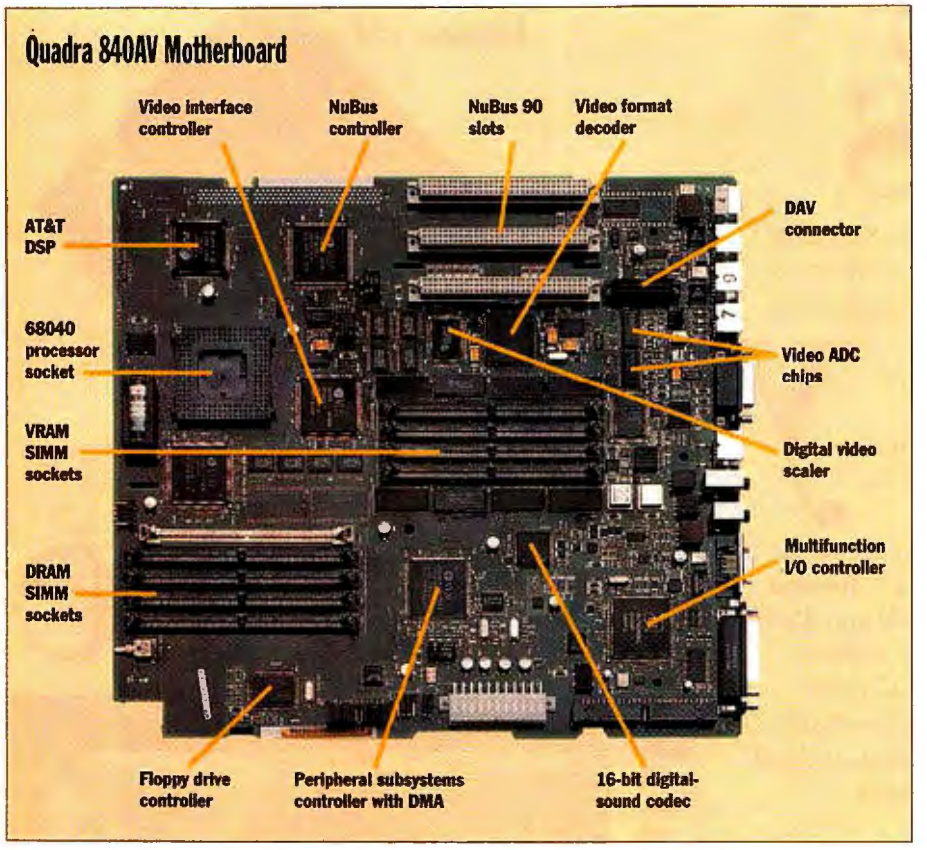

and data compression has to be active to prevent saturating the network. Third-party software such as Electronic Studio's ES.F2F application supplies an interactive storyboard and can share a foreground application window.

Making Connections

The Quadra 840AV and the Centris 660AV have an extensive built-in telephone architecture termed GeoPort. A Telephone Manager lets AV Mac applications dial numbers and handle two-way voice connections so that the Mac can operate as a full-duplex speakerphone. Control signals and digital data travel out an enhanced modem port to an adapter pod called the Telecom Adapter. This adapter pod contains the electronics that connect the Mac to the phone line, provides clock signals, and handles A/D conversions. This modular design reduces system cost while allowing the Mac to be connected to a variety of phone systems—especially important in overseas markets, where different telephone standards abound.

A POTS (plain old telephone system) adapter is available, and ISDN and digital PBX adapters will be available early next year. The modem port uses a new mini-DIN-9 connector (actually a mini-DIN-8 with an extra pin that supplies 5-V power to the adapter) that enables an incoming phone call to switch the Mac on.

In addition to providing these telephone functions, an AV Mac can also operate as a V.32 modem and a fax machine. These capabilities are implemented as programs that run on the 3210 DSP, and new features can be added later via a software upgrade. The DSP handles all heavy-duty real-time digital processing, such as the modem, fax, speech-preprocessing, and audio operations.

These functions don't have an impact on the main processor because the DSP has its own autonomous, real-time operating system, called the Apple Real Time Architecture, or ARTA. ARTA is a task switcher, jumping to a new DSP task every 10 milliseconds. When handling CD-quality sound, ARTA task-switches every 5 ms. Note that if you're using the Mac as a modem, this function consumes enough of the DSP's bandwidth (24 kHz) that you can't have CD-quality (44 kHz) sound generation at the same time.

ARTA can also allocate idle time so that other non-real-time tasks, such as 3-D rendering or image filtering, are able to use the DSP. The Sound Manager now supports 16-bit stereo sound formats at sample rates that range from 8 kHz to 48 kHz.

The Telephone Manager, the Modem API, and the Sound Manager provide consistent device-independent connections to these services for applications. Besides the DSP, nine DMA channels handle sound, SCSI, floppy drive, and serial I/O, relieving the processor of these jobs. The ARTA and the DMA channels are the first components of the future microkernel, which is being added to the Mac OS in stages.

Talk to Me

PlainTalk Speech Recognition (well-known by its code name, Casper) is a speaker-independent, natural-language, voice-recognition technology that is the result of five years of research by Apple's Advanced Technical Group. *Speaker-independent* means that PlainTalk requires no operator training for its voice-recognition software to function. It uses the DSP to preprocess and then slice the speech-input signal into 10-ms packets. These are sent to the 68040, which evaluates several hundred possible words simultaneously using a phonetic-based pattern-recognition search.

A 60,000-word dictionary provides a word-matching reference, and back-propagation logic prunes the low-probability matches to boost recognition speed. The reference words are a composite of 500 speakers from all over North America, which eliminates the influence of accent on the recognition process. As you might expect, different dictionaries must be crafted for overseas users.

A Control Panel lets you set recognition tolerances (how much PlainTalk actually guesses at an utterance). It also allows you to set an identifier word (e.g., "Computer" or "Number 1") to help PlainTalk discern a command directed at it, and you can indicate if the identifier is not required for a user-specified period of time (i.e., if you're issuing a series of commands, you use the identifier only once, at the start of the command sequence).

Once PlainTalk recognizes a word

MAC AV SPECIFICATIONS

QUADRA 840AV	CENTRIS 660AV
• 40-MHz 68040	• 25-MHz 68040 CPU
• 8 MB of 60-ns RAM	• 8 MB of 70-ns RAM
• Expandable to 128 MB of RAM	• Expandable to 68 MB of RAM
• Three NuBus 90 slots	• One 7-inch NuBus 90 slot
• 230-MB hard drive	• 80-MB hard drive
• 2-MB ROMs	• 2-MB ROMs
• Built-in Ethernet	• Built-in Ethernet
• 66.67-MHz DSP	• 55.5-MHz DSP

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The Indy's most distinguishing external feature
is the IndyCam direct-to-digital camera with built-in microphone, mounted atop the monitor.

synthesized speech. The TTS engine has numerous built-in rules for generating realistic synthetic speech. For example, it recognizes dollar amounts and dates and pronounces them correctly, and it raises the voice on the last word of a sentence ending with a question mark. The TTS engine doesn't require a DSP to operate; its output gets routed to the DSP, though, since the DSP handles all generated audio and thus reduces processor overhead. The quality of speech varies with the amount of memory that is available, and a male or female voice can be chosen.

Via the Speech Manager API, any application can select a section of text or an entire document to be read aloud. Using it along with PlainTalk's Speech Recognition, you might ask an AV Mac to "get my E-mail and read it," which would start the execution of an AppleScript or QuicKeys macro. The script or macro would then launch a telecommunications application, connect to the on-line service, download your messages, launch a word processor application, open the message files, and read the messages out to you.

or phrase, it consults a Speech Rules file and fires off the appropriate Apple Events. A QuicKeys component from CE Software will be provided that lets PlainTalk invoke either AppleScripts or QuicKeys macros in response to a spoken command. The Rules file contains phrases that drive most Finder operations, such as opening and closing windows, volumes, and files. You can add your own rules to the file, perhaps making the phrase "Clean house" empty the Trashcan, or you can have a phrase execute an AppleScript file or QuicKeys macro that starts a complex sequence of operations.

In addition, PlainTalk has a TTS (text-to-speech) engine that translates text to

The AV Macs provide new ways to communicate. First, they integrate the telephone, a modem, and fax capabilities into a single desktop system. Next, they supply ready access to video for any application. Finally, PlainTalk allows you to work with your computer more easily and offers aid to the visually impaired.

These features aren't add-ons—they're tightly integrated into the system. When the AV Macs become ubiquitous, users will discover new, effective ways to work (as in the last PlainTalk example), and to work with one another, no matter where they are.

SGI's Digital Media

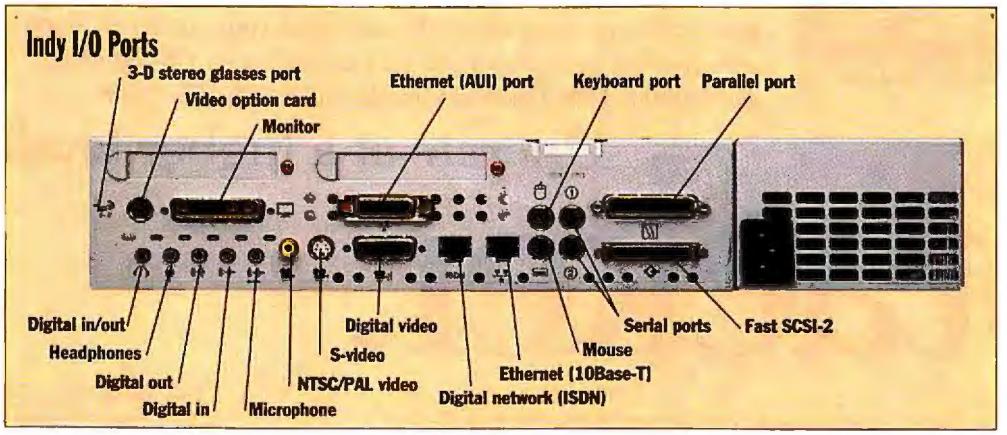
SGI wants to redefine the user interface with what it calls digital media communications. Its latest workstation, the Indy, provides all the hardware and software you need for capturing and communicating with sound and image over a network or over a digital phone line. Prices for the Indy will start at $5000, and SGI expects to begin mass production this fall. Eventually, all SGI systems and upgrades will provide this capability standard.

The digital media capabilities of this machine are particularly valuable to workgroups that need to share images and film clips over wide geographical distances—for example, medical teams, distributed engineering and fabrication groups, and research teams that use video as a data source. But as this technology spreads across the boundaries of different networks, nearly every computer user will benefit from communicating with digital media.

High-End Features

Despite its advanced capabilities for creating and displaying information, the Mips R4000PC–based Indy is SGI's low-end system. Its most obvious feature is the IndyCam, a little digital color camera that sits atop the monitor. It looks more like a squashed Kodak Instamatic than the high-tech device that it is, a direct-to-digital camera connected to the SGI digital video port. It provides a maximum of 512 by 492 8-bit color pixels at 30 fps. It contains two SGI-designed ASICs for AD conversion from the CCD (charge-coupled device), as well as the electronics for color balance, shutter speed, and color space conversion. The output format is a variation of the CCIR-601 digital standard allowing for variable image sizes.

SGI designed the IndyCam to provide an uncomplicated and inconspicuous video input for videoconferencing and quickly capturing images for attaching to mail messages. The resolution is high enough to capture text from a typewritten page, yet it can be set to capture only the color depth and image size that are necessary for a particular application, thereby reducing the data-set size of the images without compression. Without the need for compression and decompression computations, the rate at which the frames can be handled is greatly increased. (You control the IndyCam's settings for image size, color, and contrast with tools that are



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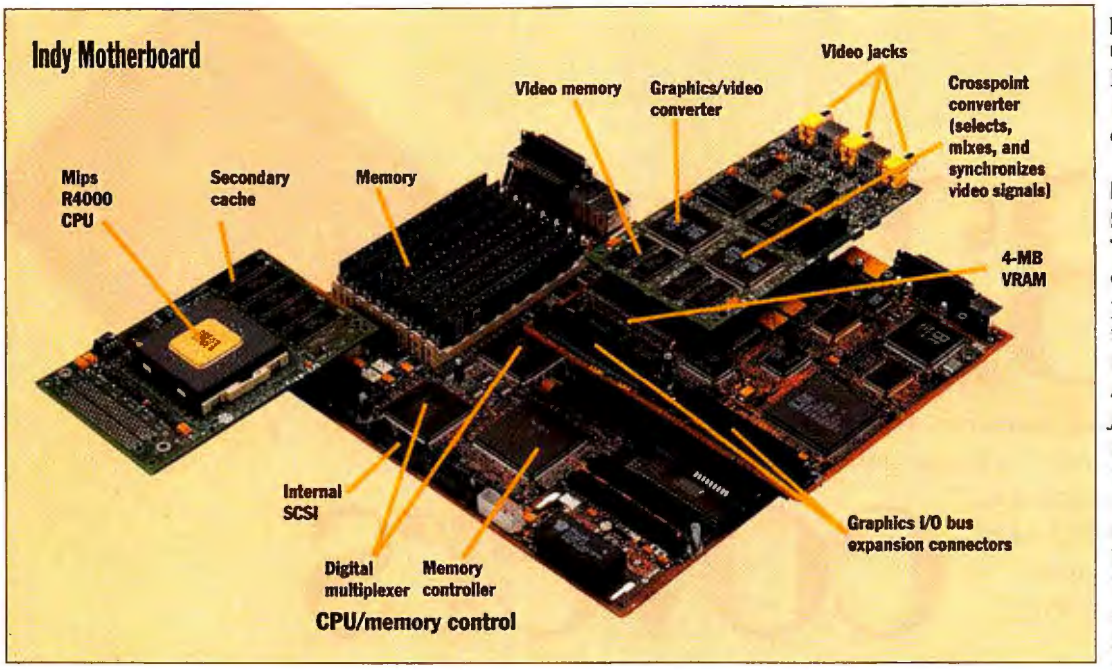

part of the Indy's user interface.)

The IndyCam and digital video are only one of the possible paths for video input. You can feed analog video from a camcorder, videodisc player, or video camera directly into the NTSC/PAL video or S-video port. The Indy uses Philips video-processing components to convert the analog video formats to YUV multiplexed digital video.

SGI's IndyCam and analog video input processing are the most obvious indication of the digital media potential of the Indy, but they're not the key to the Indy's 2-D image performance. Thanks to the enormous bandwidth (up to 267 MBps) of its graphics I/O bus and the technologically advanced graphics subsystem, the standard Indy can blast 32 million pixels to the screen memory in a second—enough to regenerate an entire 1280- by 1024-pixel screen 24 times in a second, or (more typical of video image resolution) 640- by 480-pixel frames at 50 fps.

Note that the live-video image is not in a separate video memory or even maintained as a separate video signal; it is mapped right there in standard video buffer space. This lets you grab it along with any other elements of your screen image for inclusion in SGI's standard desktop image capture and manipulation/translation programs.

SGI claims that the X Window System graphics performance is 1.2 million 10-pixel lines in a second. This is even greater performance than that of Sun's recently announced optional GX and TurboGX-plus graphics accelerator boards, which, by Sun's claims, are only 480 thousand lines per second and 1 million lines per second, respectively.

The baseline Indy 3-D graphics performance is not quite up to the level of the unenhanced SGI Indigo, according to the company. SGI has focused the Indy's performance on handling images and 2-D objects. If you want, you can order your Indy with the optional 24-bit color 3-D graphics accelerator board, which will run you roughly an additional $2500. (The base Indy simulates 24-bit color by hardware-implemented dithering.)

The Indy has the same audio subsystem as the Indigo: four-channel stereo input and output with 16-bit sampling rates ranging from 8 kHz to 48 kHz. The sound-sampling manipulation speed and resolution exceed those of CD recordings. The audio system is centered on the Motorola DSP 56001 chip.

The Indy has ports for two-channel digital audio, digital audio out, analog audio in (microphone), and analog audio out (stereo headphones). As with the IndyCam, the microphone and headphones come with the system.

Like any other SGI computer, the Indy comes with no standard floppy drive. But the optional drive is a 20-MB 3½-inch floptical drive that can read and write Macintosh and PC floppy disks directly, as well as read and write standard Unix tar and cpio formats.

As if in anticipation of the data superhighway, the Indy has ISDN among the many digital-media device ports. Other not-so-standard I/O connectors that come with the system are 3-D stereo glasses and 10Base-T Ethernet (as well as the old 25-pin AUI [attachment unit interface]). An R4000SC CPU with 1 MB of secondary cache is an option.

MultiSensory User Interface

The Indy's sophistication becomes apparent once you boot the system and begin to use it. The term *standard user interface* has taken on new dimensions: voice and video, not only for output but also for input. The Indy interface is perhaps more appropriately referred to as an SUI (multiSensory User Interface) than as a GUI. SGI calls its new user interface Indigo Magic.

The microphone that comes with your Indy is not just for creating cute voice messages to embed in your documents; it's also for controlling your system and the applications that run on it. Speech recognition/voice control will have no limit on the number of words in the speaker-independent vocabulary. You should find that a vocabulary of 300 or fewer words will produce an instantaneous response from the system. The commands need not be limited to single-word utterances. The voice recognition can learn to improve as it acquires experience with variations in the pronunciation of the words.

The voice recognition is a Silicon Graphics implementation of a technology developed by Scott Instruments of Denton, Texas. The SGI developer's kit includes libraries for implementing voice recognition and control that programmers can include in their SGI applications.

The voice-command input may be the most exotic addition to the SGI user interface, but it is not the most important: The entire Motif-based SGI graphics workspace and tools have moved up to a new level of refinement. The new user interface looks like a combination of Hewlett-Packard's VUE, Solbourne's virtual desktop, a little of NextStep, and a lot of the Mac. The goal was to combine an environment familiar to Mac users moving to SGI with the best features of the Unix interface.

SGI knows that many of its workstation users are not Unix system administrators. But since workstations tend to be

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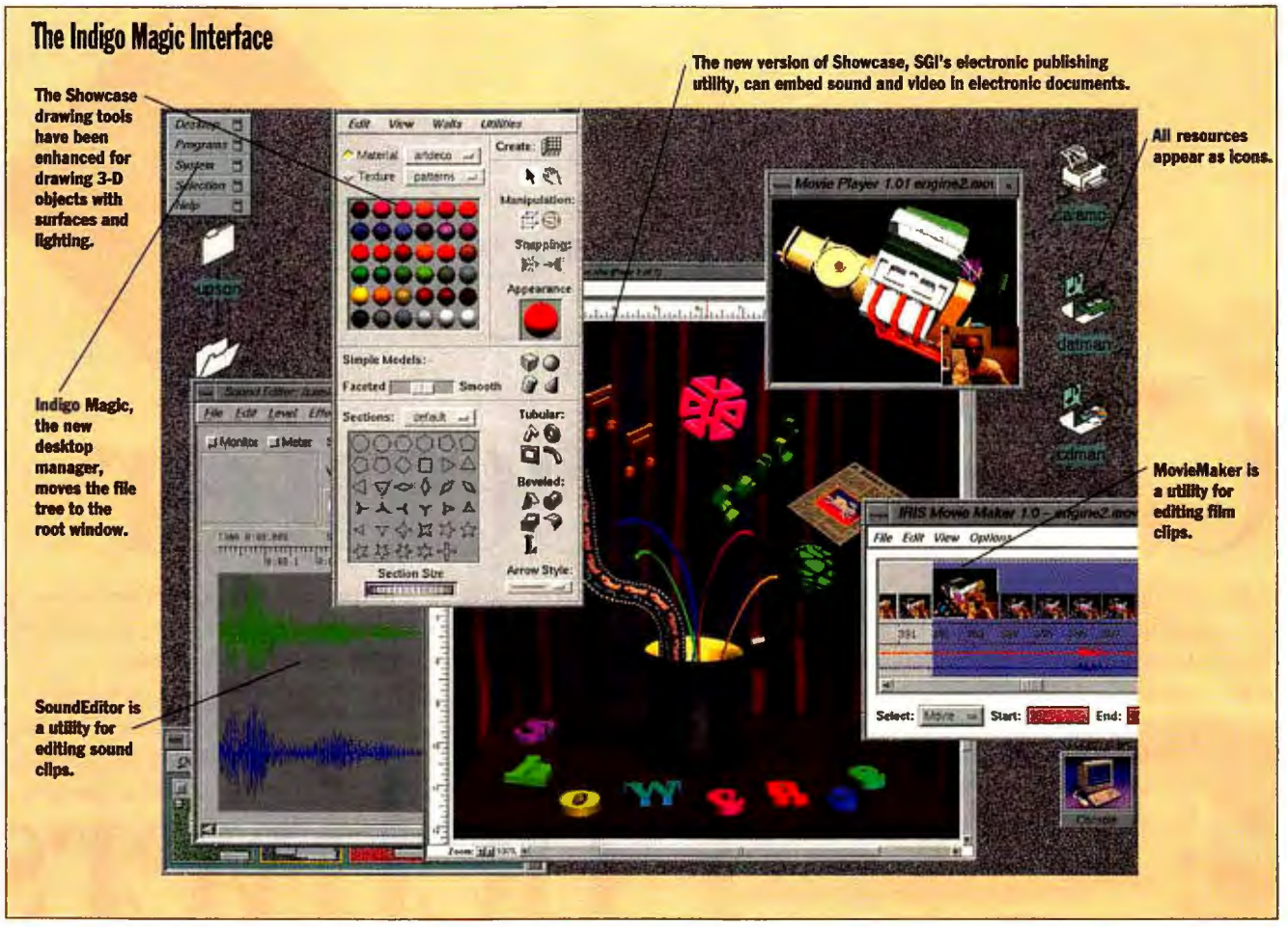

single-user systems, every user must perform some basic system administration. SGI's new graphical system administration tools make it easier than ever to do the most common tasks. With some enforced uniformity among SGI's software developers, applications installation should approach the simplicity found in NextStep and on the Mac.

It remains to be seen whether software developers start incorporating the same graphical and digital media interfaces inside their applications as SGI has done with its Workspace/File/System management interfaces. Nonetheless, the overall environment in which the user operates is easy, flexible, and attractive.

Unix workstation designers can no longer assume that the world extends only to other Unix workstations; it also includes MS-DOS, Windows, NetWare, Macintosh, and Apple networks. The Indy can reside on any of these networks, and it can read and write both standard MS-DOS and Macintosh disks on the optional 3½-inch floptical drive.

Although the hardware and software tools already exist to make the Indy an ideal live videoconferencing system, the software will not be ready until the first part of 1994. At that time, you will receive an operating-system upgrade that will include the communications programs for multipoint conferencing with shared windows, shared whiteboards, and easy-to-manage remote control with other RTP-compliant Unix workstations. Toward the middle of 1994, the conferencing software will be upgraded to support the H.261 videoconferencing standard; this will let you trade video with nearly any other H.261-capable system, including the Mac (see "Video Compression Standards Vie for Acceptance" on page 72).

Starting the Wave

Unquestionably, the Indy, with its camera, microphone, and very high image and sound performance, is pushing the envelope of many technologies to provide integrated digital media capabilities. What's important is that the digital media components are matter-of-fact—bundled goodies that you'll find on all new SGI systems and upgrades even though you will probably buy an Indy simply as a general-purpose graphics workstation.

The AV Macs also push the digital media envelope, yet many of the technologies inside these systems have been in use for several years. For example, sound input has been an integral part of the Mac's hardware and operating system for four years; the ability to store and forward video as QuickTime clips has been available for two years; and the PowerBook Duos have literally field-tested the fax/modem API for about a year. The AV Macs continue to build on this solid foundation, adding live-video, speech-recognition, and telephone services.

In theory, once machines like the AV Macs and the Indy have reached critical mass in an enterprise, users will start taking advantage of the rich communications capabilities. In practice, that means upgrading much of the business world's LAN and communications infrastructure. If the payoff in productivity proves to be as exciting as these new systems, it will be well worth the investment. ■

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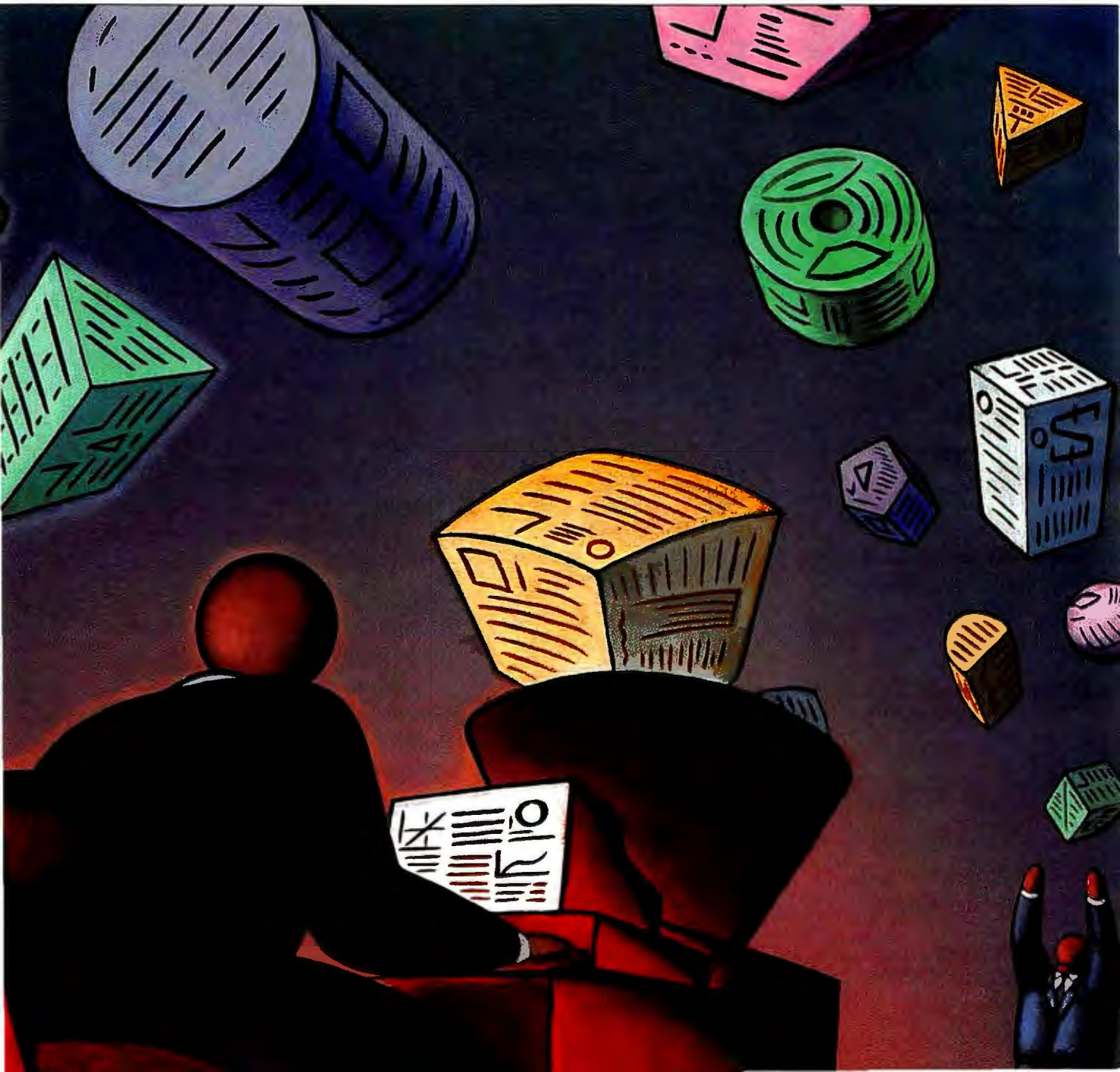

It's fashionable these days to talk about knowledge workers—the people whose knowledge drives modern organizations. But how do many organizations distribute that know-how for internal or external consumption? Mostly through paper documents, routing slips, and filing cabinets.

Electronic publishing changes all that. Whether through a client/server system or on CD-ROMs, electronic publishing lets you build, circulate, and enhance your organizational knowledge base with greater speed and flexibility than ever was possible with paper.

Paper is easy to read but often impossible to find a week later, never mind a year later. With an electronic document database, however, you can search and retrieve a file often in a few seconds using common indexing and retrieval software, such as ZyLab's ZyIndex.

But publishing your data electronically is not a trivial matter. Before you can distribute your documents electronically, you have to digitize your paper documents, index them and your digital documents for search and retrieval operations, and ensure that these electronic documents can be read across platforms and applications. You also have to figure out how to integrate data from external sources, such as commercial CD-ROMs or on-line services. You even have to devise strategies to compensate for the idiosyncrasies of the individual components in your electronic publishing system.

A one-size-fits-all solution to these problems does not exist. And none may ever exist because each organization has different needs and processes for getting the job done. Yet solutions to several of the technological barriers to electronic publishing have emerged. Document-exchange formats, for instance, have evolved from plain ASCII into formats that let you create files that retain the look and feel of the original document across any platform or application. You can even embellish your cross-platform documents with audio, graphics, and full-motion video.

Electronic publishing means bringing together a wide range of technologies, such as image scanners, indexing software, and computerized conferencing systems. Its challenges require you to meld and adapt individual component strategies to create a better whole. When implemented, electronic publishing gives you the keys that unlock all the information in your documents, information that you couldn't find before or even knew that you had.

Imaging Your Documents

Key to building an in-house publishing arm is the ability to get existing paper-based documents and those that arrive daily onto your computer. Document-imaging systems, with about 100,000 users, according to BIS Strategic Decisions (Norwell, MA), a research and marketing-analysis consulting firm, are the most common method of achieving this goal in use today.

Imaging systems essentially emulate microfiche and microfilm. With an imaging system, you pass a paper document through a scanner that renders it digital. Your system then stores on disk a bit-mapped image of the document. While scanning, you enter keywords to help you retrieve the document later.

The problem with the imaging-system approach is that your main storage consists only of images, not computer-readable text. Consequently, you cannot use your computer to search the text of documents for any reference. You can find only the keywords that you used to categorize documents. And without a specific, well-designed list of keywords, you can end up with a massive amount of imaged documents and not have a clue as to what kind of content they contain.

But imaging systems have their place. Large companies often use imaging systems for processing high volumes of routine yet critical documents, such as supplier invoices. The benefit of being able to retrieve paperwork in minutes instead of days is obvious—time is money.

The Costco retail store chain in Kirkland, Washington, uses a large-scale imaging system based on software from Optika Imaging Systems (Colorado Springs, CO) for processing invoices. Vince Carney, Costco's assistant controller, says that Costco's imaging system has cut the company's cost of processing invoices in half. "A large department store I visited still uses microfilm for their invoices," says Carney. "They spend five times the money for one-fifth the work."

Although most imaging system software runs on large-scale computers, several products, such as KeyFile's (Nashua, NH) KeyFile and Westbrook Technologies' (Westbrook, CT) FileMagic, run on desktop computers on either a network or stand-alone basis. Both run on PCs.

Bridging Images and Data

The bridge between the traditional "pure" imaging system and a computer file manager is OCR (optical character recognition). An OCR system consists of a scanner to image text and software that translates text into a computer-readable format. Among the better-known OCR programs are OmniPage Professional from Caere (Los Gatos, CA) and TypeReader from ExperVision (San Jose, CA).

OCR systems do an excellent job producing computer-readable files from cleanly printed documents that are minimally formatted, such as legal contracts. But, highly formatted documents, such as a newsletter or a manufacturer's technical brief, resist easy processing. One

Publish It Electronically

Electronic publishing breaks the barriers between the information in your documents and those who need the data.....94

Unlocking Data's Content

Document-coding techniques unlock the information content sealed inside your documents.....111

Documentation Goes Digital

Documentation is going digital. Just watch out if you want to publish it yourself.....121

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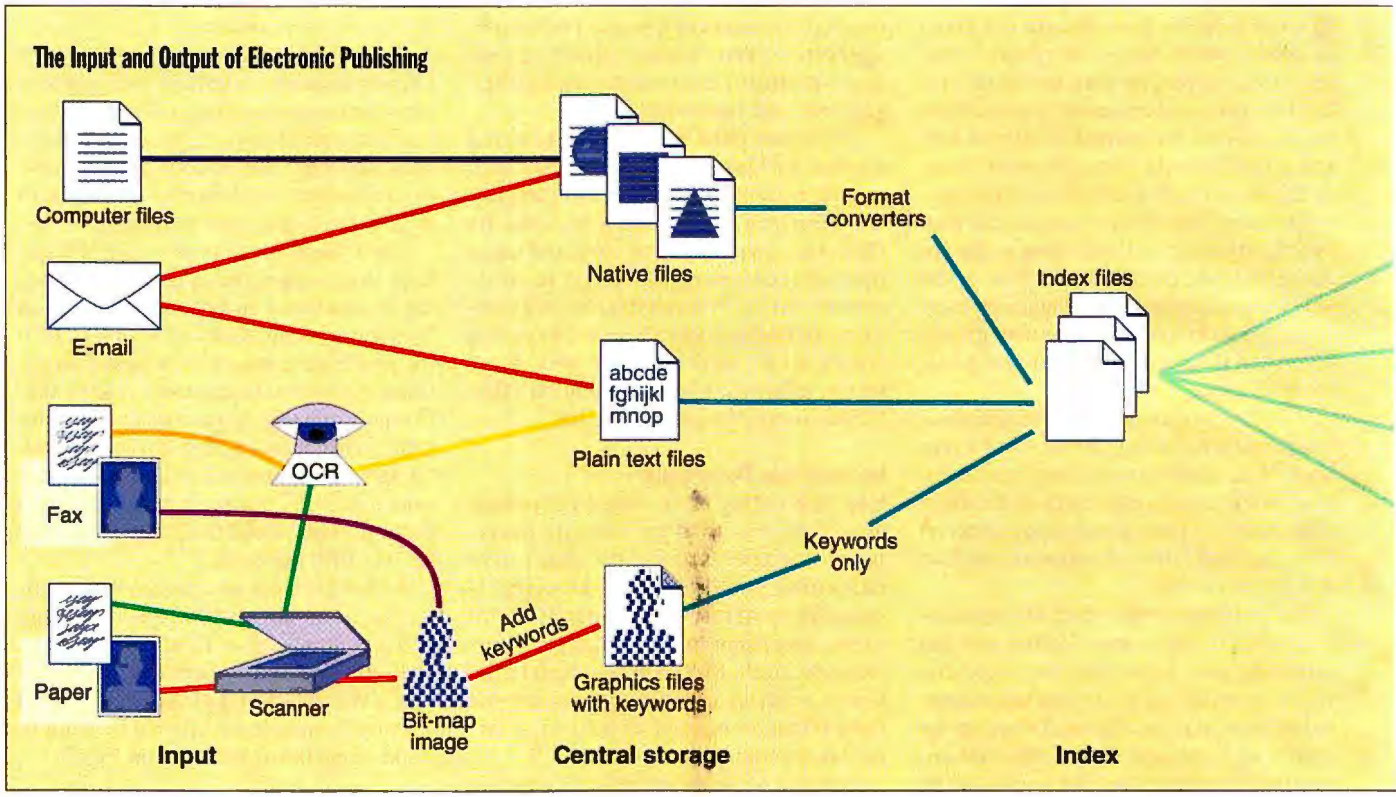


reason for this is OCR programs cannot distinguish between two columns of text and a table with two columns. Your OCR operator has to decide which it is and instruct the program accordingly.

Another problem with OCR is that it requires a good deal of manual checking and reworking to ensure that all the information in a document has been scanned into your computer properly. As a result, many organizations have given up on OCR as an input method. Terry Butler, manager of automated systems for Financial Systems Products (Seattle, WA), the company that installed Costco's imaging system, notes that only one of the company's more than 100 clients uses OCR.

Some organizations look for a middle ground by storing both the bit-mapped image and the OCR results. In this scheme, you inspect what the OCR creates during the scanning process to ensure that it stores enough information so that keyword retrieval is possible later on. Corrections, if necessary, are made manually. Any other OCR error arising from, say, a poor-quality copy, a handwritten note on the page, or a hair across the image is ignored. Later, when you retrieve the document, you can switch to the imaged version whenever the OCR text isn't intelligible. But double storage means that you have to maintain capacious disk drive, magnetic tape, or optical-storage units, regardless of the fact that you can almost always compress the bit-mapped image to save storage space.

"What's missing," says Mary Bamford, an analyst at BIS Strategic Decisions, "is the ability of people on a broad scale to understand when to use OCR. [What's needed is] intelligent OCR, not for reading printed text but [for identifying] the type of document and [applying] the correct reading technology."

Serge Blanc, vice president of engineering for Caere, responds that newer OCR programs are adding document-analysis features, but the human element will remain essential because paper documents come in so many forms. "If you scan a financial document, the program could identify and automatically create a spreadsheet," says Blanc. "But for which spreadsheet application? What is the filename? A completely automatic process will create a new set of problems."

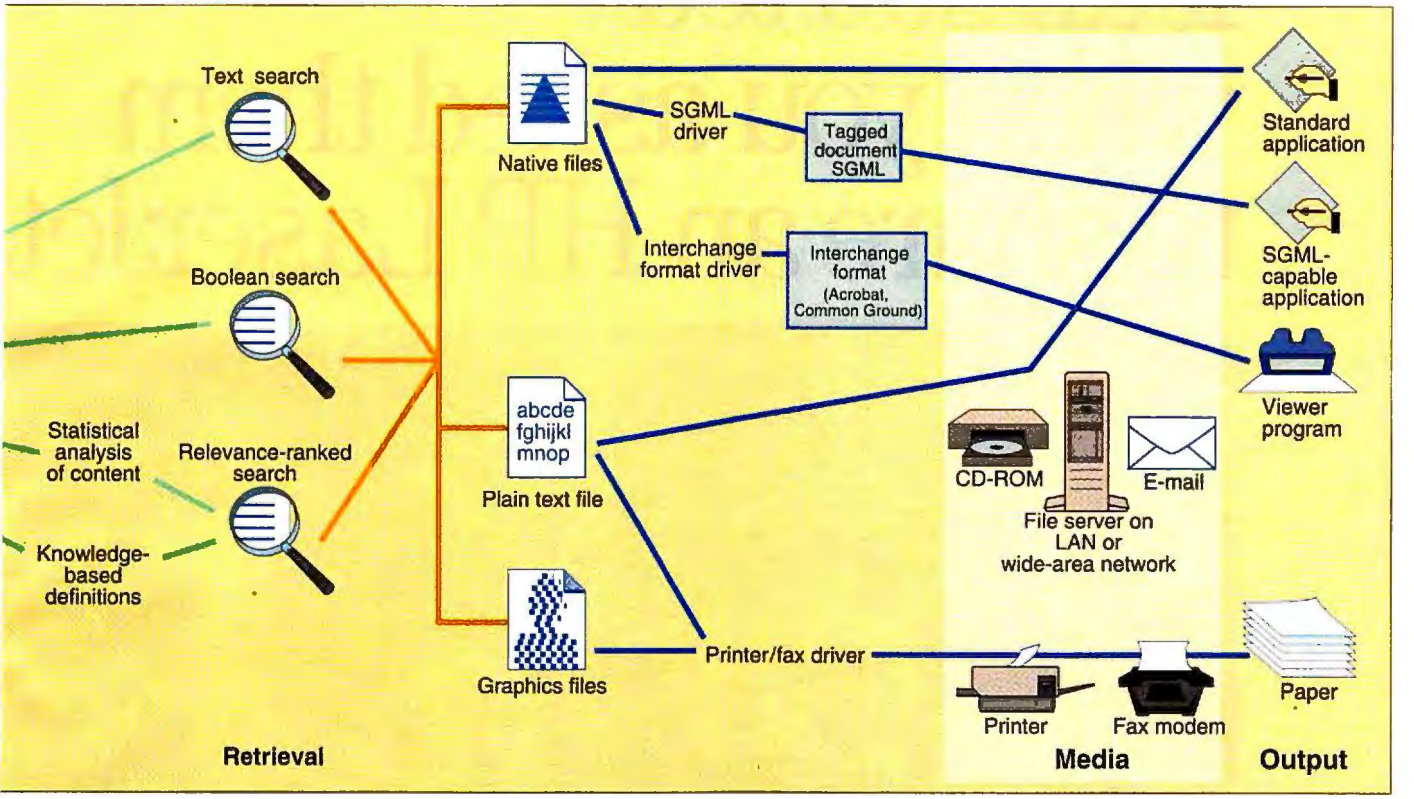
Indexing and Retrieval

Once you have determined how to input paper-based data into your electronic publishing system, you will need a way to index and retrieve your information. Although many products can handle full-text searches to find and retrieve files, locating information on your multimegabyte knowledge base is not a trivial matter.

Retrievals of no more than a few seconds are possible with a product such as Odyssey Development's (Denver, CO) Isys, because it creates an index for the document and supports both full-text and Boolean-search strategies to locate files. For example, a Boolean search lets you find every instance of the word *inventory* within 50 words of the word *problem*.

Unfortunately, full-text and Boolean searches break down when you search through a large number of files. For example, unless you are a skilled searcher, your query is likely to return too many documents, and generally you have no way to filter out the documents of interest except by inspecting each document one at a time. Additionally, you never know if you have found every document of interest to you.

The greatest problem with searching for information is human. "The native ambiguity of language leads us to describe what we are searching for in different ways," says Matthew Koll, CEO of Personal Library Software (Rockville, MD). "If you ask book indexers to index the same document two weeks apart, they will use different index words." According to Koll, one way to compensate for this is to have two people do the search so that you will



have two sets of results to compare.

Relevance-ranking retrieval systems try to speed file access by offering the most likely documents first. Verity's (Mountain View, CA) Topic and Personal Library Software's WPL (Windows Personal Librarian) attempt to determine the relative level of a document's usefulness based on the search information you provided.

Of the two programs, Topic has been more widely licensed to other companies. It uses a knowledge-based retrieval system with lookup definitions that an expert (e.g., an employee, a consultant, or a commercial information-processing vendor) on the subject prepares.

WPL achieves its ranking by several statistical criteria, such as checking how often a word is found in association with other words. For example, if you are looking up *serial port*, WPL will check associations to search for *RS-232* as well.

Audio/Visual Indexing

Today, all indexing and retrieval methods deal only with text. They typically run on network servers rather than local clients because creating an index is resource-intensive. Thus far, you can retrieve other media—audio, graphics, and full-motion video—only through keywords.

Voice recognition remains a difficult challenge. Today's microcomputers don't have the power to process the input and output of voice signals and the related algorithms that voice recognition requires. In particular, speech recognition stumbles on error and noise correction, and it has trouble differentiating between phonemes, such as *b* and *p*.

Nevertheless, voice recognition is manageable, according to Cliff Reid, executive vice president at Verity. "There isn't a technology barrier to audio," he says, provided enough computing power is brought to bear on the problem. Music usually only needs identification for retrieval from a library of recordings. Similarly, many ambient sounds may only need labeling for time and place rather than analysis of contents.

Indexing and retrieving visual information is truly difficult, according to Reid. Several research organizations, such as MIT's Media Lab, have been investigating ways to index and retrieve graphics and video by shape and color, but no commercial products have yet been marketed.

IBM hopes to offer the first commercial video search-and-retrieval product by year's end. Currently in beta test, IBM's Ultimedia Manager/2 is said to give your IBM PS/2–class machine (with at least 8 MB of RAM and running OS/2 2.1) the ability to search and retrieve images based on their color, texture, shape, and layout. According to IBM, Ultimedia will also let you analyze, annotate, classify, identify, and sort images by their content. It reportedly can recognize such simple shapes as triangles, circles, and squares, as well as complex forms such as a fish or a tree.

Ultimedia Manager/2 is a relational database that stores information on image color, texture, shape, and layout. It supports a wide range of image formats, including PCX, TIFF, and Targa, and you can use it to build and link image libraries to common database formats, such as DB2/2, dBase, and Oracle, allowing you to link text information to each image.

Once you build your image library, you can use Ultimedia Manager/2 to create sample pictures and query by image content. For example, you can set up a visual query by dragging and dropping colors and textures into an image window. Queries match the colors, layout, shapes, and textures you specify against the image database. To avoid receiving, say, every square figure in your image database, you can weigh individual elements of your query and limit the amount of matches displayed. You can use standard text queries to find images by the database records to which you have linked them. *continued*

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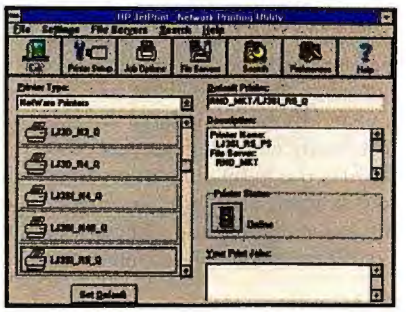

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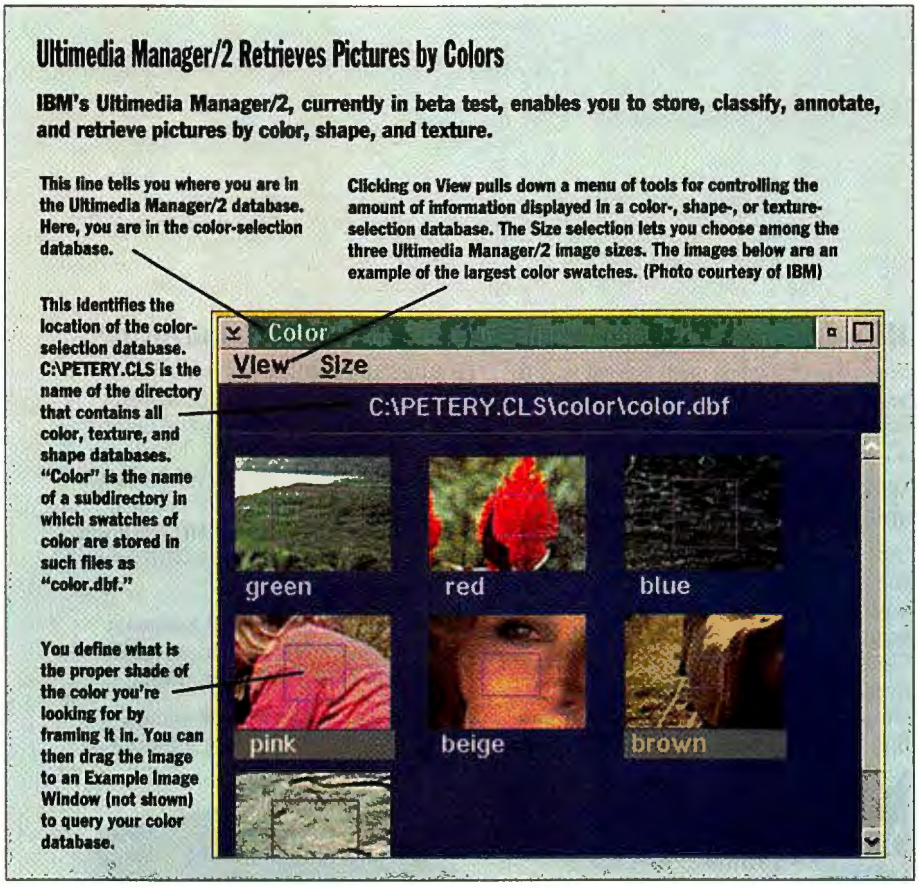
Ultimedia Manager/2 Retrieves Pictures by Colors

IBM's Ultimedia Manager/2, currently in beta test, enables you to store, classify, annotate, and retrieve pictures by color, shape, and texture.



Tracking Content

Document databases provide indexing and retrieval while giving you the ability to keep track of document content. Document database managers, such as those from SoftSolutions Technology (Orem, UT) and PC Docs (Tallahassee, FL), run on a network server. They take files produced by popular word processing and spreadsheet programs and index the contents for later retrieval. Administrative functions give you control over document revision, tracking, storage location, and authorized access. These document databases mostly track and retrieve internally generated documents. A typical installation would be in a legal office, where they would manage the storage of all legal contracts.

A key feature of document databases is that you always receive the most recent version of a file. For example, Mezzanine from Saros (Bellevue, WA) is a network librarian running as a client under Microsoft Windows. Mezzanine keeps track of file versions, sets up access control for files, and synchronizes several document servers so that all versions of a document are up-to-date. In addition, Lotus Notes performs a number of these tasks.

Apple (Cupertino, CA) has entered the document-database market with AppleSearch, a program that runs on Macintosh servers and uses the WPL search engine. Apple has given WPL a simpler user interface and has extended its search engine to work on many common file formats—including Microsoft Word, MacWrite, and WordPerfect—in both PC and Mac forms through translators.

AppleSearch, Mezzanine, and similar document databases mostly run on servers instead of stand-alone computers, because servers generally have the large storage devices and sufficient computational power to perform the indexing and retrieval operations without disrupting your work flow. But Saros reports that a single-user version of Mezzanine will be available this year.

Integrating External Data

On-line services, such as the Dow Jones News/Retrieval Service, and CD-ROMs from commercial publishers like Macmillan New Media (Cambridge, MA) offer a wide variety of data that can supplement your internally generated documents. Some of the information available from on-line services is highly structured, such as stock-market prices, but other data is found in a free-wheeling magazine-like format (see "Magazines Without Paper" on page 108).

The problem is that the only way to integrate data from external sources into your in-house knowledge base is to download the external documentation and run it through indexing software before incorporating it. This, of course, is inefficient because there is no standard for indexing information. If there were an indexing standard, the search engine could simply send a query to the CD-ROM or on-line database and get the selected documents back. With current systems, you must either run a separate search query for each type of document database or download the entire document database for indexing on your own system. An industrywide standard specifying search commands and an index format will eliminate this inefficiency by making feasible a document database that could search and retrieve from many sources.

Unfortunately, such standards are unlikely any time soon. "The marketplace is experimenting with different functionality," says Verity's Reid. "The different retrieval engines cannot be decoupled from the details of the underlying index." A unified indexing scheme will have to be flexible enough to address the idiosyncracies of a range of indexes and data types.

However, new developments indicate that this lack of standardization can be overcome in some situations. For example, you can program AppleSearch to regularly comb through data feeds from on-line services such as the Dow Jones News/Retrieval Service and create "newspapers" containing the search results. Further, the document-oriented interface promised by Microsoft's Cairo and Taligent's Pink operating systems should offer far better integration among documents from many different sources than possible with today's software (see "Objects for End Users," December 1992 BYTE).

Reading Complex Documents

Once you have established the input methodologies for your computer-based electronic publishing system, what will you see when you try to view a document? To view a file, anyone who retrieves it must have a compatible program. While

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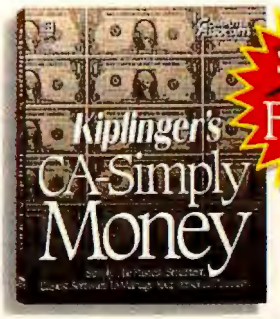

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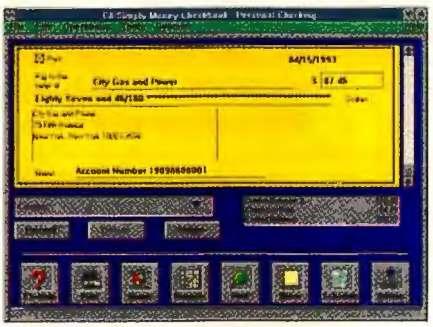

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that's not a problem for simple documents, since all the major Windows and Mac word processors can read each other's files, it is a big problem for highly designed pages from a page-layout program, such as Aldus PageMaker or QuarkXPress. Page-layout programs themselves are too specialized for universal use, yet everyone needs electronic access to the kind of pages they produce.

To produce files that everyone can read regardless of the type of computer or applications they use, you will need a universal file format that supports fonts, graphics, and layout and one that you will use as widely as people use ASCII for plain text. Adobe Systems (Mountain View, CA), the originator of the PostScript PDL (page-description language) for laser printers, is working to address that need with its print-to-screen technology called Acrobat. Acrobat extends PostScript to produce a universal output file in PDF (portable document format). Acrobat viewers running on IBM PCs or Macs display PDF files, complete with all the graphics and typography used in the original document.

Recently, Adobe Systems demonstrated Acrobat for BYTE editors. Running on a Mac Quadra 950, Acrobat captured the general design of approximately 89 pages of a recent issue of BYTE, requiring about 5 MB of storage to do so. The image files were a little grainy, depending on what resolution they were stored at, and the text was a bit hard to read on a 72-dpi screen. Nonetheless, Acrobat is suitable for the electronic publishing of company phone lists, spreadsheets, and the like. Adobe reports that Acrobat will be available for Unix systems later this year.

Adobe isn't the only company trying to establish a document-exchange standard. No Hands Software (Belmont, CA) competes with its DigitalPaper technology. DigitalPaper converts documents into computer-searchable text, which is platform-independent, and into a 300-dpi print image. No Hands Software's first product, Common Ground for the Macintosh, has two components: a maker and a viewer. The maker is used to produce DigitalPaper. The viewer, which is distributed as freeware, takes up only 62 KB and can be embedded in a document, allowing you to create portable text that can display DigitalPaper images on screen without the Common Ground application. No Hands anticipates unveiling a Windows version of Common Ground later this year.

Still, the information in a document isn't limited to its text and formatting; its structure and purpose are just as important. For example, you might want to identify every part of a document database that dealt with safety regulations. This would enable you to create a subset of documents that would be easier and quicker to search in an emergency than the entire database. SGML (Standard Generalized Markup Language) supports such coding for content and structure as well as for pure formatting features. DEC's (Maynard, MA) CDA (Compound Document Architecture) technology and the ISO's Open Document Architecture are also emerging as popular universal file-format strategies (see "Unlocking Data's Content" on page 111). Unlike SGML, these standards are designed to handle not only text but also audio, graphics, and full-motion video.

Alternative Delivery Mechanisms

Document distribution through a LAN works fine for E-mail and the typical corporate document database. But the distribution frequently must extend beyond a LAN. A company may have multiple, unnetworked sites or need

Electronic Publishing Pluses and Minuses

TECHNOLOGY	PROS	CONS
Image scanning	Captures images of important documents; lets you retrieve paperwork in minutes; preserves originals' look and feel; images are a good complement to OCR files.	The bit maps of the text you capture are not computer-readable; to find documents, you must assign keywords to each one.
OCR	OCR software digitizes scanned documents and produces computer-readable files, the full text of which you can search.	Works well with minimally formatted documents, but flunks on highly formatted newsletters and the like. It requires manual inspection and correction to ensure data was captured properly.
Index/retrieval software	Files and finds your documents; full-text and Boolean searches can pinpoint the data; relevance-ranking systems give you most likely documents.	Searches breakdown over large databases; queries can return too much data; no way to filter responses; you may never know if a crucial document was overlooked; audio files found by keywords; voice and visual recognition in developmental stages.
Document-exchange formats	Produce platform- and application-neutral data; keep text formatting and styling; some support audio, graphics, and full-motion video.	Complex standards that require expertise to use; you can define a document in such a way that it is unreadable by files that support the same standard; SGML does not support nontext elements.
Document databases	Provide indexing and retrieval with added control over file revisions, tracking, storage location, and access; give you the latest version of a document; good for managing such documents as legal contracts.	Large computational and storage requirements; desktop versions in development.
External data streams such as CD-ROM or on-line services	Comprehensive databases that can greatly expand your knowledge base.	No standards for searching or indexing, so you're on your own to get the data and integrate it with your knowledge base.

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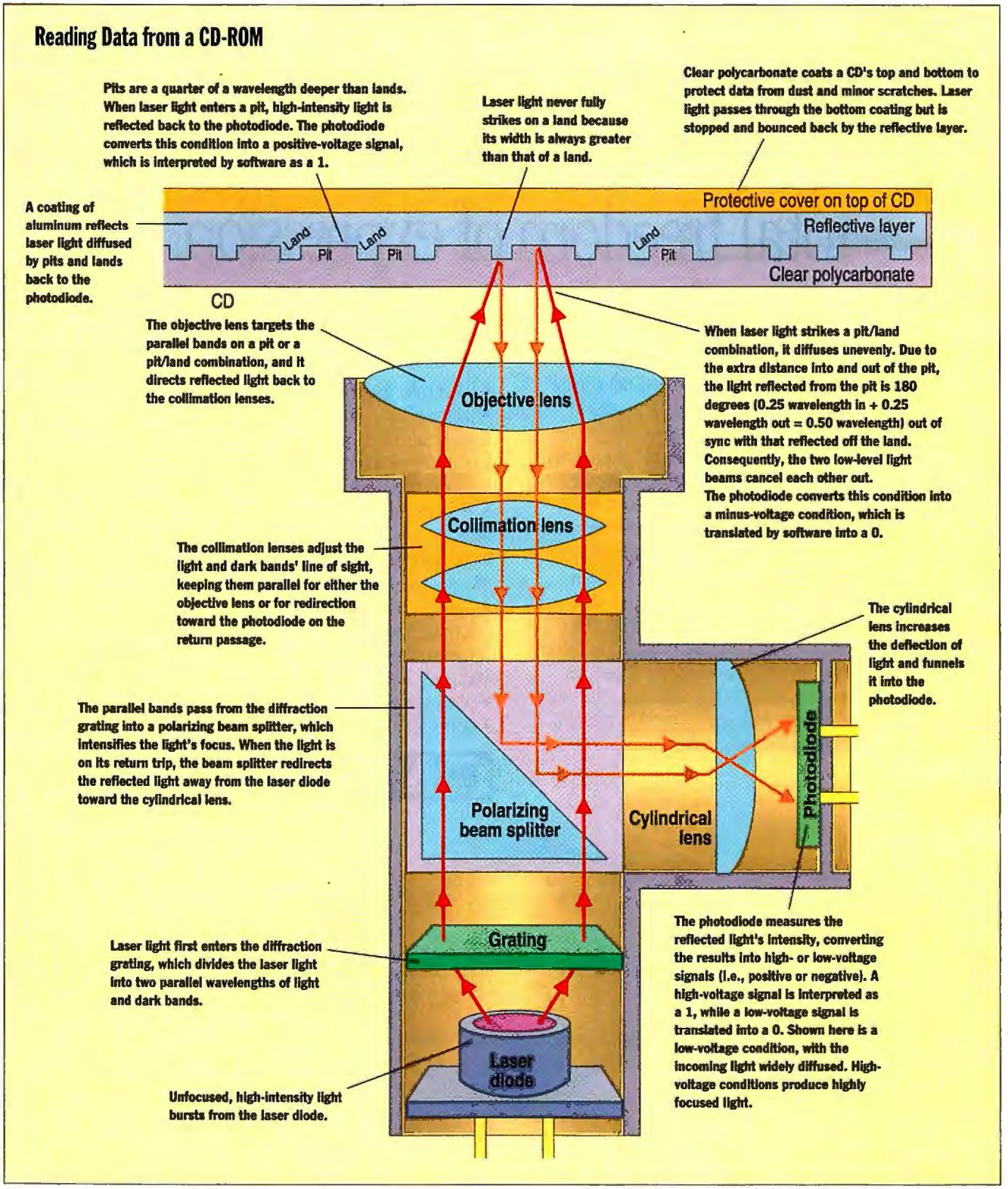

CD devices use a binary system of electrical signals *to play back data. In its simplest form, a CD is made up of a reflective layer sandwiched between a protective polycarbonate coating. The reflective layer's surface has alternating hills and valleys, known as pits and lands, that spiral out in tracks from the center of the CD to the edge. Track density is 16,000 tracks per inch; one strand of hair is wide enough to cover 50 tracks. Laser light bursts up from a laser diode and passes through a series of lenses that intensify and focus the light in on a track. Pits and lands diffuse laser light, reflecting it back in the direction from which it came. It terminates in a photodiode. Depending on the reflected light's intensity, the photodiode converts the bounced beams into a series of positive and negative signals that are translated into the ones and zeros of a computer-readable binary system.*

When protecting your software against piracy and unauthorized use, make sure that your protection system has all the following qualities:

A GOOD HARDWARE KEY

Hardware-based software protection systems are now the standard worldwide. However, not all keys are the same. A good key should have all the following features:

✔ Compatibility and transparency. The key should work without any problem on your customers' computers. The user should be able to forget the key after connecting it.

✔ Unbreakable electronics. A customized ASIC (Application Specific Integrated Circuit) component should be integrated in the key. This prevents reverse engineering and makes cracking virtually impossible.

✔ A unique and inaccessible software developer's code burnt into the ASIC. (This code should not be held in the key's memory, where it can be read and altered.)

✔ A Read/Write Memory inside the key should be available on demand. The memory should be writable in the field, on any PC, without any special programming equipment.

✔ Very low power consumption, enabling the key to work even under the worst power conditions, on PCs and laptops, with or without a printer.

POWERFUL SOFTWARE

✔ A Linkable Protection Module with which calls can be made to the key from any point in the protected program.

✔ An "Envelope" installation program. Such programs enhance security while making it possible to protect a software even without its source code.

✔ Sophisticated antidebugging and encryption mechanisms.

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✔ A Full Authorization System for protecting dozens of programs using only one key.

✔ A Pattern Code Security System (PCS) enabling parallel processing of multiple calls by the Linkable Protection Module.

✔ A Virus Detection option that can be incorporated in the protected program to check whether it has been infected by a virus.

✔ Several HASP keys can be connected one behind the other. Small physical size ensures maximum convenience for your customers.

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✔ Only one NetHASP key is needed to run a protected program from many stations in a network. NetHASP provides full support for protecting DOS and WINDOWS software under network environments, including Novell dedicated & non-dedicated servers, Lan Manager, Lantastic, Banyan, DLink, and NET-BIOS based LANs.

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PCompatible (Spain)

Trying to crack a program... that was protected utilizing all of HASP's features - is like searching for the Holy Grail.

Micro Systems (France)

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Magazines Without Paper

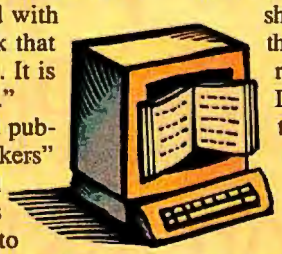
KEVIN M. SAVETZ

The common wisdom has been that freedom of the press is limited to those with access to one. However, global-computer networks such as the Internet are giving more people a quick and inexpensive means to express their point of view through a form of electronic publishing known as *electronic journals* or *E-journals*.

Through E-journals, anyone with access to a computer and a modem can produce and distribute an electronic magazine through a computer network. CICNet, a cooperative academic network, maintains a large collection of E-journals. At last count, there were more than 350 E-journals in the CICNet collection, covering every conceivable topic, including AIDS awareness, fiction, legal information, music, and telecommunications. When there isn't an E-journal that fits a need, starting one requires only a computer, access to a network, and the will to succeed.

For instance, *Unplastic News* is the sort of nutty fun that probably couldn't exist without electronic distribution. A recent edition, for example, had the unlikely title "The Psychic Net Godmother Issue," while another was dedicated to bald people "because we have bald friends who demand their human rights."

"*Unplastic News* is really only a silly magazine with no real writing in it," says publisher Todd Tibbetts. Yet "we have thousands of readers, [and] we don't pollute the world with paper. We get feedback that people enjoy reading it. It is pure silly entertainment."



E-journal editors and publishers range from "crackers" (those who gain illegal access into computers and telephone systems) to respected scientists and journalists. For example, Jason Snell, editor and publisher of *InterText*, a bi-monthly fiction magazine, is a student at the University of California at Berkeley working toward a master's degree in journalism.

Most E-journal publishers would be unable to produce a traditional magazine, due to cost and time constraints. But online publishing offers them the ability to create a publication using minimal resources. "We can go head to head with other media as far as getting information out there," notes Andrew Moss, an editor for *Unplastic News*. "It costs nothing but our time to send this thing out."

Aficionados of computer networks are by nature dabblers in many things, being "more sophisticated about technology" in the words of David Dodell, D.M.D., publisher of *Health Info-Com Network Newsletter*. Thus, E-journals usually have a more diverse, although smaller, audience than traditional magazines. Since they are distributed and read online, it's difficult to track their readership. For instance, Snell estimates that any given issue of *InterText* is read by 5000 to 20,000 people. Despite having only 1100 registered subscribers, Snell says that *InterText* is read by "untold numbers" on BBSes or the Internet.

If there's a problem confronting the entire E-journal concept, it's that they are useful only for transmitting text. "There is no easy way to transmit photographs," says Dodell. And, of course, you have to produce your own hard copy if you want to read an E-journal while commuting to work.

Like most E-journals, *InterText* is free. Subscribing means nothing more than asking to receive new issues in your electronic mailbox automatically. E-journals generally lack advertising, often because many network operators forbid it. Consequently, until there is a method for profit in electronic-magazine distribution, E-journals are not likely to become a mainstream medium, even though such commercial publications as BYTE, *Utne Reader*, and *VAR Business* offer varying forms of electronic publishing through on-line ser-

to distribute documents to business partners or customers. Publishing on CD-ROM is becoming an increasing popular answer for such situations, especially for organizations with large document databases that do not change rapidly.

CD-ROMs offer huge storage capacities—up to 700 MB—in a small package (see "Start the Presses," February BYTE). They are durable, take almost no space, and are easy to mail. For example, 3M uses CD-ROMs to distribute internally a database describing 50,000 products. The 100-MB database, prepared with DataWare's (Cambridge, MA) CD Author and CD Answer software, supports searching for products by description, pricing, and other criteria. In the past, 3M used a microfiche system that could search by product number only. 3M estimates its savings at $2.5 million annually in lower preparation and distribution costs, as well as in time saved by faster searches.

On a much smaller scale, the International Center for Diffraction Data in Philadelphia, with just 30 employees, uses DataWare to prepare CD-ROMs of scientific software and databases for internal use and for commercial sale. Mark Holomany, computer facilities manager for the International Center, uses a write-once CD-ROM drive for small jobs. "A CD-ROM blank costs $19 to $35," says Holomany, "so we can do a run of 20 to 40 discs ourselves." For its main database sold to subscribers, a master costs about $4000, including a thousand replicas—or about $4 a CD. The International Center would go exclusively to CD-ROM, but some international customers don't have CD-ROM yet, says Holomany.

Computer-conferencing systems provided by a third-party service or as an in-house venture are yet another means of publishing and building your organizational knowledge base. DEC's VTX or Softwords' (Victoria, BC, Canada) CoSy are two examples of conferencing systems.

The basic element of a conferencing system is the discussion group; hence, the use of the term *conferencing*. Essentially,

vices such as BIX and Prodigy.

While there's some worry among E-journal editors that traditional publishers will bring their capital and clout into the arena, ethical and legal matters surrounding the free flow of information over global networks may be a greater concern. "The lines between personal liberty, invasion of privacy, civil-rights violations, and government regulation of technology intersect when it comes to electronic publishing," says Geoff Duncan, a software tester for Microsoft and assistant editor of *InterText*.

Still, in Tibbetts' view, the future for E-journals looks exciting, despite such concerns. "There are many out there who believe this [ungoverned flow of information] will destroy the planet," Tibbetts says. "But I believe it will free us."

Duncan agrees that information technology is leveling the playing field in a society where information increasingly equals power. He's just not so confident about the future of E-journals. "Maybe E-journals will fade as information access becomes faster and, arguably, as attention spans decrease."

Kevin M. Savetz is a freelance writer based in Arcata, California. He specializes in networks and telecommunications. You can reach him on BIX c/o "editors" or on the Internet at savetz@rahul.net.

conferencing systems provide you with the ability to create your own database of free-form messages that you can read, comment on, and search. Your discussions can be highly structured, as in a business meeting, chaotic like an idea session, or a mixture of the two. Discussions can be open to all, or you can set up small, closed-group discussions. You can augment these systems with straight data feeds generated internally or externally, and you can set up gateways to global E-mail systems, software file libraries, the Internet, and international news services.

Assuming that you have communications capabilities up and running, setting up a conferencing system is not that difficult at first—it is simply a matter of loading the program, organizing disk files, and setting up your discussion groups. But it gets complicated once you get going. One of the biggest problems is with storage. Disk space disappears faster than you believed possible as message after message are stored. Program libraries and supplementary news and data feeds quickly eat up more space. Both situations force you to cull out messages and data, which undermines the expansion of your knowledge base through electronic publishing. To get around this, you can add more storage capacity, but that gets expensive.

Another difficulty with running your own conferencing system arises when you are using it for communications between widely dispersed offices. To do this, you'll need external data-network connections or your own modem bank, both of which are notoriously finicky. With modems, you'd set up a bank of modems connected to a telephone router. The router redirects incoming calls through a series of modem connections to the first available open line. Depending on the number of callers you anticipate, you can run up quite a bill with your local telephone company. The rule of thumb is that you need one connection for every 10 system users.

Data networks come with their own problems. For example, response speed can be variable because of network usage, network relay failure, and the condition of the local telephone lines. The X.25 protocol, a common network communications protocol, has a variety of software settings that require knowledgeable experts to set and maintain properly.

Data networks can also be expensive. Pricing generally is based on such factors as time of day and location of the call, number of characters sent and received, and the number of data packets sent and received. Unless you anticipate huge usage, connecting to an external third-party data-network operator may be prohibitively expensive.

Rather than set up your own network and conferencing system, CompuServe (Dayton, OH), General Videotex (Cambridge, MA), and other on-line service companies will set up private conferencing facilities tailored to your specifications. You can select from a variety of facilities, such as private software file libraries to send your data back and forth, external news feeds, and the like. The beauty of using third-party service providers is that they handle all computer management, disk storage, software development, and other tasks related to running an electronic conferencing system, letting you stick to running your own business. You can also open up separate discussions for your customers and for potential customers.

Pricing for such private conferencing services varies depending on number of users, network usage, and services desired. For example, General Videotex charges $39.95 to set up a private service on its Delphi on-line system; custom features are extra. Additional users in your area would pay the normal Delphi subscription and telecommunications fees, but they would have access to all Delphi features, such as full Internet access and private E-mail. For large organizations with a number of users, fees would range from between $500 and $10,000 to set up a private conferencing service, dependent on the type and level of customization you require, according to General Videotex spokesman Rusty Williams.

Spreading Knowledge, Not Paper

The in-house document publishing business is growing rapidly. For example, looking only at desktop-based document management systems, the root of any in-house publishing capability, analyst Bamford at BIS Strategic Decisions projects growth from 59,000 users this year to 345,000 users in 1997.

Several companies have put off installing a document publishing system due to the lack of a complete, packaged solution for the problems confronting electronic publishing. But given the diverse range of needs, there may never be a single solution.

While electronic publishing is a fairly new field, and many of the products do not work well together, it's clear that more and more industry leaders such as Adobe, Microsoft, and WordPerfect are giving you the ability to spread your organization's knowledge base further than before through products that create platform-independent data files. The trick is to use your computers as a way to unlock the information in your documents and build your knowledge base rather than simply as a way to generate ever more paper to stuff into file cabinets. ■

Cary Lu is the author of The Apple Macintosh Book *(Microsoft Press, 1992). He has advised several companies on document management systems. He can be contacted on BIX c/o "editors."*

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State of the Art

UNLOCKING DATA'S CONTENT

The changing structure of data types lets you leverage the information content in your data in ways you never imagined. But exchanging data across platforms requires lots of hard work.

RANDALL D. CRONK

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Over the years, the amount and kinds of information you could store in a data type have evolved from the simple binary zeros and ones to hypermedia documents in which objects are just as capable of being computed as the records in a database or the numbers in a spreadsheet. Data types have come to mean ASCII characters, as well as multimedia documents containing text, graphics, sound, and video.

The trend is to expand the information content of data and leverage that content in ways never before possible. For example, a value in a record field may tell you more than how many widgets are in stock; it may tell your purchasing program when to order more. Or you can use the same document database to generate a technical manual or a parts list. And the same content driving the presses for *The Wall Street Journal* can resurface as a CBR (content-based retrieval) service and an on-line data feed to a brokerage.

To squeeze more content into data, the structure of data has had to evolve. Bit for bit, a document is one of the richest forms of content, yet only recently has it been put to work as a computable data type. "Only about 10 percent of all data is in a form computers traditionally deal with," says Bill Arms, vice president of computing services at Carnegie Mellon University in Pittsburgh, Pennsylvania. "The other 90 percent is in documents, and the vast majority of those are still of the paper rather than the electronic variety."

One reason for making documents computable is that most of your data is found in documents. Another reason is that documents are inherently richer and more flexible in their content than are more conventional data types, such as spreadsheet cells or relational database records. Still, simply using documents to store tabular data would miss the content advantages of documents, which include the use of graphics, document formatting, and text

State of the Art Unlocking Data's Content

styling to illustrate and enhance the meaning of your work.

This is not to say that documents are the only data types or that expanded data types are the only strategy for enriching the role and substance of content. Rather, it's to say that documents exist as a data structure that carries a lot of content. The problem is how do you unlock the content inside your documents so that dissimilar applications running in a multiplatform computing environment can access, manipulate, and process it?

In the old days, exchanging documents meant filtering text. But now that word processors and desktop publishing programs routinely include graphics with their documents, exchanging these files without a standard file format for interchange is becoming increasingly difficult. New, object-oriented technologies promise to change the way we create and interchange documents.

—Mark Walter, a consultant at Seybold Publications

Computable Documents

Tagging languages and compound document architectures are emerging as the two main strategies for making documents computable across applications and platforms. The most widely used tagging language is SGML (Standard Generalized Markup Language—ISO number 8879) (see "SGML Frees Information," June 1992 BYTE). The two leading compound document architectures are ODA (Open Document Architecture—ISO number 8893) and DEC's CDA (Compound Document Architecture).

Both ODA and CDA provide a set of standards for the interchange of complex documents made up of text, images, and graphics among computer platforms and applications. SGML gives your documents the same cross-platform abilities, but it only works with text. Of the two compound document architectures, CDA is more widely adopted at this time (see "Universal Content Access" on page 116).

Compound document architectures encode documents as in-memory arrays called *aggregates*. You use aggregates to represent audio, graphics, text, and video, as well as a document's physical formatting, logical organization, and text styling. You can process aggregates as a document or as an information database, such as a parts list, an index, a glossary, or an online technical diagram.

When SGML encodes a document, it accomplishes its task using a different technique than CDA or ODA. Rather than dynamically creating new and different data types, as do CDA and ODA, SGML uses special character sequences known as markup tags to embed control information within the text stream. Markup tags can separate a document's logical elements or specify processing functions to be performed on them.

An example of applying markup would be tagging the beginning and end of a character string with special codes to indicate that the character string is in a different typeface than the rest of the text. For example, you would use the character string <I>aggregates<D> to indicate that the word *aggregates* is in italics and that your normal typeface resumes after the final letter of the word.

Markup tags let you access, edit, manipulate, publish, and store document objects by specifying the structural and procedural information that the computer programs that perform those operations require. To do this, SGML uses DTDs (Document Type Definitions) that determine the specific processing rules for encoding or decoding a document's structure and the markup tags that express that structure. For instance, a DTD rule might specify that the markup tag <D> symbolizes both the end of a character string specified by some other markup tag and the resumption of your default typeface.

Rules are specified within the DTD itself. The language in which the DTD is written is SGML. Consequently, you can have two DTDs that conform to the common SGML standard yet are incompatible because they specify different rules. For example, instead of using <D> to indicate the conclusion of a markup tag as in the previous example, a DTD could specify <E> as the end of the markup tag.

SGML only describes text-handling

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tags. Non-SGML processes such as a video editor handle nontext data (e.g., video). This is true even if video data is part of a text document, such as with a screen menu.

Although it cannot construct nontext documents or parts of documents for different kinds of content, SGML may have the inside track when it comes to industry acceptance. One reason for this is the U.S. government's CALS (Computer-aided Acquisition and Logistical Support) program. CALS is an industry government project with an agenda to define a universal document encoding structure for the U.S. military. The CALS DTD mandates the use of SGML for encoding documents for the U.S. Department of Defense.

Mark Walter, a consultant for Seybold Publications (Media, PA), cites SGML's flexibility as a reason for its prominence. "SGML has caught on the fastest [of all the tagging languages], thanks to its versatility and adaptability to a variety of applications," says Walter.

SGML No Panacea

SGML has its weaknesses. For one, it does not actually specify documents. It specifies DTDs, and incompatible DTDs defeat the purpose of universal document exchange. Another shortcoming is that DTDs do not indicate how to process nontext objects. When nontext objects are encountered, DTDs simply specify special markup tags called *escapes* that cause the processing program to jump outside the SGML-defined process to an application that can cope with the nontext object. Also not standardized is how objects are tagged for transfer to those other applications or how those applications will interpret those objects once they receive them.

A partial remedy for this weakness is the Hypermedia/Time-based (HyTime) structuring language, currently under draft consideration by the ISO. HyTime provides a standard way to tag text or nontext objects so that they can be rendered as a complete document or processed as independent objects. However, HyTime does not specify how document objects are encoded or interpreted by computer programs. But by using standardized linking, alignment, and addressing methods, it ensures that those objects are made available to programs in a standardized way.

Other Possible Approaches

Formatting content according to an encoding standard is one way you can make it more computable. Another approach is to invent new data types that combine documents and more conventional record-oriented data.

Work on such hybrid data types is proceeding from two directions. First, traditional database vendors—including DEC, Informix, Oracle, and Sybase—have added limited document support to their relational databases. Meanwhile, document-processing vendors, such as Information Dimensions (Dublin, OH), are adding relational fields to objects that contain documents. This means that you can map objects from within documents to fields inside relational records, where you can manipulate them in a conventional data-processing manner.

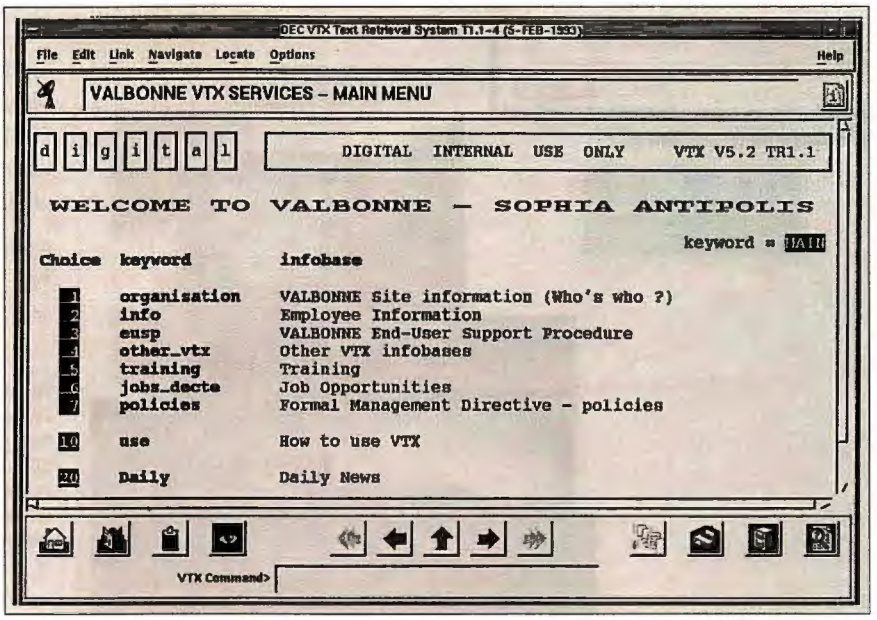
About two years ago, relational database vendors introduced BLOBs (binary large objects) as an extension of RDBMS (relational database management system) technology designed to address nonrelational data. BLOBs are free-form data buckets embedded within relational data records that you can search on using key fields.

More recently, vendors have added CBR capabilities that let you search for text objects inside of a BLOB, rather than searching just for the BLOB itself. For their part, vendors in the content-delivery businesses of document management, electronic publishing, and videotex have invented new data types that combine aspects of documents and relational records.

Content-Directed Paradigm

Rather than force-fit content into either documents or conventional data-processing structures, content-directed software uses whatever content package fits its particular needs. For example, Lotus Notes is a collaborative application that gives you a great deal of flexibility over the manner in which documents are accessed and how information in those documents affects your work-flow processes. To facilitate document lookup and manipulation, Notes implements a record, called a *form*, that allows you to append relational keys to your documents. To aid interprocess cooperation, Notes lets you attach hypertext links to internal document objects of virtually any format, size, or type. Thus, you could link a controller's spreadsheet to a work-flow process that generates dunning letters to past due accounts, enhancing your work flow by combining both operations.

Even though it borrows from both data and document processing, the content-directed paradigm is more than the sum of its parts. Content-directed products, such as Notes, have capabilities you can't find in either pure document or data-processing applications. For example, DEC's VTX, a content-directed videotex product, lets you build infinitely large data types so that you can have as much content within a single document, over as many machines, and in as many locations as you want. In other



DEC's VTX *is a network-level videotex application that lets you organize data into knowledge bases called stories. A story is made up of one or more pages. A page can store any amount of data in any format. Pages can provide cues to external applications that process or present the data contained in the page. (Screen courtesy of DEC)*

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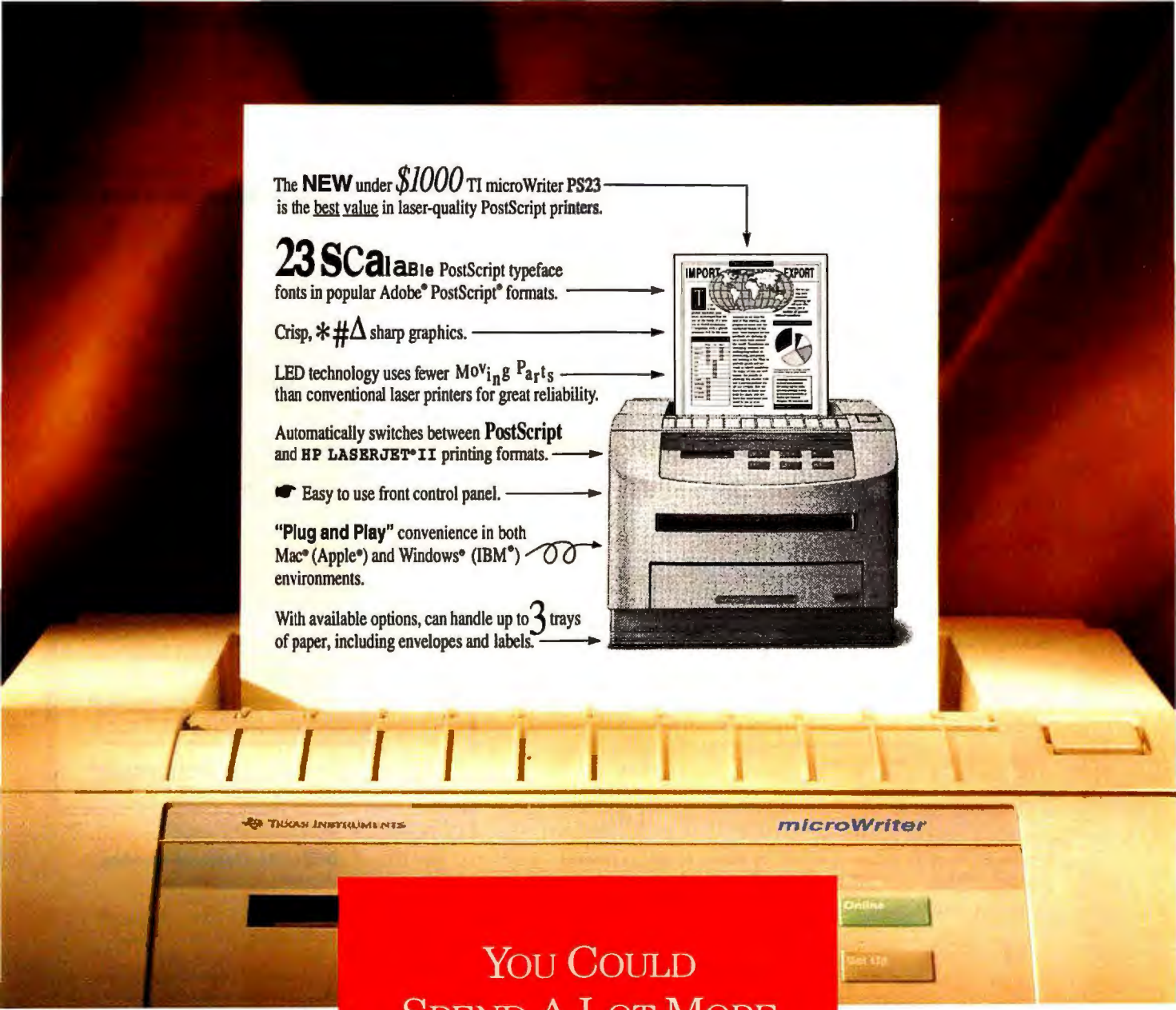

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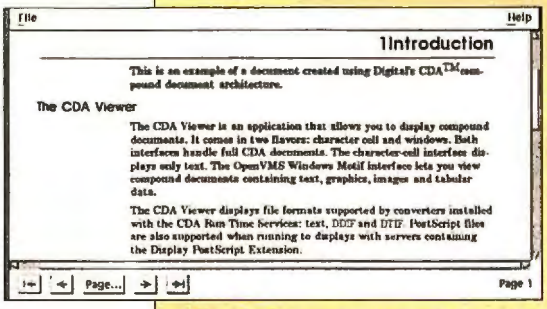
Universal Content Access

The Code Behind the Screen

```
static Widget              viewer_id = 0;  /* CDA Viewer widget */
static MrmCount            regnum = 2;
static MrmRegisterArg      regvec[] = {
                           {"open_file_proc",  (caddr_t) open_file_proc)  );

                           {"open_file_proc",  (caddr_t) open_file_proc)  );

main(int argc, char  *argv[])
{
  unsigned long stat;  /* condition status */
  MrmInitialize ();    /* initialize Motif Resource Manager */
  DvrRegisterClass();  /* Register the CDA Viewer widget class.  */

  toplevel = XtInitialize ("examp", "examp", NULL, 0, &argc, argv);
  MrmOpenHierarchy  (uid_count, uid_filename_vec,NULL,&my_MrmHierarchy);
  MrmRegisterNames (regvec, regnum); /* Register our callback routines */
  /*
   *  The CDA Viewer widget has been defined in the application's
   *  UIL.
   */
  MrmFetchWidget (my_MrmHierarchy, "My_main",toplevel,
                  &main_window,&dummy_class);
  XtManageChild    (main_window);
  XtRealizeWidget  (toplevel);
  XtAppMainLoop    (XtWidgetToApplicationContext (toplevel));
}  /* end main routine */

/*
 *  This callback is called when the CDA Viewer widget is created
 *  while the UID hierarchy is fetched.
 */
static void create_viewer_proc  (Widget w,  caddr_t tag, caddr_t reason)
{
    viewer_id = w; /* save the CDA Viewer widget for future reference */
}

/*
 *  This callback routine is called when the user selects "Open" from
 *  the CDA Viewer's file menu.
 */
static void open_file_proc  (Widget w, caddr_t tag, caddr_t reason)
{
    /* Tell the CDA Viewer to display text1.doc */
    DrvViewerFile(viewer_id, "text1.doc", "ddif", NULL, NULL, NULL);
}
```

The CDA Viewer is a Motif widget. You use the bulk of the code here to get the CDA Viewer to come up.

This highlighted function call is the key to ensuring that your application can use the CDA Viewer.



DEC's CDA document-encoding scheme *ensures that compliant applications have enough information to render a document. Shown to the left is the complete code needed to display the compound document above using the CDA Viewer. (Screen courtesy of DEC)*

DEC's CDA (Compound Document Architecture) defines a set of ground rules and services for the interchange of compound documents between applications. CDA-compliant applications can revise each other's documents even if the applications are written in different languages, run under different operating systems, and are located on the far corners of a distributed network.

CDA was designed from the outset to be independent of computer platforms, according to Mark Walter, a consultant for Seybold Publications (Media, PA). Over the last two years, DEC's CDA has become the compound document architecture of choice for such heavyweights as Lotus Development, Microsoft, and WordPerfect.

CDA includes an overall strategy for compound document interchange. It encompasses both a specific set of encoding rules, or DDIF (Digital Document Interchange Format), and a set of run-time services to help programmers develop applications that support those rules. CDA run-time services give you tools such as the CDA Viewer, which allows applications to display compound documents.

CDA has been employed in a variety of applications, including document-format converters, real-time data acquisition, and work-flow management. Among the more well-known products supporting CDA are FrameMaker, Interleaf, Lotus Notes, and SAS.

CDA is an under-the-hood technology, meaning that applications developers work with CDA directly, while end

users benefit indirectly. One way that CDA benefits you as an end user is that it simplifies the task of working with graphics, text, images, and other data types in a single project. It also lets you receive and manipulate documents generated by foreign applications and from different computing environments. CDA opens up documents so that different applications can work on pieces of them. This gives you the ability to, say, publish all the diagrams in a repair manual as a separate book with its own table of contents.

Aggregates Cast in ASCII

```
aggregate_type = DDIF$_TXT;
status = CdaCreateAggregate (   root_aggregate_handle,
                                aggregate_type,

        &aggregate_handle_stack[ahs_index]
```

Aggregates reserve and initialize space *for document components, such as text and picture frames. Here, sample code written in C shows how you can code an aggregate to define a text galley.*

How DDIF Works

DDIF's document-encoding scheme ensures that every application that understands the code has sufficient information to faithfully render a properly encoded document. Document encoding differs from document rendering, which is the job of PDLs (page-description languages) such as PostScript, in three key respects. First, document-encoding schemes determine the nature of a document's content and how that content is organized logically (i.e., by sections, paragraphs, chapters, and so on). Document encoding also determines how your content is organized physically (i.e., whether the document is organized into text blocks or galleys, or whether headings are used). Finally, document encoding determines how your content is presented—meaning it determines such styling information as italics, underlines, and bold headings.

Every digital document has three stages in its life cycle. In its first stage, a digital document exists as a rendered document—the printed page. Then, it is an encoded document existing as the sequence of bits transmitted in a data packet or formatted on a disk. Last, it's an in-memory structure that an application works on.

ASCII-encoded documents are considered flat, which means that they are a sequence of 7-bit character strings. Their in-memory structures are also flat. Document structure and styling information is carried in application-specific tags embedded within the ASCII. The meaning of these tags is defined using a DTD (Document Type Definition), which is specified using a markup language such as SGML (Standard Generalized Markup Language). To successfully interchange and edit each other's documents, applications must employ identical DTDs.

Unlike ASCII, DDIF conveys structural information such as layout and text styling, not just a document's contents. DDIF's in-memory structures consist of linked lists of entities called aggregates and items. Aggregates reserve and initialize space for document components, such as text and picture frames. Items are the values that size or populate aggregates. Therefore, an item specifies how large a frame should be, at what coordinates it should be positioned, and what text is enclosed within the frame.

DDIF uses ASCII to encode text. The above sample code shows a C-language version of an aggregate that defines a galley for some text. The sample code to the right shows an aggregate item that positions the galley on the page.

Values for these structures (the `status =` lines) are supplied by the application through an in-memory array defined earlier in the program. Aggregate definitions are not a part of C or any other language CDA supports. CDA provides a run-time service that is embedded in the compiled application to let the application create, populate, and delete aggregates.

The in-memory form of a CDA document is a link list of aggregates (some with items attached) that can be parsed from top to bottom to define content, logical structure, layout, and presentation style. To render a list of aggregates as a printed or screen-displayed document, CDA run-time services include a PostScript driver. To render this list on disk, CDA uses a TLV (type-length value) encoding scheme that is patterned after the ASN.1 (Abstract Syntax Notation One) standard, ISO number 8825. An aggregate list is encoded as a series of 8-bit data frames or octets. The type octet indicates the kind of information encoded (e.g., text or graphics). The length octet indicates how many octets are needed to encode the complete series of aggregates from this point in the list.

A value octet contains the value of this aggregate (e.g., ASCII text or a frame position) if it is "content only," meaning that this aggregate does not contain subaggregates or structural information. Otherwise, the value octet contains the TLV encoding of the next subaggregate attached to this aggregate (i.e., this aggregate is a structure containing subordinate structures, content, or both).

CDA can encode virtually any structure in a platform-neutral way. Because of this, when a document is sent between applications, the sender and receiver don't have to agree in advance on the size, type, or complexity of the data types involved. They just accept the document and let you get on with your work.

Items Position Aggregates

```
aggregate_item = DDIF$_SGA_FRM_POSITION_C:
integer_value = DDIF$K_FRAME_GALLEY;
status = CdaStoreItem (  root_aggregate_handle

        aggregate_handle_stack[ahs_index],
                        aggregate_item,
                        integer_length,
                        & integer_value,
                        0, 0)
```

Items are the values *that size or populate aggregates, determining, for example, the size of a frame and where it should be positioned. Here, sample code written in C shows how you can code an item to position a galley.*

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products, such as Information Dimensions' docXform document database, you can do a relational database search not just on a document but in a document.

VTX is a network-level application that lets you create and publish on-line knowledge bases, called *information services*, of virtually any size. At the heart of VTX is a data structure called a *story*. A story is a structured set of information, such as a policy manual, that's carried over the network and is of unlimited size. What distinguishes VTX from other on-line applications is its ability to manage an unlimited number of stories, users, clients, and servers.

The structure of a VTX story is built around one or more pages. The key to VTX's extensibility is that each page can contain data of any format. In addition, you can tag pages with attributes that provide cues to external applications that process or present the data in the page. For example, an attribute tag can tell you that the page is a Lotus spreadsheet.

A story can also provide cues to such VTX routines as "set this up as a menu page" or "set this up as a query page." A menu page is an interactive screen that lets you select specific pages from a list (e.g., "current jobs listings" or "van pools"). A query page lets you construct ad hoc queries such as "list all jobs that pay over $75,000."

Stories can indicate whether a page is *remote*, meaning that the page seen locally is really a window through which you are viewing a page from a story physically located on another machine. If you select a remote story, VTX puts that story's topmost menu page on your screen and marks it as a remote page. You can then access the remote menu's selections as if they were extensions of your story's address space, which, in fact, they are until you break the remote link. Except for network delays, once you select a remote story, you have the perception of reading a local story.

Employees at Hughes Aircraft in Malibu, California, log in to their VTX service more than 40,000 times each month. Hughes installed the system seven years ago to maintain and distribute data on U.S. Air Force policies and practices. Today, it has more than 200 information services that publish everything from in-house job listings to surplus equipment inventories. Client systems connected to VTX include Windows, Macs, DOS-based PCs, and VT-100 terminals. In total, Hughes has 90 VTX server processes distributed among five clustered VAX 8800s. Everything is tied together over TCP/IP and Novell IPX networks. Hughes reports that in just the first six months of its operation, the surplus equipment service alone saved the company over $400,000.

The docXform Method

DocXform for MS-DOS, SunOS, and Unix systems uses a novel data type. Described by its manufacturer, Information Dimensions, as a "component-level document database," docXform's data type is a structure made up of 9000 sections, each of which can be 128 MB in length. You can assign a category of document content (e.g., chapters), which has been marked up using SGML tags, to a section.

Unlike BLOBs, where finding a document in a relational database is an all or nothing proposition (except for CBR), docXform lets you access individual parts

of documents as if they were conventional database records. To mark up documents prior to loading into the database, docXform uses FastTag from Avalanche Development (Boulder, CO). FastTag scans a document, which can be a paper-based or a PostScript file, and creates a file of marked up content that docXform imports into its proprietary relational database.

"IDI makes better use of SGML structures because users can map them into a relational database," says Carl Frappaolo of Delphi Consulting in Boston. "Users can manage their document-bound information at the component level with the same speed and efficiency that they apply to managing their other information assets."

In the future, what we currently think of as separate applications, such as work flow, conferencing, and text retrieval, will become parts of a common service.

—Carl Frappaolo, executive vice president at Delphi Consulting

Extending Data's Domain

Electronic publishing, multimedia, videotex, and work flow are all part of a growing list of seemingly disparate applications that enable you to communicate your data in new and different ways. Since information content, especially document content, is no longer something that is just read or achieved, it has begun to control organizational work flow in the same way that data in "just-in-time" process-control programs affect the movement of a car engine on an automotive assembly line. The difference now is that human work flows are being automated, not conveyor belts.

For example, work-flow products such as Lotus Notes route and store information. But they can also determine who does what job and when it gets done. Thus, they don't simply remind you that, say, the vice president of your company must approve purchase orders of more than $50,000, they also route the purchase order to the vice president and keep it there until he or she acts on it.

The evolution of data types from elementary items of information to complex objects that can affect external events signifies the breakdown of the predefined limits that determined both the make up of a data type and how your information content could flow from one data type to another. Moving beyond computing that information packaging restricts means that your knowledge-based activities can use a common technology to exchange, expand on, and react to your data. Soon, the idea of building an application around a particular data type may seem arbitrary and, perhaps, even a bit primitive. ■

Randall D. Cronk of Boston, Massachusetts, is a freelance writer who has been researching and writing about document interchange for more than two years. You can reach him on BIX c/o "editors."

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Diskette	3.5"	3.5"	3.5"	3.5"
Display	6312 14" SVGA NI	6312 14" SVGA NI	6312 14" SVGA NI	6314 14" SVGA NI
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ValuePoint Desktop	425SX/D	433SX/D	433DX/D	466DX2/D
Processor	i486SX/25 MHz	i486SX/33 MHz	i486DX/33 MHz	i486DX2/66 MHz
Hard Drive/Memory	120MB/4MB	120MB /4MB	120MB/4MB	245MB/4MB
Diskette	3.5"	3.5"	3.5"	3.5"
Display	6312 14" SVGA NI	6312 14" SVGA NI	6312 14" SVGA NI	6312 14" SVGA NI
Operating System	IBM DOS & WINDOWS	IBM DOS & WINDOWS	IBM DOS & WINDOWS	IBM DOS & WINDOWS
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Processor	i486DX/33 MHz	i486DX2/66 MHz	i486DX2/66 MHz	i486DX2/66 MHz
Hard Drive/Memory	340MB/4MB	527MB/4MB	527MB/4MB	527MB/8MB
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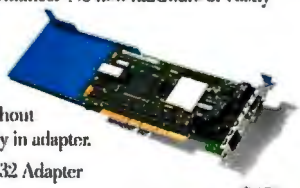

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Electronic reference documents, or ERDs, serve the same purpose as hard-copy reference documents. Also known by such names as *softcopy*, *enhanced documents*, and *hypertext*, ERDs let you use computer power to locate answers to your problems quickly. While they can contain graphics, sound, and video, ERDs differ from most multimedia documents in that their primary role is to give you fast access to data so that you can solve a problem efficiently. Most multimedia documents, on the other hand, are designed to assist with learning and mastery or to entertain.

ERDs offer a variety of features that are beyond the ability of hard copy. For example, some let you browse through a table of contents in one window while a synchronized companion window presents the text of the section under your cursor. Others offer graphical access tools to help you locate information. With careful analysis, you can tailor an ERD to the specific needs of your intended audience.

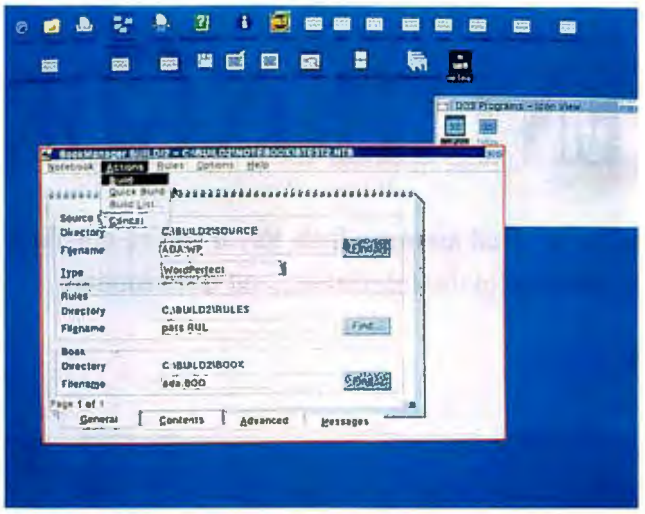
But ERDs are not a mature technology. For example, consistent end-user features and interfaces have not appeared. And ERD production practices and techniques still need standardization. Real growth in ERD use will occur only when improved authoring tools, clear data models, and product standards emerge.

Signs of Acceptance

Digital delivery of reference information is growing increasingly popular. For example, Shared Medical Systems (Malvern, PA), a health-care information-systems provider, produces electronic documentation for most of its IBM-based software, and the U.S. Department of Defense has mandated electronic delivery of maintenance manuals for new weapons systems.

Producing more than 30 million printed pages per year of supporting documentation, SMS is a large-scale commercial

information provider. Fred Drake, software product communications manager for SMS, is helping to transform the company's information delivery from paper to CD-ROM. SMS uses IBM's BookManager ERD publishing system for creating and delivering ERDs. BookManager's Build component serves as the engine that creates electronic documents that can be used with BookManager's Read software on five different operating systems commonly used in IBM environments, including MVS, OS/2, and DOS. BookManager's full-text search and hypertext linking features make it especially useful for organizations such as SMS that have applications requiring large reference documents.



IBM's BookManager *ERD publishing system has a Build component that converts word processing sources into ERDs. (Screen courtesy of IBM)*

Drake cites two reasons for SMS's switch to electronic document delivery: ease of updating and speed of information access. SMS's products change rapidly. Electronic documentation obviates the need for errata sheets, new typesetting and print runs, and the like. SMS applications are accompanied by comprehensive technical manuals; some applications have 10 or 12 400-page handbooks. This volume of information makes it difficult to find answers in the paper manuals, no matter how well-designed and written they may be. CD-ROMs unlock the barriers to better access and use up less shelf space.

Drake lists cost of delivery as last among the major reasons for SMS's transition to ERDs, but only because the company is phasing in documentation on CD-ROMs. Drake expects to also realize savings in publishing costs as ERDs become the company's primary method of documentation delivery.

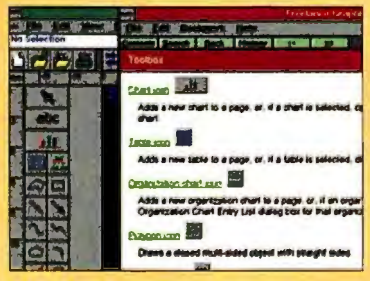
SMS is also evaluating BookManager

Windows Help: Like a Book

The flood of applications available for Microsoft Windows is blurring the distinction between on-line help and electronic reference documents. While on-line help for character-based applications is often marked by extreme brevity and carefully crafted, fixed-size screens, on-line help for GUI-based applications is often structured and formatted more like a book.

The on-line help for Lotus's Freelance Graphics for Windows, for example, has help documents with relatively long topics and built-in browsing paths that maintain access to the linear organization of the document. The versatile formatting options of Windows Help and its ability to display text in a variety of fonts and sizes are the agents of this gradual transformation.

On-line documents for Windows Help can be prepared with any method that creates code compliant with Microsoft's RTF (Rich Text Format), an ASCII-based coding system that can be used to describe the appearance of word processor and desktop publishing documents. However, a spate of new applications dedicated to this purpose, including Blue Sky Software's (La Jolla, CA) RoboHelp and Softronics' (Colorado Springs, CO) Universal Help, simplify not only the coding but also the complexities of designing and maintaining hypertext links, including tracking the identity of target nodes for hypertext links, generating tables of contents, and recording browsing paths.



Help for the *Freelance Graphics' Toolbox uses a book-like format.*

Such tools are indicative of the growing level of interest in using the Windows Help viewer. In addition, commercial usage of the Windows Help viewer is growing. For example, DEC is using the viewer as a mechanism for its on-line support manuals. The viewer has even been used for such applications as the FAQ (frequently asked questions) file for the Internet's alt.hypertext news group.

The Windows Help viewer does not have all the features needed for many forms of ERD publishing. For example, the current version lacks full-text search capabilities, making it inappropriate for many long documents. However, the lack of run-time fees and its ready availability make it attractive to potential publishers.

Will the Windows Help viewer push innovative solutions from other vendors out of the market? It's still too early to say. However, the increasing sophistication of comprehensive on-line help for Windows and other GUI applications, coupled with an insistence on user-friendly interfaces, is producing a generation of computer users who often prefer on-line help to bulky printed manuals. The growing level of comfort with this particular form of electronic document may help win broad acceptance for ERDs in desktop publishing applications.

as a way to tie the documentation closely to its applications so that end users can have context-sensitive, on-line help instead of separate on-line reference manuals. The key requirement is adding code to the applications software that maps program states or contexts to specific points in the help system. This is the type of coding that lets you press, say, your F1 key to get help about the current drop-down menu in a Windows application.

However, help systems typically are compiled for a specific operating system, which poses thorny development and maintenance problems for multiplatform applications such as those from SMS. But if programs can invoke direct calls to specific sections of a BookManager document, then multiplatform ERD development and maintenance problems can be solved, because the same BookManager documents can be read with BookManager Read software on five different operating systems in the IBM product line.

Read software *in IBM's BookManager ERD publishing system can display graphics in resizable, movable windows. (Screen courtesy of IBM)*

SMS is not an isolated case. For example, the U.S. Postal Service supplies its employees with copies of the *Domestic Mail Manual*, the bible of U.S. postal clerks, in Window Book's (Cambridge, MA) format. And Folio's (Provo, UT) Folio Views is in use by more than 80 commercial publishers.

Obstacles to Acceptance

Many obstacles block broader acceptance of ERDs at the desktop level. For example, there are some 200 ERD authoring and publishing products. By contrast, a few well-known systems serve as yardsticks for desktop publishing software, making it easier to narrow and identify requirements when choosing such software.

Narrowing your choice of ERD systems to two or three can require substantial research. Requirements for multiplatform delivery and displaying complex material (e.g., display equations) may limit your choice of systems. Among the other considerations you have to weigh are the types of graphics and external program links you need to support, the types of search features that you can use, and the acceptability of the user interface.

For example, if you want to produce long reference documents but you don't want to hand-craft thousands of hypertext links, you'll want a product that supports full-text search. KnowledgeSet's (Mountain View, CA) Knowledge Retrieval System and Flambeaux Software's (Glendale, CA) xText would be appropriate for such an application.

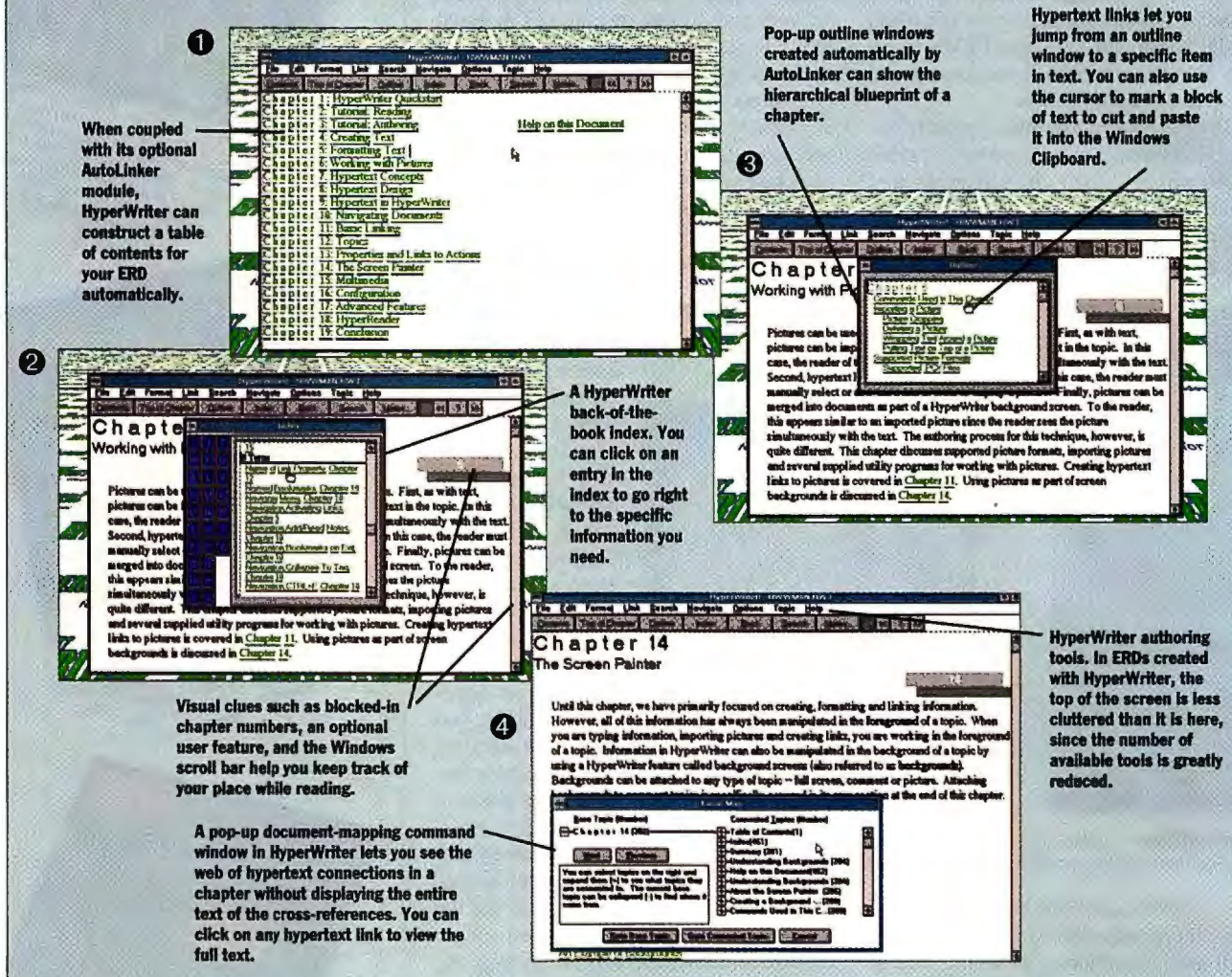
To deliver documents digitally, you must first identify the principles behind ERD creation and choose the particular strategy that meets your objectives and then choose the best tool for the job. Most important, however, is to begin the process by carefully analyzing the needs and use patterns of those for whom your are creating your ERD.

For all but the smallest projects, extensive prototyping is a worthwhile investment. After you identify your objectives, you should create a sample ERD and test it on end users in the environment in which it will be used. Remember, ERDs are for finding information as rapidly as possible. You, not the ERD authoring software, might have introduced a problem by, say, using too few hypertext links. In addition, in any testing that compares the performance of printed documents to on-line documents, you should attempt to account for skewing factors. For example, people often perceive any change of routine as an improvement.

continued

Anatomy of an Electronic Document

Ntergaid's HyperWriter ERD authoring system converts documents that already exist in digital form into electronic documents complete with ❶ tables of contents, ❷ back-of-the-book indexes, ❸ chapter outlines, and ❹ maps of hypertext links. HyperWriter runs on DOS- and Windows-based computers. A Mac version is in development. (Screens courtesy of Ntergaid)



Finding and Using Data

Keeping what's good about printed books in your ERDs seems like a logical thing to do, but sometimes the wrong things are kept and the right things are discarded. Ironically, chief among the often-discarded features is the most frequently used method of information access in books: the back-of-the-book, or "conceptual," index.

Full-text searching is not an adequate replacement for indexes in electronic documents, as studies of the effectiveness of searching have shown. For example, writing in the December 1992 issue of *Communications of the ACM*, Peter W. Foltz and Susan T. Dumais report that keyword matching often fails because of the natural ambiguity of the English language. For example, a single word such as *chip* can have more than one meaning. Conversely, many different words can describe a single concept (e.g., *human factors* and *ergonomics*).

In an ERD that supports hypertext links, a conceptual index can provide direct access to all significant ideas in the document from any point in the document, not just the names of things that can be found easily by search features. In addition to familiar conventions that help you find information easily, such as directing you from synonyms to primary listings, good indexes include parent-child and "see also" entries that show relationships among the ideas.

The manner in which conceptual indexes point to information and describe relationships brings up other questions about how hypertext links should be used. For example, are one-to-many hypertext links essential? Is it essential to have one style of indicators for hypertext links that take the reader to more detail and a different style for links that take the reader to closely related information?

Information Navigation's (Durham, NC) Train of Thought supports most features of

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conceptual indexes, but few other ERD authoring systems directly support the construction of conceptual indexes at the present time. But you can find ways to construct them. For example, Ntergaid's (Fairfield, CT) AutoLinker software can trap embedded indexing codes for print applications and convert them into indexes for ERDs produced by its HyperWriter ERD authoring system.

> **Everyone wants their documents published electronically. It's just a matter of how and when—not if.**
>
> —Jeff Peoples, president, Window Book (Cambridge, MA)

Limitations of the Page

While Thaumaturgy Software's (Redmond, WA) Eddars PostScript file-viewing system and Adobe's (Mountain View, CA) Acrobat technology promise to display complex pages on virtually any platform, the slavish adherence to a printed document model stays the course laid out by Gutenberg. It limits the implementation of new ways of providing access to data and transferring knowledge. In spite of their comforting familiarity, physical pages actually impede access to information in some cases. For example, pages often contain illustrations at locations that are far removed from their in-text references, and breaks in information can occur at awkward points. Pages also provide only a single view of the information, and they aren't easily resizable.

Yet to be defined are techniques for making documents more capable of responding to the needs of end users with substantial variations in skills, levels of understanding, and interests. However, some software that is now available hints at some of the many possible methods of making documents more adaptive. For example, Knowledge Garden's (Setauket, NY) KnowledgePro has expert-system features that allow end users to profile their own needs interactively.

Managing Document Development

Document production is only a small part of the overall process of generating digital documents. While the time that must be spent researching, writing, reviewing, and revising the content of long printed documents constitutes as much as 80 percent or 90 percent of the process, the time that's spent formatting them for delivery constitutes perhaps only 10 percent to 20 percent. Given the speed with which you can revise electronic documents, the purely mechanical tasks of building and formatting ERDs will become an even smaller component of the overall development process.

Valuable information often outlives the tools used to create and process it, making it important to store data in a format that accommodates technological change and multiple delivery modes. Document tagging and encoding standards are intended in part to address this need (see "Unlocking Data's Content" on page 111).

You can use documentation management systems, text-retrieval systems, and even customized relational database management applications to reduce your management effort. Unfortunately, outline processors, word processors, and other applications do not produce neutral data that's acceptable to all ERD publishing systems. Transferring textual content is generally not a problem, but important information about content architecture, as well as basic formatting, usually is lost in the translation. A universal, platform- and time-independent storage and interchange model for notes and ideas—not just documents—does not yet exist. In fact, such a standard may never exist because lack of transferability is not generally recognized as a problem.

The focus on documents as discrete, rigid, highly structured entities is another inheritance from print models that has outlived its usefulness. Adding a web of hard-wired hypertext links, which is comparable to adding extra crosspieces in a steel bridge, makes electronic documents more rigid and harder to change than printed documents. For example, what happens when you remove text that is a target of a

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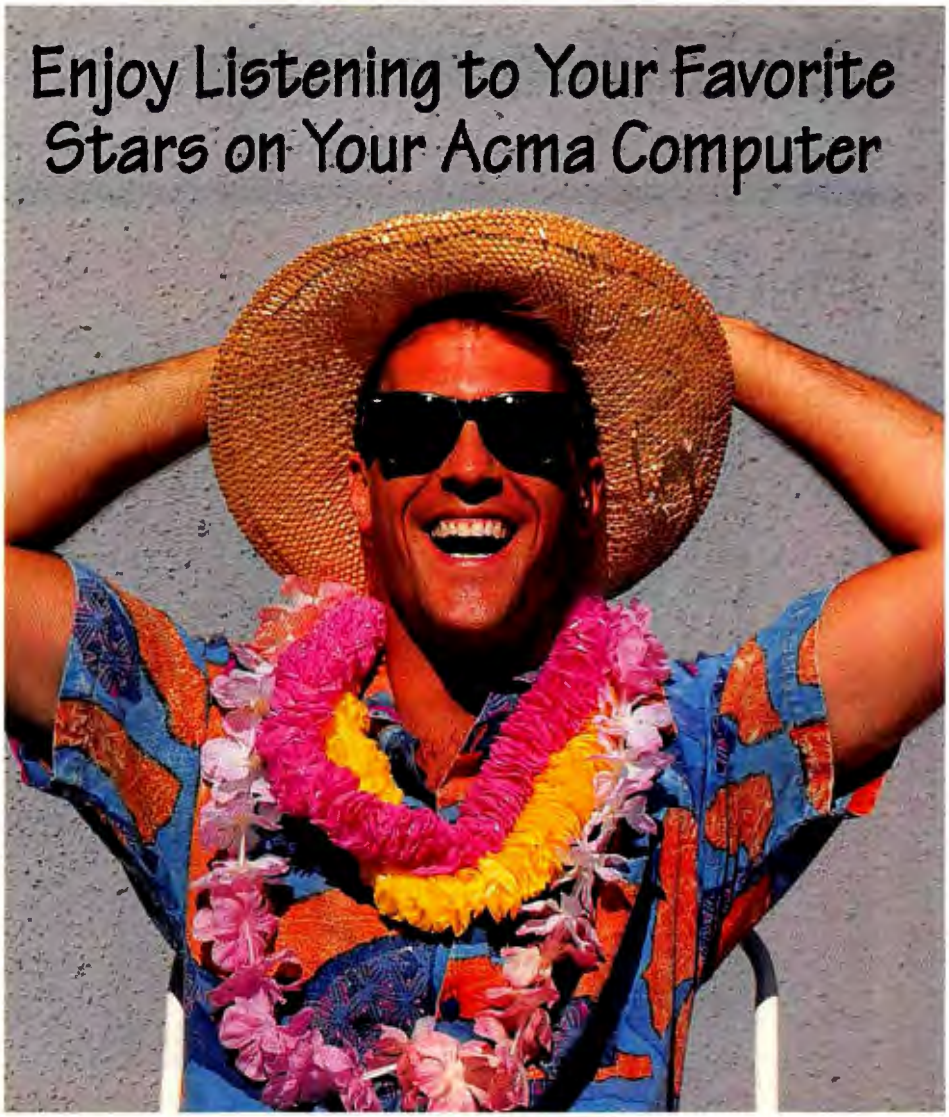

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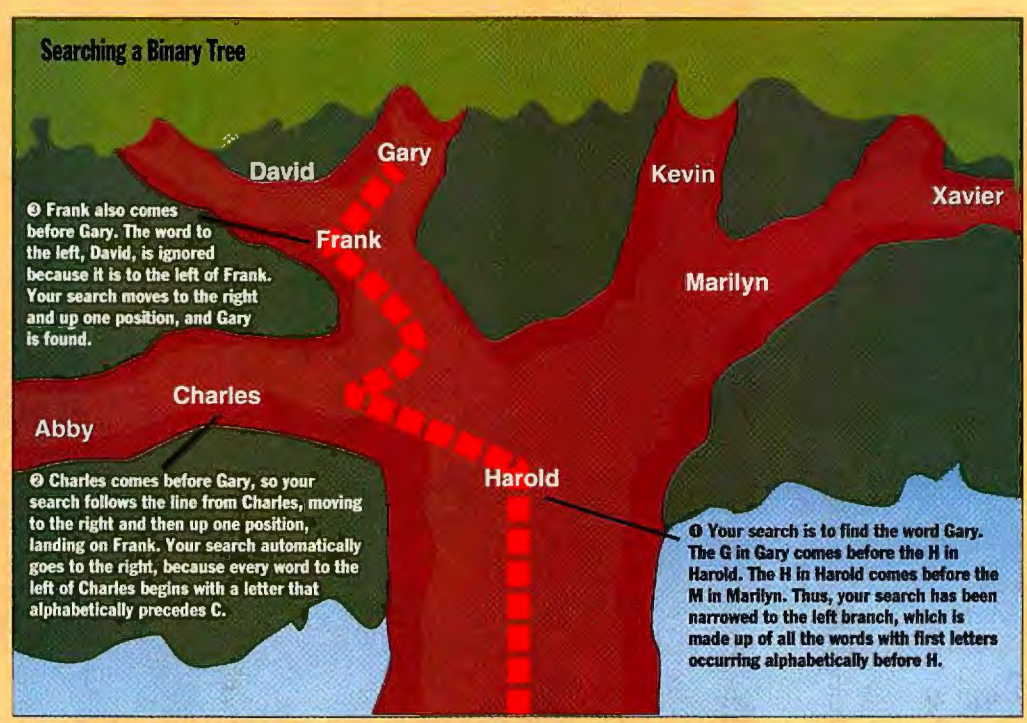


Binary-tree indexes *store words by splitting them alphabetically. A search of a binary-tree index begins looking at the first letter of the first word in the index—in this case,* H. *It then uses a process of elimination to home in on its target.*

PETER WAYNER

The purpose of a search engine in any indexing system is simple: to find every item that matches your query, no matter where it is located in your file system. The trick for the software designer is to create a search engine that carries out this job quickly and accurately while taking up as little disk space as possible.

To accomplish accuracy and conserve disk space, some text-indexing software uses *file-level* information to structure words stored in your index. This means that each indexed word is complemented by a list itemizing all the files in which that word appears at least once. A file-level index does not carry any additional information about the location of words within files. Such an index uses disk space economically, usually taking up about 10 percent of the size of the main text that it indexes.

More sophisticated indexing software uses *word-level* information about the location of every instance of a word. Word-level indexes let you search for complete phrases or words that are in close proximity. ZyIndex from ZyLab (Buffalo Grove, IL) is an example of a word-level index program.

Operationally, there is a vast difference between file- and word-level index searches of a document database. For instance, say you entered a query on President Clinton into a file-level index. Such an index might return the sentence "in 1805, George Clinton was the U.S. vice president." A word-level index, on the other hand, contains the location of each word in your file system, so it avoids such mistakes by ensuring that *President* and *Clinton* are adjacent.

The problem with word-level indexing schemes is that all the extra information they contain gobbles up a lot of disk space—anywhere between 35 percent and 100 percent of the size of the original text. They also can be slower than file-level indexes because they have more information to search through.

Faster Searches

Indexes are really just lists of lists. Lists are a sensible way to store information in alphabetical order. But they are slow for text-indexing purposes, because the average search has to go through about half of your word list before finding the word you want. Enhancements, such as binary-tree index structures, can make list searches faster, especially on rapid-access media such as RAM disks.

Binary-tree structures work by splitting your indexed words alphabetically so that words beginning, say, with the

letters *A* through *L* are on the left-hand side of the tree while those beginning with *M* through *Z* are on the right. If the tree is well balanced, the search time is proportional to the logarithm of the total number of words in the tree—that is, the number of bits in the binary expansion of the total number. When the trees are unbalanced, however, they begin to act like lists, which, in turn, slows down search-response times.

The problem with binary-tree structures is that each word in the index needs to have pointers to find words on its left and right. A list, on the other hand, has to store directions only to the next word—50 percent less overhead. More important, binary-tree structures often store the left and right branches in separate segments of a disk file. This fragmentation slows searches when the data is stored on a slow-access medium such as a CD-ROM. A list, however, can be stored in a linear fashion without pointers, lessening disk-space consumption and increasing speed. Additionally, the next element in a list is almost always in the same disk block as the current element. When these practical considerations are taken into account, lists will often perform substantially faster than a binary-tree structure.

Depending on the medium holding your index, the space you save by storing only the directions to the next word is not always worth the increased speed. CD-ROM searches, for example, are slower than hard disk searches anyway, because a laser takes more time to align with its data track than the head of a hard drive takes to align with its data track. Consequently, your CPU might be able to run through a list of 1000 words in the time it takes to load the data pointed to by the binary tree.

Converting Words

Hashing functions, such as those used in On Technology's (Cambridge, MA) On Location, produce the smallest indexes. Unfortunately, they are also the most error-prone indexing approach.

Hashing functions work by converting words into short integers. For example, a function might convert each letter of a word into numerical equivalents and add these values together: *A* would be equal to 1, *B* would equal 2, and so on, with *Z* equaling 26. Thus, the numerical equivalent of the name *Abby* would hash to 30, because 1+2+2+25=30, and the number 30 would become a surrogate for the four-letter word, taking up less storage.

However, hashing functions can fail when two words have the same hashed value. For example, such functions do not discriminate between anagrams like *Elvis* (5+12+22+9+19=67) and *lives* (12+9+22+5+19=67), because both have the same numeric value. While this confusion can be significantly minimized with hashing functions that are statistically tuned to the structure of English, it is never completely eliminated.

Text-indexing systems such as the public domain WAIS (Wide-Area Information Server) system on the Internet give you the ability to input long phrases for partial, fuzzy matching. With WAIS, you can search for words and rank the matches according to a complex formula of the number of matches and their proximity to each other. These fuzzy-logic solutions can also use, say, the contents of a magazine article as the basis of a query to find other articles in the database with similar contents.

Consequently, you can find documents even if they don't contain the keyword for which you are searching. If you do a fuzzy search on a 100-word phrase, your search can take a great deal of time. Searches of this nature can be prohibitive on some CD-ROM databases, but they are reasonable on databases that are maintained on fast hard drives.

The process of indexing data is a simple problem in theory. While software engineers go through many different iterations to determine the best way to create the smallest, fastest indexes, your best bet is to evaluate indexing software based on the type of storage medium you intend to use and the amount of disk space you can allocate to indexing your data.

Peter Wayner, a BYTE consulting editor, has written several text-indexing systems. You can contact him on BIX c/o "editors" or on the Internet at pcw@access.digex.com or at pwayner@bix.com.

hypertext link? The process of finding and fixing a few resulting dangling links may not be any problem, but repairing hundreds of such connections can become a nightmare.

Systems such as Information Dimensions' (Dublin, OH) BasisPlus document management system can help large publishing environments overcome some of these problems. For example, BasisPlus stores building blocks of information in a relational database and provides features that allow publishers to build documents, including ERDs with hypertext links, from these building blocks.

You may not be able to afford an off-the-shelf solution, which can cost tens of thousands of dollars, but adopting a clear strategy for treating information as building blocks will help. Implementing a formal scheme for classifying those building blocks according to their meaning—a form of conceptual indexing—can help you replace the ad hoc generation of hypertext links that might prove costly whenever changes are made or new documents are created.

What's Needed

At one time, desktop publishing systems were better suited for producing newsletters than they were for producing long documents, because they lacked long-document-handling features. What made the difference with desktop publishing? Vastly improved software, such as PageMaker, QuarkXPress, and Ventura Publisher, helped. But the growing base of experience with the principles of good design and understanding of efficient methods of production helped more.

ERDs have not yet reached that stage of development, because the development and use of electronic documents of all kinds are still in their earliest phase. ERDs are a new delivery mechanism. Consequently, a knowledge base from which you can learn about past mistakes and successes has not yet been assembled. ERD technology awaits the kind of focus and standardization that experience brings to technology. ■

Philip C. Murray, president of Knowledge Management Associates (Virginia Beach, VA), is an ERD consultant. He is the author of From Ventura to Hypertext *(Knowledge Management Associates, 1991) and the editor of ACM SIGLINK's hypertext/hypermedia newsletter. You can contact him on BIX c/o "editors" or on the Internet at p00327@psilink.com.*

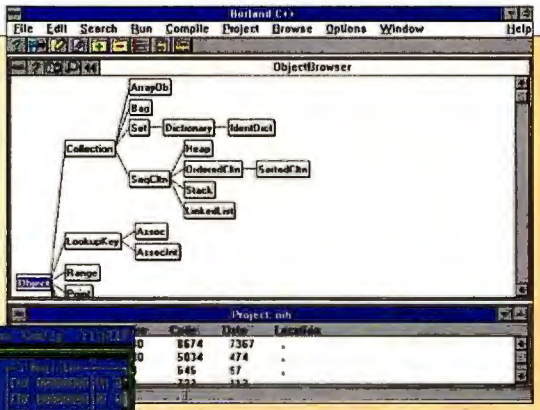
C++ Does Windows

The BYTE Lab tests five C++ compilers to find out if C++ really simplifies Windows development

RICK GREHAN

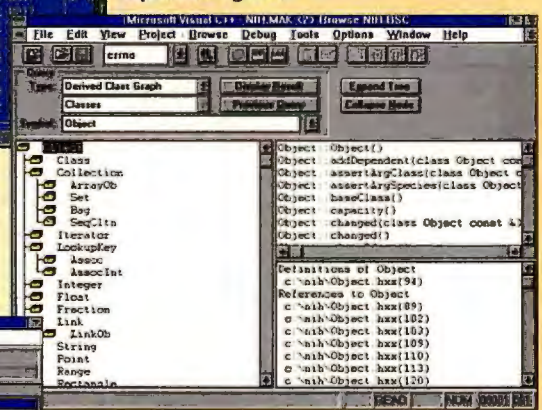
The ultimate benefit of an object-oriented language like C++ depends on how well it can be made to simulate the system in which you're working. Windows is an event-driven system whose respiration is the flow of messages triggered by devices and windows and sent to menus, scroll bars, and suchlike. An object is just a useless lump of code and data until it's wired into that flow. Windows, which is a world of objects and events where procedural development requires back-breaking work, appears to be a perfect target for the object-oriented wonderland that C++ promises.

In this review, I'll cover the latest crop of C++ compilers for Intel's 80x86 series of processors (including the Pentium) and the Windows 3.x operating environment. This harvest includes Microsoft's Visual C/C++ 1.0, Borland C++ 3.1, Symantec C/C++ 6.0, MetaWare's High C/C++ 3.1, and Watcom C/C++32. Each simplifies Windows to some degree, but they mostly fall into two camps: The Microsoft, Borland, and Symantec compilers come with a rich set of tools aimed at easing the burden of Windows programming, while the compilers from MetaWare and Watcom focus more on speed than on comfort.

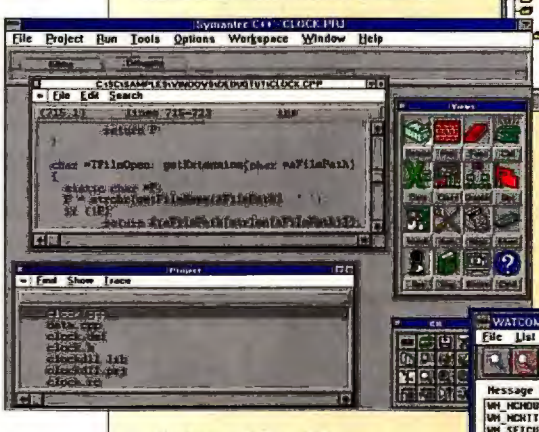


▶ **Borland C++ 3.1's** Windows-based IDE provides an excellent development environment with good tools. Application Frameworks class libraries are Borland C++'s greatest strengths. In this screen, Borland's ObjectBrowser provides a graphical view of class hierarchies within an application.

◀ **MetaWare's High C/C++** is built for speed more than comfort. MetaWare's extended-DOS debugger allows access to 32-bit flat-model executable files running under Phar Lap's DOS extender. Multiple windows allow views of C++ source code, the equivalent assembly language, and processor and coprocessor registers.



▶ **Microsoft's Visual C/C++** provides unique tools and great integration between them. In Microsoft's class browser, not only can you examine class hierarchy, you can also view member functions and locate source code where the class is defined.



◀ **Symantec C/C++ 6.0** is a strong newcomer to the Windows C++ field. Its IDE is built around a workspace paradigm and incorporates tear-off tool palettes. Here, the current workspace is "Editing," but the "Debugging" workspace is instantly available by clicking the folder tab near the topmost menu bar.

▶ **Watcom C/C++32** supports a wide variety of platforms. Although Watcom C/C++32 has no Windows-hosted IDE, the package comes with Windows-based tools. Dr. Watcom is a crash-analysis tool, Watcom Spy lets you examine messages headed for a selected window, and the Heap Walker permits exploration of an application's local or Windows' global heap.

Microsoft's Visual C/C++ 1.0

Microsoft's Visual C/C++ 1.0 will probably be your first stop in the search for a development system. After all, this is the company that makes Windows, and you might reasonably assume that the Microsoft compiler would be the most tightly woven into the Windows environment.

As far as the set of development tools goes, that's truly the case. Visual C/C++'s IDE (Integrated Development Environment), Visual Workbench, is a concert of development tools that includes AppWizard, AppStudio, and ClassWizard. AppWizard is the jump-starter in program

development. With it, you can quickly create a skeleton of classes and associated source code filenames for your application. You can then move on to the other tools to fill those files with actual code.

AppStudio is Visual C/C++'s resource toolkit, where you build user-interface objects (e.g., dialog boxes and menus). It is tightly coupled to ClassWizard, where you bind executable code to those interface objects.

All these tools work together on a single project. Visual C/C++ works directly with make files that can be built within the IDE or externally by Microsoft's NMAKE. The process of building user-interface objects and binding them to code goes something like this: You select a class in ClassWizard, and you're shown the object IDs of objects built in AppStudio. You click on an object, and a listbox shows messages to which the object can respond. Select the message, click on the Add Function button, and enter a function name in another listbox. ClassWizard automatically adds the function declaration to the class, writes an empty function header in the source file where the class is defined, and ushers you quickly to the editor, where you fill out the function body.

The Microsoft Foundation Classes 2.0 are the behind-the-scenes wiring that make this work. Within MFC, you'll find class definitions for all Windows objects. More important, MFC also provides the connections necessary to enable the event handling that's at the heart of every Windows program. MFC's fundamental component is the message map. This is a data structure that holds the routing information of messages to class member functions. In MFC's base classes, many of these member functions simply call Windows API functions directly.

As you build derived classes, you can define your own message-handling member functions that override those of the base class. Using macros that Microsoft supplies, you build a message map for this derived class, linking the functions to the message IDs. A specific member function of MFC's base class, `CWinApp`, gets all messages sent by Windows to the current application. This function routes the message to its target object. When a Window object defined by MFC receives a message, it searches its own class definition's message map for a function to handle that message. If that function can't be found, a special entry in the local message map points to the message-map table of the parent class.

MFC follows this link up the chain to the parent class and searches the parent's message map. This process continues until MFC either encounters a map entry corresponding to a handler function that can deal with the message or "pops out the top" of the class hierarchy. In the latter case, the message is passed to the equivalent of the default message-handler procedure.

AppStudio and ClassWizard together form a simple environment for quickly building complex applications, and MFC 2.0 makes a solid foundation for professional-level applications. One significant addition to Visual C/C++ is a Windows-hosted debugger. (Visual C/C++ also includes CodeView.

At $495, the Visual C/C++ Professional Edition falls somewhere in the middle of the price range. Counting all the supporting tools—there are so many it's sometimes hard to find the compiler among all the icons—the price is quite good. Programmers interested in a less expensive route into Windows programming might want to look at the Standard Edition, a $195 product that lacks CodeView, a profiler, and DOS target compilation.

Borland C++ 3.1

Borland C++ 3.1 comes with two IDEs: one for DOS and one for Windows. The DOS-based IDE can generate Windows and DOS applications; the IDE for Windows produces either Windows executable files or DLLs. Both of these IDEs allow rapid development of application projects; you add files to a project by selecting them from file lists, and the IDE handles the chore of chasing down dependencies for you. You can convert a project into a make file.

Although Borland's C++ environment doesn't include an equivalent to Microsoft's AppWizard and ClassWizard, it comes with plenty of Windows tools, including Borland's Resource Workshop, help compiler, and resource compiler. Borland C++ also has a free copy of ProtoView Development's ProtoGen, a reasonably useful code generator that lets you rapidly build menus and link their components to dialog boxes. ProtoGen will crank out the corresponding user-interface code for you.

Borland C++ includes class libraries for both DOS and Windows: TurboVision and Object Windows Library. TurboVision can build DOS applications under a character-based windowing system, while OWL targets the Windows environment. Unfortunately—and this is a major gap—the two class libraries are completely incompatible.

Although the ultimate goals of OWL and MFC are quite similar, OWL builds a thicker layer between the programmer and the Windows API than does MFC. By thicker, I don't mean less efficient—in fact, OWL does a better job of abstracting Windows objects than MFC does. You can generally construct OWL programs in less source code than MFC equivalents. OWL achieves this goal thanks to Borland's modifying its compiler to accept new (and nonstandard) syntax that expresses the connection between a function within an object and the Windows message to which that function responds in a single line of code. MFC, on the other hand, requires two or three lines to express the same connection.

This nonstandard syntax gives OWL another advantage over MFC, in that the documented coupling of message ID to function is recorded in one place. MFC forces you to declare message-handling functions in one place and associations elsewhere.

Internally, OWL operates much like MFC: The compiler builds tables in the executable file that link the message ID to a function address. Because OWL is built into Borland's C++, it has access to the language's internal pointers that link derived classes to parent classes and thus doesn't need MFC's additional links further up in the class hierarchy. Dispatching Windows messages is potentially faster under OWL than under MFC, because OWL uses optimized assembly language for table searching, while MFC must search using C++ code.

However, Borland may be willing to sacrifice OWL's conciseness for portability's sake. The upcoming OWL 2.0 abandons the language extensions of OWL 1.0 and takes a strict C++ approach, with the addition of (among other things) support for templates and true C++ exception handling.

OWL is an outstanding class library. In a direct comparison of Borland C++ 3.1 to Microsoft's Visual C/C++, however, Borland C++ suffers primarily from its lack of an equivalent to ClassWizard. Additionally, at $749, the price is somewhat steep. But where Borland has equivalent tools, they are excellent. The real strengths of Borland C++ are OWL, an excellent IDE, and accompanying DOS and Windows development tools that make for a kingly development system.

continued

C++ COMPILERS COMPARED

Naturally, compilers vary in the types of tools they supply. However, these packages also vary in the nature of the code they produce. Executable files built by High C/C++ 3.1 and Watcom C/C++32 include pure 32-bit code: Consequently, the DOS executable files run under DOS extenders, and the Windows 3.x executable files must be bound with a supervisor that translates from the 32-bit code to the 16-bit API of Windows. (Symantec C/C++ 6.0 can also produce 32-bit code running under a DOS extender). Borland C++ 3.1 and Visual C/C++ can create DOS executable files that exceed the 640-KB boundary via an overlay mechanism. Finally, Microsoft's compiler optionally emits p-code that can optimize space savings. (● = yes, ○ = no; N/A = not applicable.)

	MICROSOFT VISUAL C/C++	BORLAND C++ 3.1	WATCOM C/C++32	METAWARE HIGH C/C++ 3.1	SYMANTEC C/C++ 6.0
Host platforms					
Windows 3.1	●	●	○	○	●
DOS	●	●	●	●[2]	●
OS/2[1]	○	○	●	○	○
Target platforms					
Windows 3.1	●	●	●	●	●
DOS	●	●	○	○	●
Extended DOS	○	○	●	●	●
OS/2	○	○	●	○	○
Other	Overlaid DOS, p-code	Overlaid DOS	.NLM, Pen Windows, NT	N/A	Win32s, NT
Processor support					
808x	●	●	○	○	●
386/486	●	●	●	●	●
Pentium[3]	○	○	●	●	○
Language support					
Cfront 3.0	●	●	●	●	●
ANSI C	●	●	●	●	●
Unix C (K&R)	○[4]	●	○	○	●
Included tools					
Assembler	○	●	○	○	○[5]
Symbolic debugger	●	●	●	●	●
Remote debugging	○	●	●	●	●
Profiler	●	●	●	●	○
Run-time source	Option	●	○	Option	●
Class library source	●	●	○	Option	●
Precompiled headers	●	●	○	○	●
Class browser	●	●	○	○	●
Memory[6]	6 MB	2 MB	4 MB	2.5 MB[7]	8 MB
Disk space[6]	52 MB	45 MB	25 MB	15 MB[7]	50 MB
IDEs	Windows	Windows, DOS	N/A	N/A	Windows
Debugger environments	Windows, DOS	Windows, DOS	DOS	Windows, Extended DOS	Windows, DOS[8]
Windows specific Class libraries	MFC	OWL	None	None	MFC
Utilities					
Heap walker	●	●	●	○	○
Message spy	●	●	●	○	●
Crash analysis	●	●	●	○	●
Resource builder	●	●	○	○	●
Help compiler	●	●	●	○	●
Price	Professional: $495 Standard: $195	With Frameworks, $795 No Frameworks, $495	32-bit: $599 16-bit: $495	$795[9]	Professional: $499 Standard: $129

Notes:

[1] Many vendors support OS/2 with other compiler products.
[2] High C/C++ produces DOS programs that require Phar Lap's 386|DOS-Extender package, an additional $495 cost.
[3] The entry in this field indicates whether the compiler produces code structured for Pentium execution.
[4] No strict Kernighan and Ritchie support, but it will support K&R function headers.
[5] Although Symantec C/C++ does not include a separate assembler, it has a full-featured in-line assembler.
[6] Memory and disk requirements are approximate.
[7] Windows development requires Microsoft's Windows SDK, which brings the total disk requirement to 24 MB.
[8] Symantec C/C++ lets you debug DOS applications from within Windows.
[9] Price does not include Phar Lap's DOS extender. A DOS extender/compiler package is available for $995.

Symantec C/C++ 6.0

As this article headed for press, Symantec was deep into the final stages of its new Windows-based C++ compiler. I worked with a late beta version of the package that should match the functionality of the final product. Symantec expects to release version 6.0 in August, so it should be available as you read this.

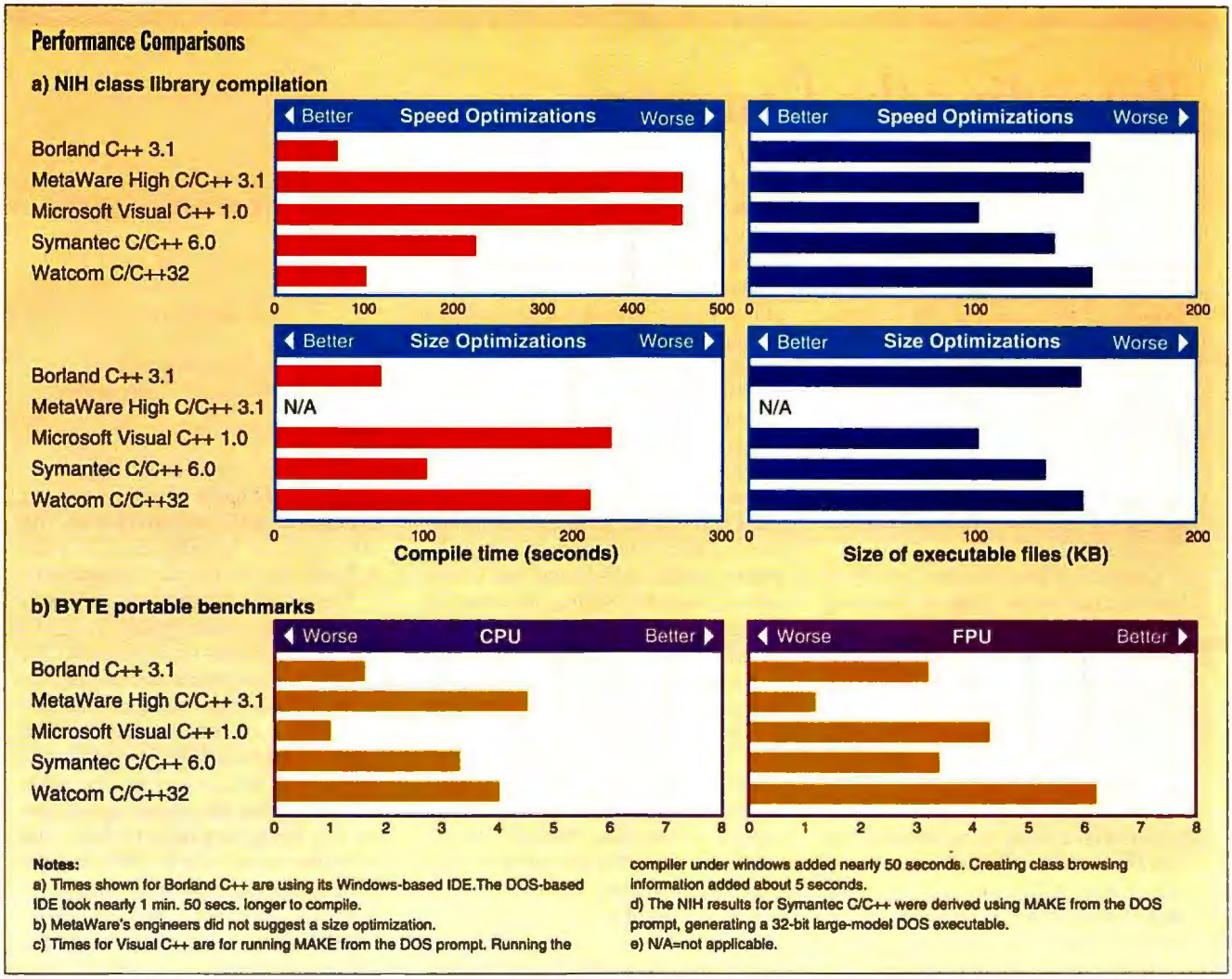
This product is a vastly updated version of Zortech C++. It's so heavily rewritten that the only similarity might be that both are C++ compilers. The Symantec compiler is also escorted by so many tools that it rivals Visual C/C++ in ancillary support. And unlike Zortech C++, Symantec C/C++ provides a solid class library—a licensed version of MFC 2.0—to provide a framework for Windows development.

Symantec C/C++ takes its Windows-based IDE to new heights, breaking from the usual MDI (Multiple Document Interface) approach and instead creating an environment of loosely coupled windows and toolbars organized within workspaces. Each workspace (you can have several active simultaneously) offers you a particular view into a project (e.g., one workspace may be where you do your compiling and editing; another may have all your debugging tools active).

Symantec's IDE incorporates tear-off tool palettes that you can position and resize to customize your workspace. Icons within these palettes operate on a drag-and-drop paradigm. For example, you can grab the source tool icon, drag it out of the palette, and drop it on the desktop. An empty edit window opens. Go into the file list within your project view window, grab a filename, and drag it into the new edit window. The file's source code appears, ready for work.

The Visual Programmer is Symantec's answer to ClassWizard. Many of the functions that you would find in a resource editor are here. You can create dialog boxes and menus from within the Visual Programmer. The real strength of the Visual Programmer, however, is its ability to rapidly associate Windows controls with messages and to define actions for events. For example, your program may respond to an OK button by launching the Windows Edit program. In the Visual Programmer, you can quickly build all the code needed to accomplish this by mousing through dialog boxes. (The only typing you have to do is to enter Edit's path.)

Symantec's debugger is also well developed. You can examine changing data structures, as you can in most debuggers'



Compiler benchmark results. (a) *These tests involve the compilation of nearly 98,000 lines of source code based on the National Institutes of Health class library. The intent is to measure compilation speed, as well as the size of the generated executable file. Compilation was performed twice, once optimizing for speed and then for size. All compilers were required to emit 32-bit code. Headers were not precompiled.*
(b) *This benchmark uses the CPU and FPU portions of BYTE's portable benchmarks. As above, all compilers were required to generate 32-bit code. All compilers were set so that they emitted floating-point code that searched the machine for a coprocessor and used that coprocessor for floating-point-intensive operations. The results for each test were normalized to the lowest score of all compilers for that test. These results were then combined using a nonweighted average to generate a CPU index and an FPU index for each compiler.*

watch windows; however, Symantec's debugger also lets you explore those structures graphically. Suppose your program builds a binary tree in memory. Symantec's debugger will show that structure as a block diagram with boxes and arrows. As you single-step through your program, the displayed structure will be automatically updated to reflect the goings-on in RAM.

All in all, Symantec's C/C++ compiler is an enticing entry. A full-blown system costs $499, but entry-level developers can get started with the more reasonably priced $129 version. Although the latter's compiler is not an optimizing compiler and doesn't produce 32-bit code, it still provides a full Windows 3.x development and debugging environment, as well as the Visual Programmer.

MetaWare's High C/C++ 3.1

MetaWare's High C/C++ package is the most Spartan of all the products reviewed here. You'll find no heap walkers or message spy programs. It's just a C++ compiler that produces 32-bit code compatible with either Phar Lap's DOS extender or Windows 3.x, a 32-bit debugger for extended DOS or Windows applications, and a handful of Unix-like DOS command-line tools (e.g., `cat`, `ls`, and `fgrep`).

Because High C/C++ emits only 32-bit code that uses the flat addressing model, creating a Windows application involves binding resources and protected-mode executable files with a Windows extender supplied as part of MetaWare's Windows ADK (application development kit). This supervisor acts as an intermediary between your 32-bit flat-memory-model MetaWare application and the 16-bit segment/offset Windows environment.

Wherever a call to a Windows routine appears in your application's source code, the High C/C++ compiler aims that call at a function in the supervisor. The supervisor function makes any adjustments to arguments, switches to 16-bit mode, and calls the corresponding Windows routine. Because callback functions require that Windows be able to call functions in your application, the supervisor must also perform translation in the other direction:

Extending the Language

At the time of this writing, the ANSI C++ committee was at work producing a standard description of C++ that is often referred to as C++ 3.0. C++ 3.0 includes all the features of Cfront 3.0, a version of C++ from AT&T implemented as a preprocessor.

Cfront 3.0 includes two new syntactic elements: templates and nested classes. All the compilers reviewed here support both. Exception handling, a third new C++ construct, is part of the ANSI specification but not part of Cfront 3.0.

Class templates let you specify a kind of class recipe. That is, you spell out how the class works—its member variable names, member function names, and how the member functions operate—but you leave out type-specification details. Those are filled in only when you instantiate a class built from the template.

For example, suppose you've built a class that defines array objects that sort themselves. Without templates, if you want to define such a class for arrays of integers, longs, and floats, you'd have to type in (and maintain) three class definitions. With templates, you type in the class definition once, leaving a placeholder wherever a type specifier would have appeared in the definition. When you define an object of such a class, you specify not only the class name, but also the type specifier to be filled into the placeholders you wrote into the template.

Cfront 3.0 also extends the idea of templates to functions. Continuing with the example, function templates would allow you to write a single function template for sorting an array of any numeric type.

A nested class is a class defined within another class. The enclosed class has scope only within the enclosing class. Nesting can provide relief from name-space pollution. Since a nested class is invisible outside its enclosing class, it won't clutter your program by adding another global name you'll have to keep track of. Nesting provides yet another dimension in the factoring of objects into their component parts.

Finally, the latest addition to the C++ language syntax is the `catch-throw` exception-handling construct. A class that supports exception handling includes exception class names as public members. A member function that can trigger an exception "throws" the exception to one of the exception classes. The exception class "catches" the exception as part of a `try...catch` structure.

For example, assume you've defined an `Array` class. `Array` includes the exception-handling class `RangeError`. Additionally, you've overridden `Array`'s subscript operator ([]) so that any out-of-bounds references will throw an exception to a function that is designated as the `RangeError` handler. Examine the following code:

```
Array av(100);
try {
      read_array(av);
}
catch (Array::RangeError) {
// Handle array range error
}
```

Should an out-of-bounds error occur anywhere inside `read_array`, an exception will be thrown to the `RangeError` handler (i.e., the code defined after the `catch()` statement).

The beauty of exception handling is that no matter where inside `read_array()` the exception is triggered, no matter how deep the stack nesting, the stack will be unwound so that the `RangeError` code executes at the proper stack level. Most important, unlike a `setjmp...longjmp` structure, C++ unleashes the proper destructors on any temporary objects that come from the stack as it is unwound. In essence, dealing with an exception won't leave bits and pieces of incompletely initialized objects lying around taking up memory.

Of the compilers reviewed here, only Watcom supported C++ exception handling, even though the other vendors promised such support in upcoming releases. Borland expects exception handling to play a major role in the next release of Object Windows Library.

from Windows to 32-bit mode.

High C/C++ can also build a 32-bit DLL. In this case, you must bind into your code a special DLL supervisor whose job is similar to the supervisor described above.

At the time of this review, MetaWare's High C/C++ was one of only two C++ compilers that could emit code optimized for the Pentium. Other compilers should follow suit shortly.

High C/C++ is definitely a compiler for the high-octane, 32-bit programming crowd. It turned in the best performance results for CPU-intensive operations. However, its $795 price certainly won't break any price barriers, and that price doesn't include the Phar Lap DOS extender that you'll need to create extended-DOS applications.

Watcom C/C++32

Watcom C/C++32 is a compiler that emits code for more operating systems than most developers will ever target. At the top of the list of supported systems are extended DOS—Watcom C/C++32 can produce code for Rational Systems, Ergo Computing, and Phar Lap DOS extenders —and Windows, where Watcom C/C++32 can generate Windows 3.x and Win32s code.

You perform all compilation from the DOS prompt. Also, because the output of the compiler expects to execute in a 32-bit flat address space (referred to as a linear executable file), you must bind your application and resources to a supplied Windows extender. The company does produce a 16-bit version of C/C++ that can create 16-bit Windows 3.x applications directly.

You won't find an IDE in Watcom's package, although the software does come with some useful tools. Watcom's capable debugger, Video, is at home in as many

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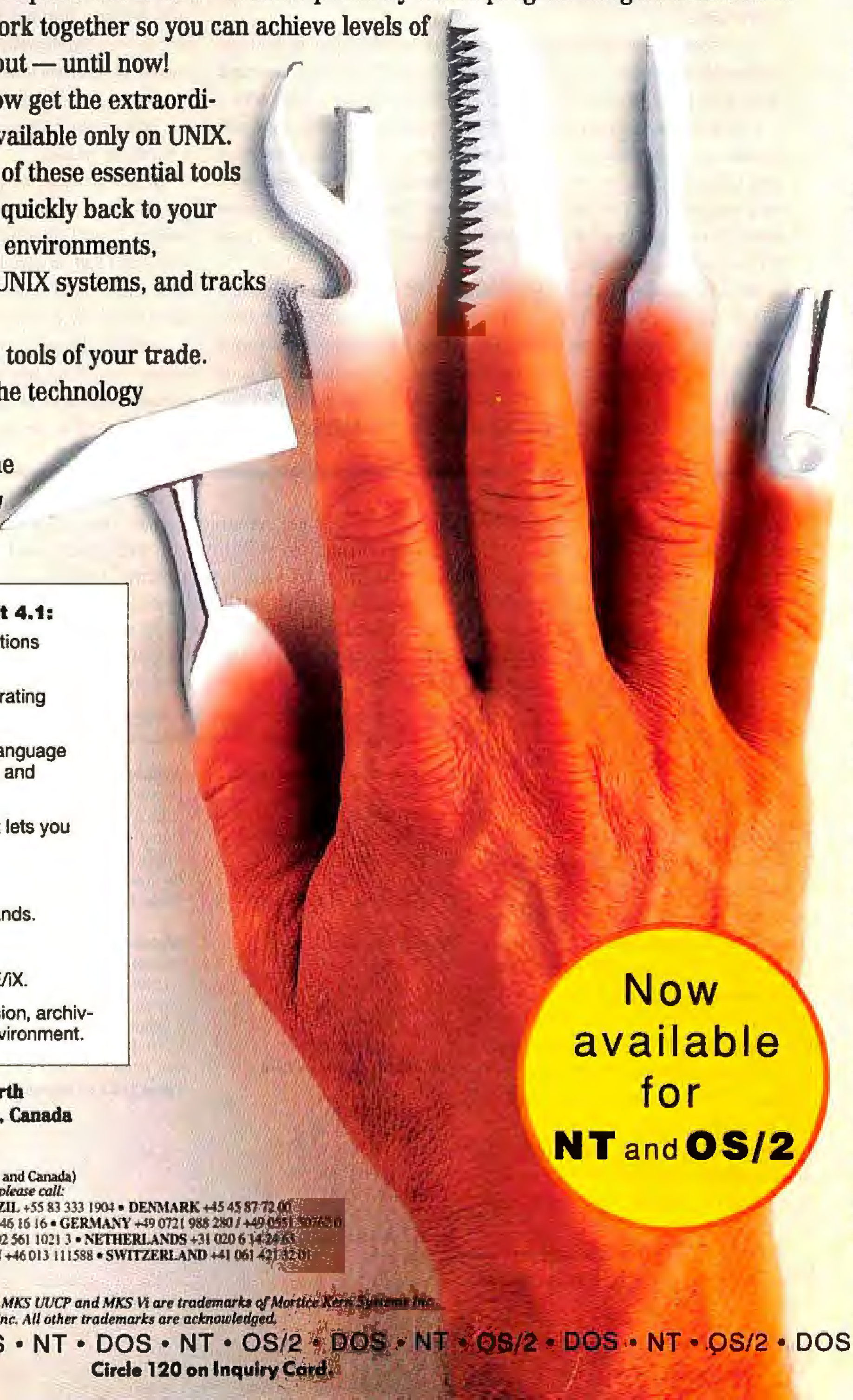

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PERFORMANCE TESTS

I passed all products through two waves of tests. The first wave was designed to measure each product's compilation time and the resulting size of the executable files. For these tests, I used a subset of the public domain National Institutes of Health (NIH) C++ class libraries tacked onto a couple hundred lines of exercising code. All told, building this project required the compilers to chew through nearly 98,000 lines of source code.

The second wave was designed to measure the efficiency of the code the compilers generated. These tests were strictly C code and consisted of the CPU and FPU portions of BYTE's portable systems benchmarks.

In both waves, I ran the compilers through the wringer twice: once with compile and link switches set to generate the fastest code, and once with those switches set to generate the smallest code. Consequently, each compiler ran the gauntlet at least four times. (Some took more trips. For example, I performed an additional set of tests to explore Visual C/C++'s p-code generation.)

All compilers were required to generate 32-bit code. The performance tests were run under DOS, so that none of the overhead of Windows would corrupt the execution times. Three of the packages—MetaWare's High C/C++, Watcom C/C++32, and Symantec C/C++—produced code that ran in conjunction with a DOS extender. In the case of High C/C++, I used version 5.0 of Phar Lap's 386|DOS-Extender. For Watcom C/C++32, I used the bundled run-time version of Rational Systems' DOS/4GW. Zortech's DOS extender (DOSX) was also bundled with the compiler.

The results of the tests are shown in the figure on page 133. In the NIH-class tests, all compilers generated code in the range of 100 to 150 KB. Three of the compilers—Visual C/C++, Symantec C/C++, and Watcom C/C++32—turned in compilation times that were startlingly close to one another. Borland turned in the best compilation time, and High C/C++ was significantly slower than the others. Interestingly, Borland's fastest compilation time was from its Windows-hosted IDE (Integrated Development Environment); Microsoft's fastest compilation time was from the DOS command line. Note that High C/C++ has no compile options for optimizing for size.

BYTE's portable benchmarks for CPU and FPU formed the basis of performance tests. It's obvious from the results that those compilers using a 32-bit DOS extender (High C/C++, Symantec C/C++, and Watcom C/C++32) had an easier time of things in the CPU tests than did Borland C++ and Visual C/C++, which had to deal with the segment/offset overhead of the huge memory model.

In the FPU tests, all compilers generated emulation code that used a coprocessor if one was present (one was in our test system). MetaWare's compiler appeared to have the hardest time with the FPU test, with Watcom C/C++32 at the top.

operating-system platforms as is the compiler.

Watcom's offering fits in a niche somewhere between MetaWare's High C/C++ and Microsoft's Visual C/C++. Still, Watcom's compiler has a different kind of plenitude: the vast number of supported platforms. This support exacts a high toll: $995 for the 32-bit version, and $599 for the 16-bit version.

Plus-Pluses and Minuses

The C++ compilers covered here partition themselves into two categories: Those operating primarily from the command line (High C/C++ and Watcom C/C++32), and those providing GUI-based development environments (Borland C++, Visual C/C++, and Symantec C/C++). In addition, Borland C++, Visual C/C++, and Symantec C/C++ make available class libraries designed specifically for Windows development, while the others are satisfied to provide access to the Windows API.

Neither OWL nor MFC holds a clear advantage. Both at least hold a source code advantage over the strict C approach to Windows programming and its miles of switch statements. On the execution side, neither is an improvement over tradition, because they add a layer of decision making that messages must navigate. OWL is more concise; MFC does not require extensions to the language.

For sheer executable performance, High C/C++ and Watcom C/C++32 are probably the best choices. Watcom C/C++32 is a likely choice for programmers whose target environments are in flux, given the range of target platforms Watcom supports.

But programming for Windows is about more than all-out performance. If you are looking for a development environment that will truly simplify Windows programming, choose between Borland C++ 3.1, Visual C/C++ 1.0, and Symantec C/C++ 6.0. My choice is Symantec C/C++. With its full complement of excellent tools and good performance, it strikes the proper balance between a high-performance compiler and a full-featured, Windows-hosted development environment. ■

Rick Grehan is technical director of the BYTE Lab. Before coming to BYTE, he worked as a professional programmer. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. You can reach him on BIX as "rick_g."

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fax: (408) 429-9273
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Microsoft Corp.
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Symantec Corp.
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Watcom International Corp.
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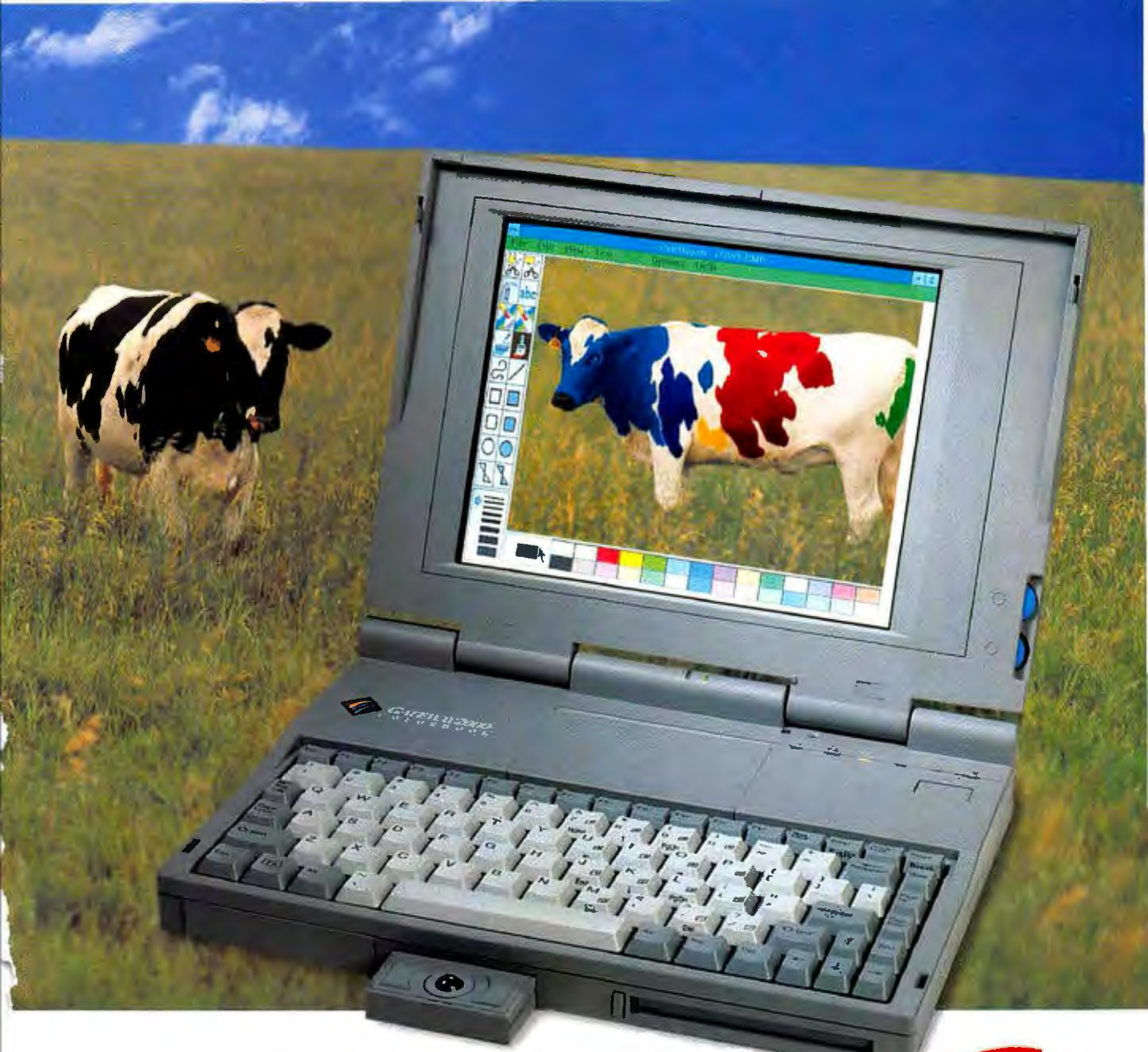

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486 Power

You don't have to sacrifice performance to have color, either. ColorBook models are based on Intel® 486 processors. Both ColorBook models include a floppy drive, 4MB or 8MB of RAM (upgradeable to 20MB), and a large, fast hard drive. These notebooks are powerful enough to become your only computer!

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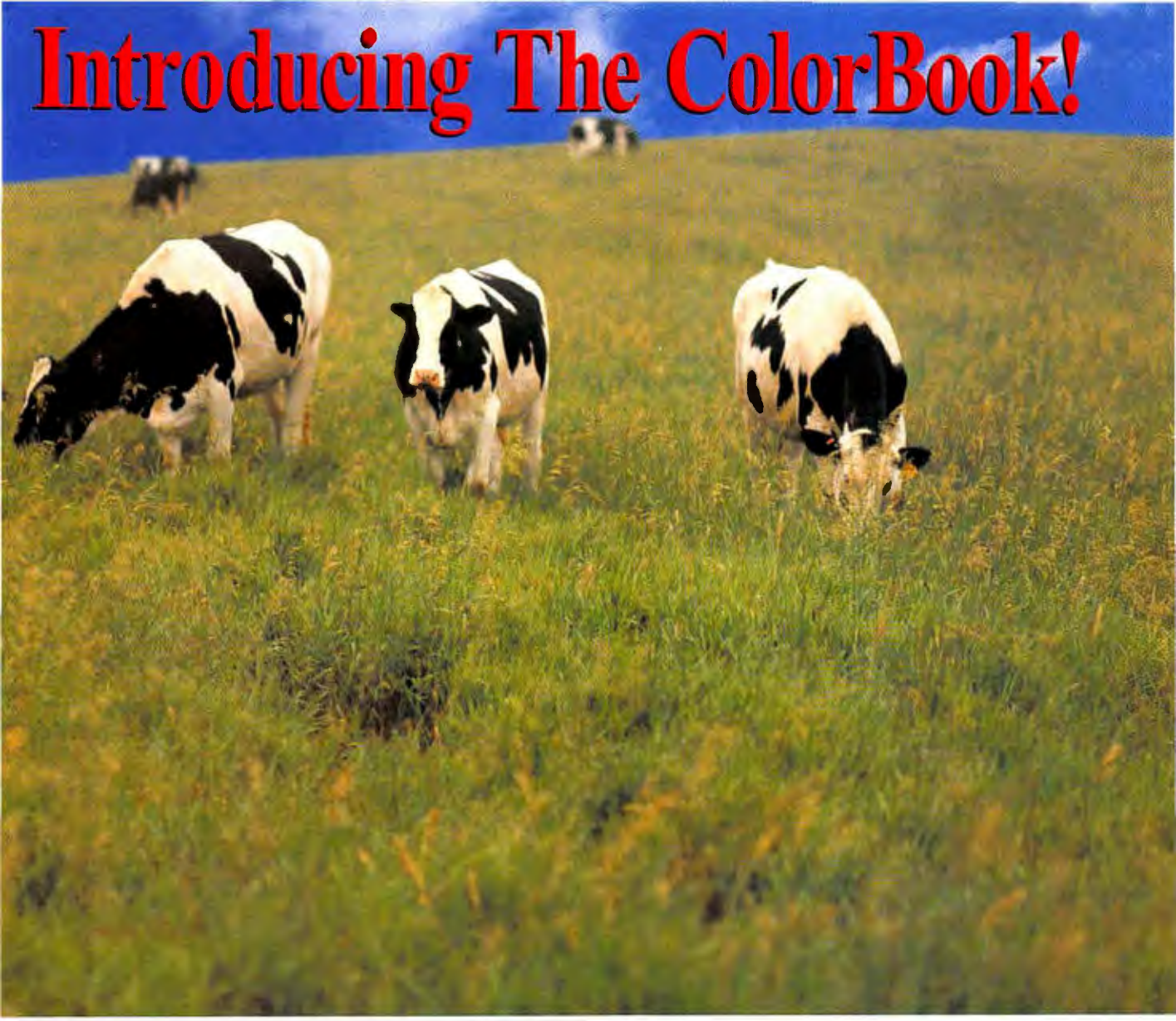

For the same money, you can have a black-and-white 486 notebook. Or you can have a color 486 notebook. Which is it going to be? Hay, it's not too hard to spot the best deal: the ColorBook from Gateway 2000! The new ColorBook has everything you're looking for in a portable at a price you'd expect to pay for a monochrome system. That's a special breed!

Exploding The Myth

Why do you expect to pay so much more for a color portable? Because other manufacturers always charge a plump premium for color. They've been milking the market, brainwashing you into thinking high-quality color costs a lot more to manufacture. It doesn't! We're selling the ColorBook for our usual cost-plus-small-margin. Now other companies will have a hard time perpetuating the color portable price myth. (Competitors absolutely *hate* us! Isn't it great?)

Experts' Reaction

We gave several PC trade publication editors a sneak preview of the ColorBook. Here's what they said about it: "Way cool!" "Dead on." "You won't be able to make enough of these."

Dazzling Color Display

The editors were impressed by the bright, crisp color graphics from the latest-technology, dual-scan STN display. It's a 9.4-inch VGA LCD, backlit for use in any lighting conditions. The editors said the ColorBook has the best STN color display they had ever seen! When they learned one model was priced *less than $2,000*, they were convinced the ColorBook will cause a stampede in the industry.

No Compromise On Size

Adding color to a portable usually means adding weight and bulk. Not so with the Gateway 2000 ColorBook. The ColorBook is the thinnest color notebook on the market — 1.77

Introducing The ColorBook!

The ColorBook is the thinnest color notebook on the market — 1.77 inches. Its footprint measures only 11.7 x 8.5 inches, and it weighs just 5.4 pounds.

You'll appreciate the convenience of using PCMCIA cards. They're as easy to carry as credit cards, and they plug right into your ColorBook.

The integrated track ball slides out from a compartment by the space bar on the keyboard. You simply pull it out and go to work. Finished? Just slide the track ball back into the ColorBook.

FEATURES

Size

With the ColorBook, you get great color at a great price while maintaining excellent portability.

Intel® 486 Processor

ColorBook notebooks are based on Intel 486 microprocessors, which makes them powerful enough to serve as your desktop PC with an external mouse, keyboard and monitor. Supports simultaneous video, up to 1024 x 768 resolution.

Dual-Scan STN Color Display

Dual-scan STN color is the latest technology in portable color displays, and it looks fabulous! You get 256 colors with the ColorBook running in VGA mode (640 x 480 resolution).

PCMCIA Type II Slots

Add a modem, network card or any of dozens of available PCMCIA-compatible peripherals. The ColorBook's two Type II slots can also be used for one Type III PCMCIA card.

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- 9.4" Backlit VGA Dual-Scan STN Color Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II Slots
- Integrated Track Ball (2 Buttons)
- 85-Key Keyboard
- Parallel, Serial & PS/2 Mouse Ports
- External CRT Port
- MS-DOS® and Windows™

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- 170MB IDE Hard Drive
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The Littlest Notebooks

Next-generation subnotebooks from CompUSA, Hewlett-Packard, and Zenith maximize portability—with one or two compromises

STEVE APIKI

Sometimes, innovations in technology really do have a direct impact on day-to-day life. Personal systems like Apple's Newton remain on the horizon, but technologies like PCMCIA 2.0, 3.3-V processors, and 2½-inch disk drives are driving portable system design today—and the results are practical Windows machines that are genuinely portable.

The CompUSA 4SL/25 Subnote, Hewlett-Packard OmniBook 300, and Zenith Data Systems Z-Lite 320L represent this next generation of ultra portable, high-power subnotebooks. All three are smaller than a three-ring binder, less than 1.6 inches thick, and under 4 pounds. Yet each has at least the performance of a 20-MHz 386, as well as the high-resolution screens and pointing devices necessary to run GUI applications designed for the desktop.

In addition to running the usual complement of BYTE Lab tests, I took each of these machines on the road. All are capable travelers, but they have different strengths: The Subnote is the most powerful, the OmniBook is the most portable, and the Z-Lite has the best screen. But a week on the road also exposed some significant compromises, like the Subnote's unworkable trackball, the Z-Lite's frustratingly small keyboard, and the OmniBook's reliance on PCMCIA and other technologies that are still developing.

New subnotebooks *from ZDS, CompUSA, and HP (left to right). HP easily captures the title of "most portable," weighing in at just under 3 pounds and with a profile smaller than that of most three-ring binders. However, CompUSA's Subnote packs quite a bit more processing power, and both the Subnote and ZDS's Z-Lite make fewer compromises for portability.*

The Cutting Edge

All three subnotebooks owe their combination of small size and high performance to a collection of state-of-the-art technologies. Among these, the most significant are PCMCIA 2.0, 3.3-V processor systems, and high-capacity 2½-inch hard drives. But with the exception of 2½-inch drives, where reliable 80-MB devices are no longer hard to find, these technologies have a few limitations.

Using PCMCIA devices with any of these machines is not a plug-and-play operation. I tested each with a Xircom CE-10BT CreditCard Ethernet adapter. I couldn't get the OmniBook to recognize the Xircom card at all, and HP was unable to offer a solution. As of this writing, HP doesn't officially support the CE-10BT, or any other network adapter. ZDS's and CompUSA's machines worked with the card, but both took some tweaking of drivers that wasn't always obvious.

Drivers for PCMCIA I/O cards are supposed to hook in through an interface called PCMCIA Socket Services, which should make every driver work on every PCMCIA-capable machine. But Socket Services is a new specification, and not all machines support it, or support it properly. So I/O card drivers often support PCMCIA controller hardware directly; the most common controller is Intel's 82365 PCIC.

Of these three, the Subnote and the OmniBook support Socket Services. The Z-Lite does not. The Z-Lite and the Subnote use the 82365 as a peripheral controller, but the OmniBook has an HP proprietary controller. So except for the Subnote, you have only one out of two chances at eventually getting third-party cards to work. But you're still only completely safe with PCMCIA I/O peripherals supplied by the system manufacturer.

These subnotebooks provide 3.3-V processors; the Subnote includes an Intel 486SL, the Z-Lite runs on a 3.3-V Intel 386SL, and the OmniBook runs on AMD's equivalent 386 part. Low-voltage parts mean a great deal in terms of power savings (and weight savings, if you consider battery size), since power varies with the square of the voltage. But full 3.3-V peripheral support is not completely in place

SUBNOTEBOOKS: A COMPARISON OF FEATURES

	COMPUSA 4SL/25 SUBNOTE	HP OMNIBOOK 300	ZDS Z-LITE 320L
CPU	25-MHz 486SL	20-MHz 386SXLV	20-MHz 3.3-V 386SL
RAM	4 MB	2 MB	4 MB
Storage	80-MB internal IDE	10-MB flash disk	60-MB internal IDE
Video	64-gray-scale backlit LCD	16-gray-scale reflective LCD	64-gray-scale backlit LCD
Display size (inches)	7.5	9	8.5
Resolution (pixels)	640 × 480	640 × 480	640 × 480; 800 × 600
Size (H x W x D; inches)	1.57 × 10 × 7.1	1.4 × 11.1 × 6.4	1.5 × 9.9 × 7.6
Weight (lb.)	3.9	2.9	3.9
Expansion	PCMCIA 2.0 slot; internal modem (option); external 3½-inch floppy drive	Four PCMCIA 2.0 slots; internal modem (option)	Two PCMCIA 2.0 slots; external 3½-inch floppy drive
Price	$1999	$2375	$1799

yet. The OmniBook is almost entirely a 3.3-V machine; CPU, memory, video memory, and the main system controller all run at 3.3 V. However, the Subnote runs only CPU and RAM at 3.3 V, and the Z-Lite's only 3.3-V component is the 386SL processor.

CompUSA 4SL/25 Subnote

The Subnote is a high-powered machine manufactured for CompUSA by Taiwan-based Twinhead. Of the three reviewed systems, the Subnote is the only one built around a 486-class processor, and the only one with an FPU. Although not as radical in innovation as the others, the Subnote is a solid performer, easily portable, and inexpensive—a 4-MB RAM, 80-MB hard drive model costs just $1999.

Not surprisingly, the 25-MHz Subnote was the fastest machine of the group. But although strict CPU tests like BYTE's DOS CPU benchmark rated the Subnote as nearly twice as fast as the second-place Z-Lite, the overall system was not that much faster than the Z-Lite running real Windows applications.

The Subnote is reasonably miserly with power. Battery-life tests placed the Subnote's running time at just under 5 hours on a full charge. Intel's 3.3-V 486SL lets the machine support the usual complement of CPU power management functions, including standby mode.

I had a little trouble getting the contrast setting to "stick" where I wanted it for Windows—the "hard" power switch resets the contrast. Once the level was set properly, the display looked great. The screen is tiny—at 7½ inches, it's at least an inch smaller on the diagonal than the other machines' LCDs—but it's bright and easy to read at 640 by 480 pixels.

The keyboard, though not as pleasantly laid out as the OmniBook's, makes touch typing easy. However, the trackball is horrible; either my fingers are too long or the buttons aren't far enough away from the ball.

The Subnote is nice and portable. It's thicker than the rest, but squarer, and it carries easily. You'll need to carry both the external floppy drive and the AC adapter when traveling. Both are small: The charger measures 1.8 by 4.4 by 2.5 inches, and the external floppy drive is only slightly larger and heavier than a 3½-inch floppy disk.

The Subnote has a single PCMCIA slot. I got the Xircom Ethernet adapter to work with little trouble.

I had only one negative experience. After a few weeks, the 80-MB internal drive (which is removable, although the process requires a screwdriver) developed a whine that sounded like a bearing problem. However, I had no problems actually using the drive.

Hewlett-Packard OmniBook 300

In contrast to the Subnote, the OmniBook is a real departure from traditional notebook designs. It's incredibly small—at 1.4 by 11.1 by 6.4 inches, it's more like a tall novel than a notebook. The odd form factor and its sub-3-pound weight make it so easy to carry that I chose the OmniBook whether I needed to take a machine on a plane or just down the hall.

HP left out a lot to get the size down. The OmniBook has no floppy drive support, not even as an option. It relies on Traveling Software's LapLink Remote and a serial cable to mount drives on other systems. LapLink Remote can send itself over the wire, so you need never carry a floppy disk. Once I got it set up on my desktop system, I just left the cable hooked up and treated it like a docking station.

LapLink Remote, like most of the functions in the OmniBook, includes a Windows Control Panel for configuration. The OmniBook is a Windows machine: If you don't like Windows and Windows applications, you can scratch this one off your list. Power management settings and all OmniBook configurations are handled through Windows Control Panels, and there are no DOS equivalents.

More significant, the OmniBook is the first machine to include Windows 3.1 in ROM. ROM holds all the core software, including Windows itself, LapLink Remote, DOS, and some OmniBook-specific DLLs. The OmniBook also includes Microsoft Word, Microsoft Excel, and an HP calculator utility—all ROM-based.

Besides saving on hard disk power, this ROM Windows design provides some nice enhancements. The most noticeable is that Windows, Excel, Word, LapLink Remote, and many other utilities are all available at the touch of a function key. Also, the Windows start-up sequence is fast, given the machine's relatively low-speed processor.

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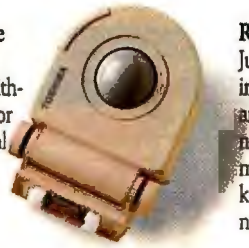

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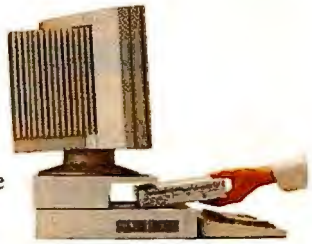

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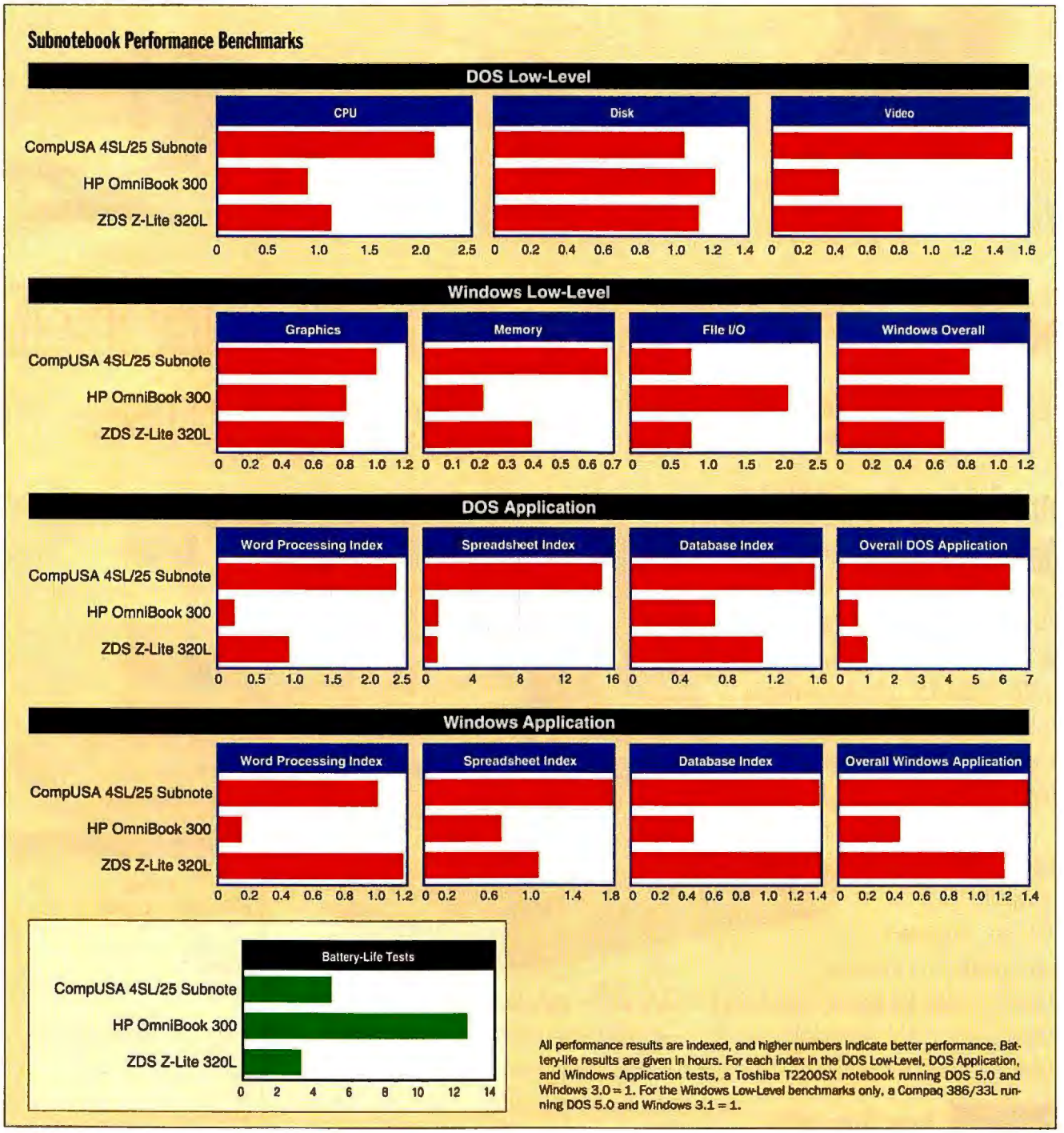

Performance testing highlights *the trade-offs between performance and portability chosen by CompUSA, HP, and ZDS. CompUSA's 4SL/25 Subnote has the most capable processor (its integrated FPU was responsible for the unbalanced results on the floating-point-intensive spreadsheet application test), but it was outperformed on disk-related tasks by the OmniBook and its fast but expensive flash storage system. Its 3.3-V operation, no rotating storage, and no display backlight also combined to give the OmniBook an unprecedented 12½-hour duration on BYTE's battery-life tests.*

slots. Two of these are "system slots": One is occupied by the ROM card that holds the system software, and the other holds either a 10-MB flash memory card or a 40-MB Type III hard drive. My test machine was the flash version. Although it has less capacity, it's slightly more expensive than rotating storage; however, the hard drive will use up two PCMCIA 2.0 slots. The OmniBook uses a modified version of DOS 5.0 that includes Microsoft's DoubleSpace compression to effectively double the space on any storage medium (so the storage on the flash disk was 20 MB).

With the flash model, two sockets are available for more storage, memory card interchange, or I/O cards. You generally can't use DoubleSpace on a card you intend to use in another machine. As mentioned above, I couldn't get a Xircom I/O card to work in the OmniBook, which was

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disappointing. HP's current list of supported PCMCIA I/O peripherals includes only four modems and fax modems.

The ROM DOS installation is not complete. It lacks utilities like MORE, EDIT, EDLIN, and MEM; I couldn't bear using Microsoft Word just to edit AUTOEXEC.BAT, so I downloaded a full DOS installation to the flash card. After that, the OmniBook handled DOS tasks well.

The OmniBook's screen is not backlit, but the contrast is outstanding, and the screen is larger than the other systems'. The keyboard is full-size and virtually indistinguishable from a full desktop model. HP's pointing device is a real (but tiny) mouse that pops out of a socket on the side of the machine—instead of a wire, it uses a mechanical arm connected to an internal sensor. It's the best solution to be found in these three machines, but it doesn't compare to a desktop mouse for usability.

With no backlight, no rotating storage, and 3.3-V design, the OmniBook's battery life is incredible. Lab testing measured it at over 12 hours. But the single feature I liked best about the OmniBook was its instant resume from standby. You can let the machine go into standby at any time, and a key press brings the screen up just as you left it—instantaneously. I found myself sending the machine into standby as a habit, even for very short breaks.

The standard OmniBook's worst feature is its 2-MB configuration combined with emphasis on Windows. The OmniBook runs only in standard mode, and 2 MB is not enough for real applications. BYTE's DOS application benchmarks (e.g., dBase IV, which can use a built-in disk cache) really suffered from the memory limit. All the benchmarks were hampered by lack of memory, although the speed of reads from flash memory (versus mechanical memory) put the OmniBook ahead in some categories. You can upgrade the OmniBook to 4 MB for $179, and you probably should.

There are other features, such as an infrared link for 115.2-Kbps connection to other HP infrared devices (although few are installed), and the ability to run on AA batteries. Besides PCMCIA, the machine also has a proprietary card slot for internal modems. The $2375 OmniBook is the best choice if you run Windows applications. But some of the technology on which it depends—such as PCMCIA, the infrared link, and RAM cards instead of floppy drives—is a little too new and uncommon to be fully exploited.

Zenith Data Systems Z-Lite 320L

Although only a few months older than HP's and CompUSA's portables, ZDS's well-built Z-Lite 320L is already a few steps behind the competition. The Z-Lite is a handsome machine, with an innovative external floppy drive design, the best of the screens in this collection, and a tolerable trackball as a mouse replacement. But the Z-Lite reaches neither the peak of performance set by the Subnote nor the level of portability established by the OmniBook. ZDS promises performance enhancements in the very near term, but the current Z-Lite takes only the middle ground between the other systems.

The Z-Lite is certainly a capable Windows portable. It comes with Windows installed and system documentation on-line. ZDS sells two models of the Z-Lite, the one I tested ($1799, which includes 4 MB of RAM, a LitePoint pointing device, and an external floppy drive) and a stripped-down model with a 2-MB base configuration and none of the external options.

The screen on the Z-Lite is the best provided by these systems; although somewhat smaller than that of the OmniBook, the Z-Lite's LCD is backlit. Unfortunately, the keyboard is just too small to use for touch typing, with key spacing a very noticeable 1.2 millimeters tighter than it is on the OmniBook.

Performance testing put the Z-Lite somewhere between the very fast CompUSA Subnote and the OmniBook. Subjectively, the system runs Windows and Windows applications at a comfortable clip, at least with 4 MB installed. I ran Microsoft Excel and Lotus Ami Pro and never found it wanting for performance. ZDS plans both a Z-Lite based on the 486SL, which will compete squarely against the Subnote, and an 80-MB replacement for the 60-MB drive. The company claims that both the storage upgrade and the new 486SL model will be out by the time you read this.

The Z-Lite is indeed light, at just under 4 pounds. It's thinner, though a little deeper, than the Subnote. The LitePoint device is a plug-in bar that fits on the front of the machine, with a trackball and buttons slightly off center. The external floppy drive is designed to serve as both a drive and an AC connector. The floppy drive plugs into a jack at the side of the machine—if you connect a small AC adapter to the back of the floppy drive, the Z-Lite also draws its power through the cable. This lets you set the floppy drive on a desk, connected to a power outlet, where it can act as a home base for the notebook with just a single connection.

The floppy drive, built-in hard drive, and relatively simple PCMCIA support make the Z-Lite a suitable desktop replacement, if you can get past the keyboard. It's certainly easier to work with on that basis than the OmniBook. But despite the innovative floppy drive, the Z-Lite is perhaps the most difficult subnotebook to actually pack. It has as many pieces as the Subnote, and if you leave the LitePoint attached, there are a lot of irregular edges to handle.

Sub Culture

Choosing between these tiny, innovative machines means choosing between compromises. The choice is between the powerful Subnote, the innovative but sometimes inconvenient OmniBook, and the Z-Lite, somewhere between the other two.

I'll take the OmniBook, with a 4-MB upgrade, please. Despite some gaps between technology and real-life requirements, this is the best machine if you run Windows applications on the road. ■

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Steve Apiki is director of the BYTE Lab. He has worked as a programmer and engineer and has a B.S.E.E. from Rensselaer Polytechnic Institute. You can reach him on BIX as "apiki" or on the Internet at apiki@bytepb.byte.com.

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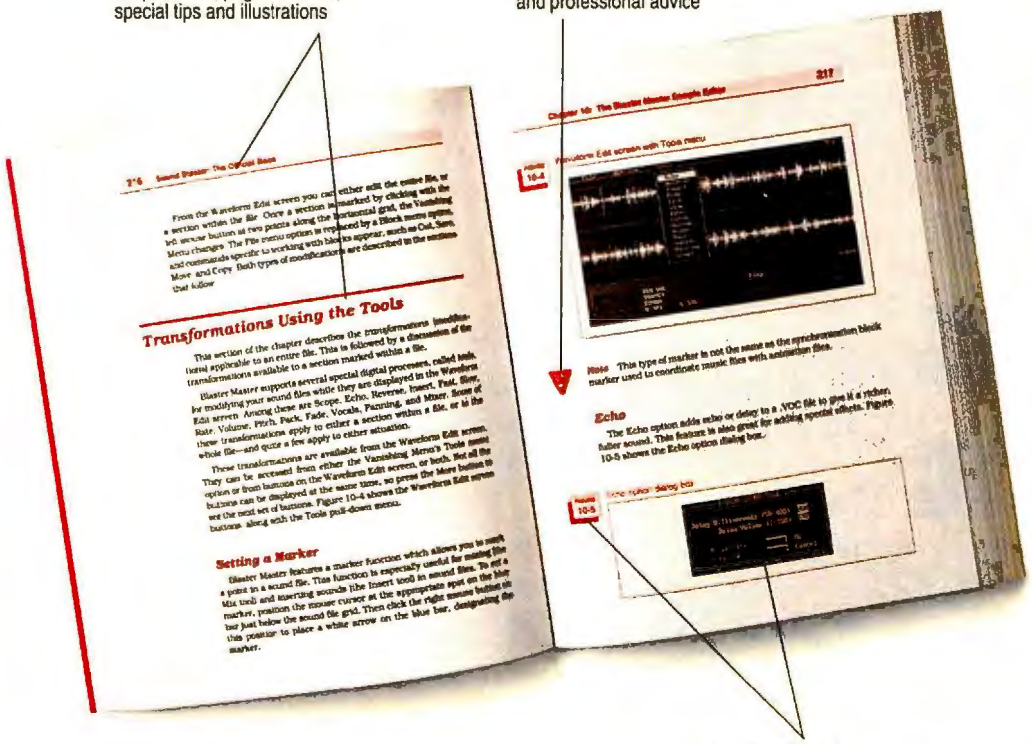

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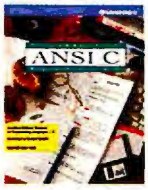

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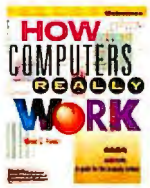

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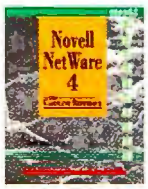

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A Giant Leap to OS/2 2.1

From running Windows 3.1 applications to providing hardware support, version 2.1 is truly a better OS/2 than OS/2

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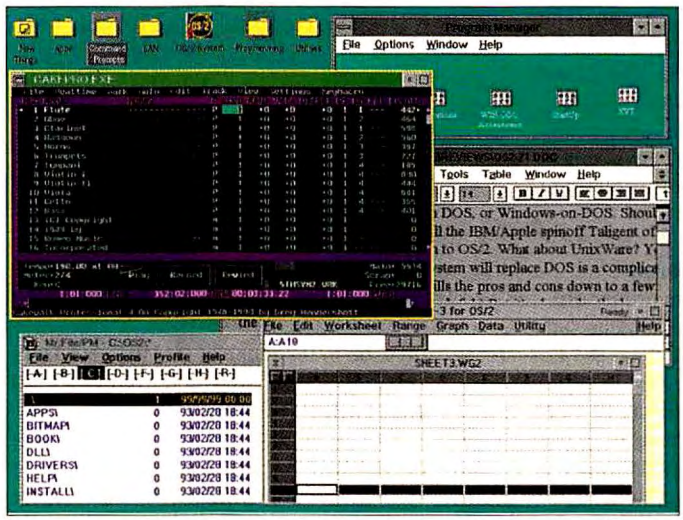

OS/2 2.1's WorkPlace Shell *at a resolution of 1024 by 768 pixels and running Word for Windows, Lotus 1-2-3 for OS/2, and a few other applications. The WorkPlace Shell hasn't changed from version 2.0, but Windows support and device support has certainly improved. When this shot was taken, the system was simultaneously printing and playing an audio file.*

IBM has been working on OS/2 for years, and the various problems and detours the company has experienced in its drive to establish this operating system are well known. With OS/2 2.1, IBM's sixth incarnation of this operating system, IBM has delivered a 32-bit environment that seamlessly multitasks DOS, Windows 3.1, and OS/2 applications. Version 2.1 of the operating system offers a definite step up from the confines of DOS or Windows-on-DOS, as well as an improvement over OS/2 2.0.

To effectively run OS/2, you'll need at least a 386 processor, a minimum of 6 MB of RAM, and 20 to 45 MB of hard disk space. What you'll pay for OS/2 is not so much the price of the package itself but the training and potential hardware upgrades you'll require.

OS/2 2.1 offers the same features present in 2.0: crash protection, virtual memory, preemptive multitasking, fast disk I/O, more DOS memory, the HPFS (High Performance File System), and the object-oriented Workplace Shell. Enhancements in version 2.1 include the ability to run Windows 2.1, 3.0, and 3.1 applications in both enhanced or standard modes, support for a range of Super VGA adapters in various resolutions, more printer drivers (over 260 printers are now supported), and compatibility with more SCSI cards and CD-ROM drives. Version 2.1 supports the APM (Advanced Power Management) and PCMCIA specifications, has extensions for pen-based computers, and includes IBM's multimedia software, MMPM/2. You can install OS/2 2.1 from a CD-ROM drive, instead of from floppy disks. Other features include a limited fax send/receive applet (the size of a fax goes just to one page) and a mah-jongg game. The documentation, provided in book form, is well written.

For less than the cost of buying DOS ($129.95) and Windows ($149.95) each, OS/2 offers both DOS and Windows for $249.The number of native OS/2 applications continues to grow. Recent notable arrivals that support the Workplace Shell, multithreading, and HPFS include Lotus's cc:Mail and WordPerfect 5.2. Through September, if you order through (800) 342-6672, you can buy OS/2 2.1 for $99 (CD-ROM) and $119 (floppy disks). With OS/2 2.1, you get the usual Windows 3.1 accessories, including Sound Recorder, Character Map, Media Player, Notepad, Paintbrush, and Write. If you prefer to manage your computer through Windows, you can use the Windows 3.1 File Manager and Print Manager included in OS/2. IBM also offers the system-diagnostic tools MSD.EXE and DRWATSON.EXE with OS/2.

OS/2 2.1 Picks Up the Pace

I ran OS/2 2.1 on a 486 notebook, an NEC PC on a NetWare LAN, and an IBM PS/ValuePoint 486/25. All have 8 MB of RAM and either VGA or Super VGA monitors. OS/2 2.1 installed easily from floppy disks and from a CD-ROM using a Toshiba 3301 drive. However, due to a BIOS problem, OS/2 2.1 failed to install on a clone computer with a Phoenix BIOS labeled V1.10 M6. IBM has acknowledged that certain early versions of the Phoenix BIOS code might not work with OS/2 2.1. Interestingly, that same clone ran version 2.0 without a hitch.

The most noticeable change from earlier versions is speed. I found that version 2.1 runs Windows software 10 percent to 50 percent faster than Windows-on-DOS. An IBM spokesperson said that IBM's developers tuned the Win-OS/2 environment considerably and used the Watcom C compiler rather than the Microsoft C compiler to produce the Windows portion of OS/2 2.1.

You can even launch DOS sessions from within Win-OS/2. OS/2 allows you to have several Windows sessions under way on your desktop, with each session running a unique copy of Windows separately in its own address space or sharing a single instance of Windows. You can select whether you want DDE and the Clipboard to operate in public mode or private mode. In public mode, OS/2 Presentation Manager software can share data with Windows software through DDE or a global Clipboard. The Win-OS/2 environment offers TrueType and Adobe Type Manager fonts.

Super VGA: The Magnificent Seven

Probably the biggest complaint about OS/2 2.0 was the lack of support for Super VGA. IBM answers the complaints with version 2.1 by offering 32-bit high-resolution video drivers for seven chip sets, in either 800- by 600-pixel or 1024- by 768-pixel resolutions in 256 colors. You can choose from VGA, XGA, 8514, and Super VGA adapter drivers as you install OS/2 2.1.

The seven Super VGA chip sets that OS/2 supports are ATI Technologies' VGA Wonder XL, Headland Technology's Video Seven, Trident Microsystems' 8900, Tseng Labs' ET4000, Western Digital's Paradise,

A Giant Leap to OS/2 2.1

Cirrus Logic's CL-GD542X, and IBM's 256c SuperVGA chip. Immediately after installing OS/2 2.1, and with a Tseng Labs ET4000-equipped video adapter in place, I ran the OS/2 utility DSPINSTL to switch from the default 640- by 480-pixel resolution VGA screen to 1024- by 768-pixel resolution Super VGA screen. The DSPINSTL utility automatically detected the ET4000. The 32-bit video driver provided fast screen updates, and OS/2 automatically updated the Win-OS/2 environment to also use the higher resolution I had chosen.

OS/2 2.1	WINDOWS NT
• Requires at least a 16-MHz 386SX	• Requires at least a 25-MHz 386DX
• Needs at least 6 MB of RAM	• Needs at least 12 MB of RAM, and 16 MB of RAM on a RISC system
• Consumes at least 15 MB of hard disk space	• Consumes at least 70 MB of hard disk space
• 32-bit	• 32-bit
• Walkaway password protection	• Requires you to log in
• Preemptive multitasking	• Preemptive multitasking
• Not yet portable to other processors	• Is portable to other processors
• Only one message queue	• One message queue per process
• Workplace Shell interface	• Windows interface
• Runs DOS, OS/2 16 bit and 32 bit, and Windows 3.1 applications	• Runs DOS, Windows 3.1, Posix, OS/2 16-bit text mode, and Win32

Better Peripheral Support

OS/2 2.1 offers more printer drivers than version 2.0, including support for the Hewlett-Packard LaserJet 4 and Desk Jet 500 series. In addition, version 2.1 supports Hitachi, IBM, NEC, Panasonic, Sony, Texel, and Toshiba CD-ROM drives connected through an Adaptec, DPT, Future Domain, or IBM SCSI controller.

OS/2 2.1 supports Microsoft's MS-DOS CD-ROM extensions, or MSCDEX, in each DOS session via a VCDROM virtual device driver. VCDROM allows DOS and Windows multimedia applications that are MSCDEX-aware to process audio and other digital data concurrently under OS/2 2.1.

If your notebook's BIOS supports APM, OS/2 will cooperate with the hardware to help you conserve battery power. You can double-click on an icon to determine how much battery life remains or to change your power management settings. Version 2.1 also supports PCMCIA 2.0, so you can insert or remove PCMCIA peripherals (perhaps a modem, hard drive, or network adapter) while the PC is still running.

Improving on DOS

IBM says that OS/2 2.1 improves on DOS in many ways, and I found the improvements worthwhile. In one situation at my office, OS/2's illegal instruction message, complete with offending address, register dump, and button for clean termination, gave a programmer the information she needed to fix a stubborn bug. On plain DOS-based PCs, the program simply locked up the computer and required a hard reboot. In addition, OS/2 2.1 declared the following DOS batch file statement invalid: "IF ERRORLEVEL 1000 GOTO BADRESULT." The statement is in error—DOS return codes must be in the range of 0–255—but DOS versions 3.3, 5.0, 6.0, and even OS/2 2.0 didn't detect the error.

However, I found the NetWare Requester for OS/2 didn't properly detect file sharing violations when one user (using the Copy command) tried to write to a file in use by another workstation. I realize that the Requester is a Novell product, not an IBM product, but Novell and IBM should have worked more closely to produce a more reliable LAN environment for OS/2 users. Novell says it is aware of the problem and is working on a fix.

To my delight, I discovered that OS/2's HPFS option automatically remaps bad sectors on a disk to allow write operations to proceed normally. When you set up a partition, HPFS creates a pool of spare sectors that stand ready to replace bad disk sectors. When a program attempts to write a file to a damaged area on the disk, HPFS displays a message informing you that a spare sector was used to store the data and advises you to run CHKDSK to replenish HPFS's reservoir of spare sectors. This smart file allocation logic within HPFS is a vast improvement over the simple-minded, error-prone "Abort, Retry, Ignore, or Fail?" messages that you get from DOS.

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Multiple Multimedia

OS/2 2.1 has built-in multimedia support in the form of MMPM/2 1.01. I found MMPM/2 a joy to use—once I obtained a driver for my MPU-401 adapter from the IBM National Support BBS. MMPM/2 will play standard MIDI (.MID) files, and I have configured OS/2 to generate attention-getting sound effects when OS/2's alarm clock needs to tell me I have a meeting or some other appointment.

DOS-based multimedia programs run well in a DOS session as a result of IBM adding dual-thread DOS session support in version 2.1. As a multimedia-based program reads or writes to a disk file, the multimedia program needs to service sound card interrupts on a timely basis. Dual-thread support, in effect, allows DOS applications to multitask along two threads within a single DOS session. The second processing thread within a DOS session allows the program to handle sound card interrupts at the same time file read or write operations take place. The support is automatic; the DOS program does not have to do anything different to take advantage of the extra multitasking. Dual-thread support helps improve playback performance of a multimedia CD-ROM title that's playing music through a sound card. A DOS session settings notebook entry, INT_DURING_IO, enables the dual-thread feature.

Still Missing

There are still one or two gaps in OS/2 2.1. It doesn't maintain a separate message queue for each application. Implementing this would reduce the time spent staring at an hourglass cursor. You still have to boot two installation disks if you need to run CHKDSK against your OS/2 boot partition. And official on-line support remains limited to CompuServe.

But OS/2 2.1, when installed on the proper hardware, is a definite step up from the confines of DOS or Windows-on-DOS. I find version 2.1 a productive environment when I want to run DOS, Windows, or OS/2 software. It is speedy, gives me about 630 KB of DOS memory (with network drivers loaded), and supports my ET4000 video adapter. Unless you need a prohibitively expensive hardware upgrade, you should think seriously about replacing DOS or Windows-on-DOS with OS/2 2.1. I've even grown attached to the object-oriented Workplace Shell. ■

Barry Nance, a programmer for the past 20 years and BYTE contributing editor, is the author of Using OS/2 2.1 *(Que, 1993),* Network Programming in C *(Que, 1990) and* Introduction to Networking *(Que, 1992). Barry is the Exchange Editor for the IBM Exchange on BIX, where you can reach him as "barryn."*

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PC MAGAZINE EDITORS' CHOICE
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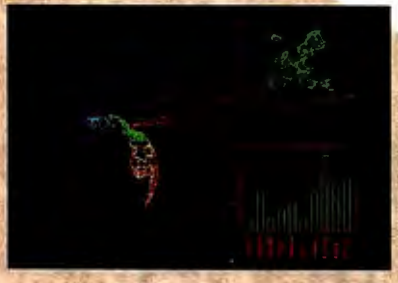

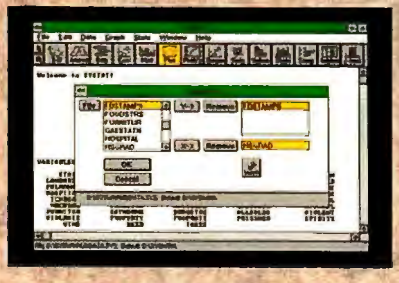

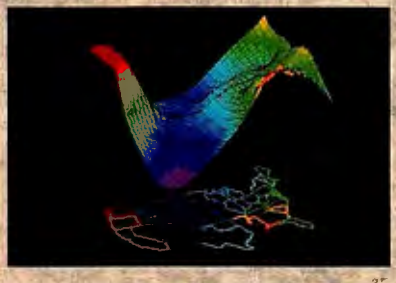

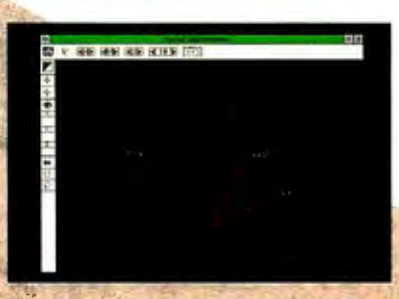

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A FirstClass Experience

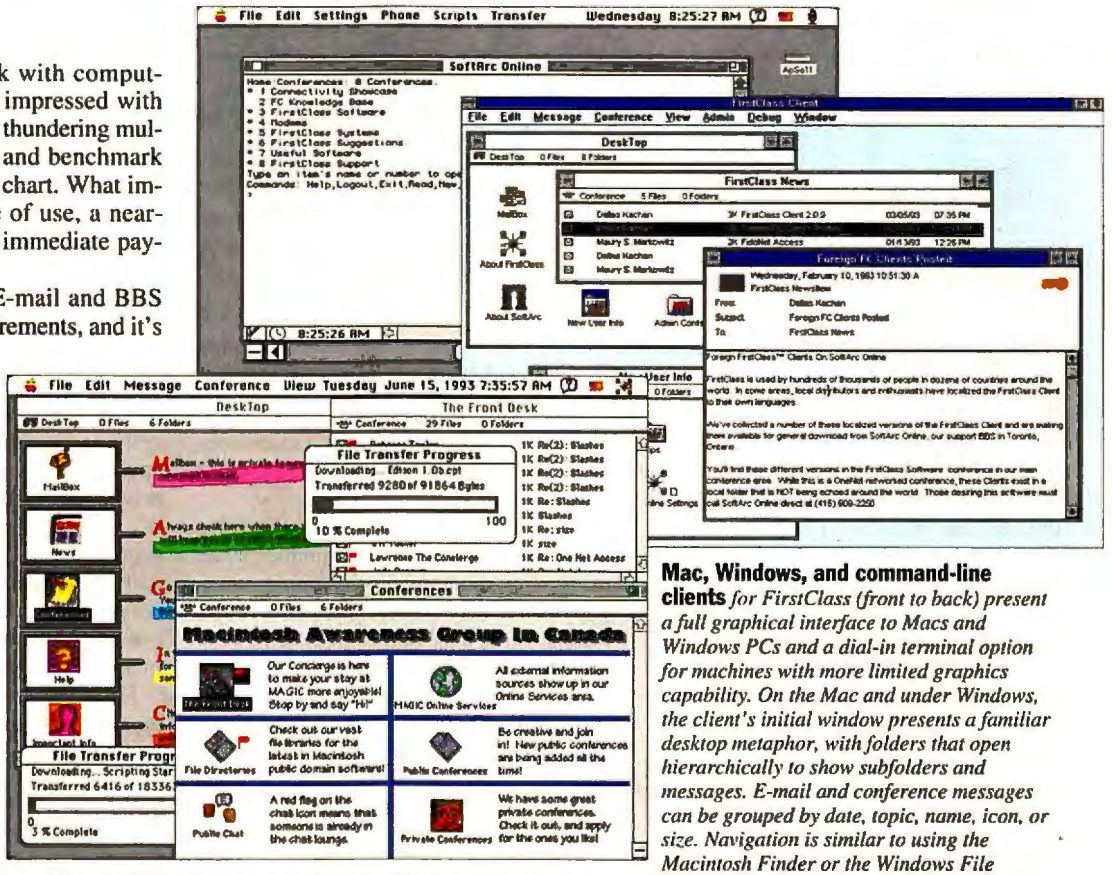
SoftArc's FirstClass E-mail and conferencing system goes multiplatform with Mac, Windows, and terminal support.

RAYMOND GA CÔTÉ

The longer I work with computers, the less I'm impressed with splashy graphics, thundering multimedia demonstrations, and benchmark figures that zoom off the chart. What impresses me more is ease of use, a near-zero learning effort, and immediate payback in productivity.

SoftArc's FirstClass E-mail and BBS product meets these requirements, and it's flashy, too. FirstClass is an integrated E-mail and conferencing system that works equally well over LAN and dial-up connections. Regardless of transport, users connect to the FirstClass server through a graphics-based (Windows or Macintosh) FirstClass client. Remote users with less-capable hardware can also log on through a menu-driven command-line interface using generic VT100 terminal emulators.

With its latest release, SoftArc has broadened FirstClass's reach with the addition of a Windows client as strong as the original Mac implementation. FirstClass remains a Macintosh-centered system—the FirstClass server still runs under the Mac OS—but its new multiplatform focus pits it squarely against mail systems like QuickMail, Microsoft Mail, and cc:Mail.



Mac, Windows, and command-line clients *for FirstClass (front to back) present a full graphical interface to Macs and Windows PCs and a dial-in terminal option for machines with more limited graphics capability. On the Mac and under Windows, the client's initial window presents a familiar desktop metaphor, with folders that open hierarchically to show subfolders and messages. E-mail and conference messages can be grouped by date, topic, name, icon, or size. Navigation is similar to using the Macintosh Finder or the Windows File Manager. As is obvious from the Mac client screen (showing a connection to the MAGIC BBS), a little work on the part of the mail or BBS administrator can convert a normally plain interface into a pleasing view without cluttering up the screen.*

Although it doesn't have the graphical power of the other two interfaces, the command-line client offers access to all conferencing and mail services from text-mode clients, including DOS and Unix machines.

FirstClass blends conferencing and mail together under a remarkably clean interface that goes far beyond the capabilities of most mail systems. It easily outperforms its new competitors on those fronts. What it lacks is solid support for large networks, including multi-hop mail (i.e., mail that must be routed through several servers), a full complement of gateways, and distributed directories.

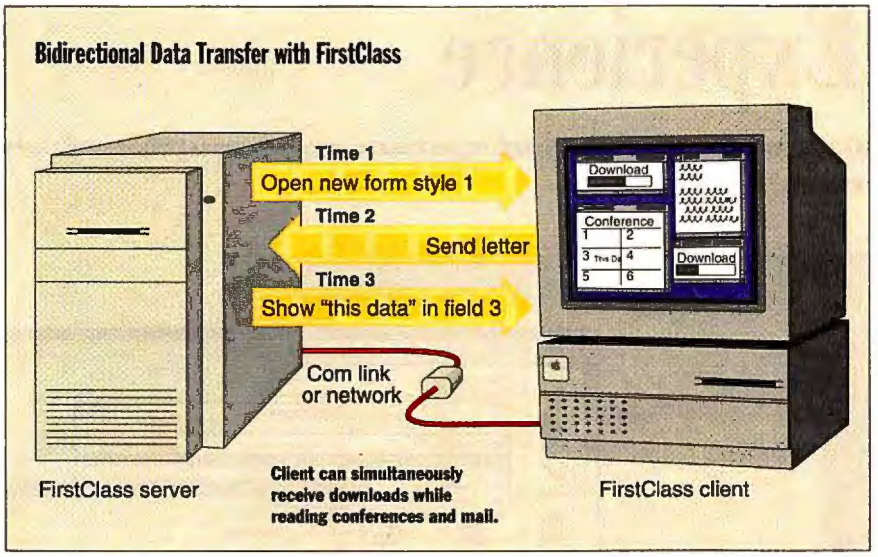
Client Side

The graphics-oriented clients are where FirstClass shines most noticeably. From the first time you sit down in front of the Mac or Windows interface, you'll know how to drive FirstClass. Most communication and conferencing functions are right where you expect them to be. Finding the rest requires only minimal hunting or a quick check of the documentation.

FirstClass grants direct (though controlled) access to files stored in actual hard disk folders (or directories). This allows you to download and upload files directly to and from the server. The target folder need not reside on the FirstClass server—it can be any machine to which the server has access, such as other Macs sharing files on the network or any NetWare server. This feature, combined with careful use of System 7 file sharing and network permissions, can allow users who work on the network when locally attached to log in via dial-up and obtain direct access to their own private disks and directories.

The clients present a truly graphical interface, not just a windowing application using text. The configuration databases that define the "look" of a client screen are stored on the FirstClass server on a per-user basis; administrators can customize an interface, and user changes (e.g., changing the location of icons) are permanently stored.

The clients' built-in text editor provides full text manipulation—font, size, style, and color. Although I wouldn't call it full-featured, it exceeds anything available with



FirstClass multitasks communication sessions, *allowing you to maintain several active transfers simultaneously while browsing conferences and reading mail. FirstClass shares the communication line by splitting time slices between sessions.*

other messaging and conferencing systems I've seen. Besides text, FirstClass also supports graphics display and sound on both the Mac and Windows platforms.

Beyond the Obvious

There's considerably more to the FirstClass client than the well-designed interface. Underneath the smooth presentation lies a remarkably efficient communication engine that lets you make the most of every second you spend on-line. With FirstClass, you rarely wait for operations to complete; you'll hardly glimpse a watch or an hourglass cursor during any session.

Historically, interactive conferencing systems have been inefficient. You read messages, compose replies, scan a few conferences—all low-bandwidth operations. If you use most of the bandwidth by, say, initiating a download, your keyboard is rendered inoperative for as long as the file transfer takes to complete.

FirstClass is a "multitasking" communication system. Multiple communication sessions, running in both directions, can be active at the same time. That means you can start a download and then move over to browse a conference while the download completes. Or you can start uploading mail replies, start downloading a few files, and then go on to read new messages as the transfers proceed in both directions.

Naturally, file-transfer speed degrades as you use up more sessions. However, the transfers never stop; they continue to run as quickly as they can over the shared communications line. If all you're doing is browsing conferences, which consumes very little bandwidth, you'll scarcely notice a degradation in transfer speed.

FirstClass's multitasking ability also improves your overall performance when using slow modems. For example, when you open a busy conference, you will immediately see a list of messages being built as each title is downloaded. If you see a message you want to read, you don't need to wait for FirstClass to build the entire list. You just immediately double-click on the item of interest. A window will open with that message, and the list update will continue in the background.

Something to Start With

Installation of both clients and server is straightforward. Each FirstClass server is delivered with the full complement of capabilities: Macintosh, Windows, and command-line interface services; NetWare IPX interface for Windows; and unlimited users. Each of these capabilities is activated using a license floppy disk. A simple Installer script loads the server files, and you're ready to come on-line with a five-user AppleTalk network system.

The Mac and Windows client software is freely distributable. If you intend to use FirstClass for customer support, you can ship a client with each software package. In-house users can have clients loaded on their desktop machines, portables, and home machines without having to worry about license violations. Licenses apply only to the number of active users registered on the server and the types of clients supported.

Network administration for the Mac is trivial. Install clients and servers on all your machines, make sure AppleTalk works, name your server and select that server on each client machine, and you're up and running.

Configuring for Windows operation is only slightly more difficult. First, you need the NetWare IPX option for your FirstClass server. Then NetWare client software must be installed on each Windows machine and the server name configured as above. Notice I didn't say you needed a Novell server. The IPX option on the FirstClass server provides an IPX interface that allows direct communication between the server and networked Windows clients.

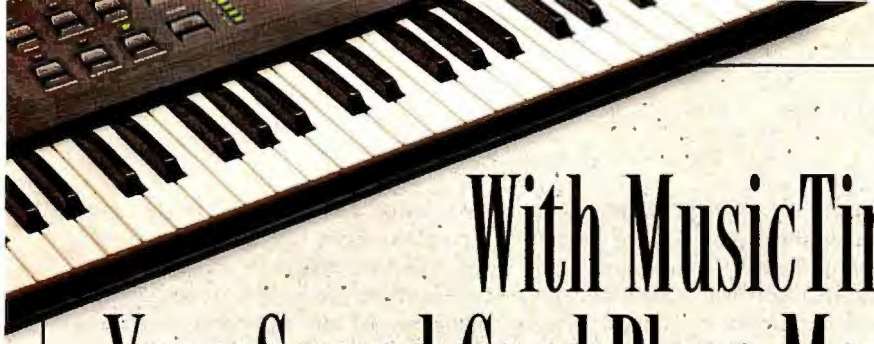
Administering FirstClass

All system administrative actions are performed using the standard client software (any client type) logged in with administrative privileges. Although the server is delivered with an administrator account, any account can be given administrative privileges. This removes the need to give out a single special password when you need someone else to perform administration. It also means that administration does not need to be done locally. Administrators can call in from remote locations or log in anywhere on the network.

FirstClass permission and privilege designations are complex and will take some getting used to. Privileges are assigned on a per-user (or, more commonly, per-group) basis; these define the type of services to which users are allowed access. Several privilege groups, such as All Users, Network Users, Telecomm Users, and Auto-registered Users (self-registered users on a public system), exist by default. Privilege groups may also be grouped hierarchically. For example, a single user can be a member of the All Users, Network Users, Management, and Secret Project groups, all of whose privilege settings combine to provide actual privileges.

Permissions operate on a much finer level. While privileges determine whether a user has access to the conferencing system at all, permissions define the level of access an individual (or group) has to specific conferences. Over 17 individual permission flags are available, from the relatively standard decisions as to whether to allow uploads and downloads, to the more specific abilities to create conferences or folders.

Privileges and permissions are complicated subjects and may require a bit of fine-tuning for best operation. However,



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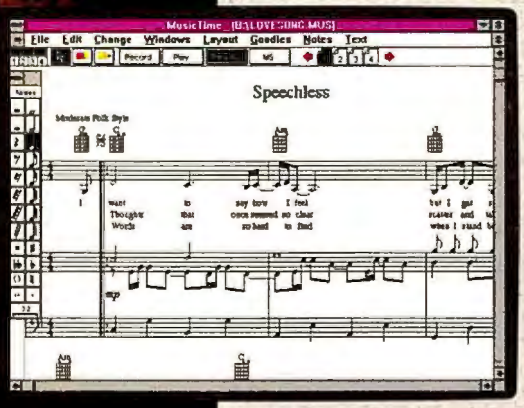

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the default settings let you get a small- or medium-size network operational quickly.

The Outside World

FirstClass servers can communicate with each other to transfer mail and conference messages. Conference messages can be replicated across any number of servers, so all sites can see the same information.

E-mail currently operates only in a point-to-point mode. This is a serious deficiency because it requires the server at the sending site to call each destination server. SoftArc promises multi-hop mail for future releases, and I've seen a version in beta test that delivers this capability.

There is also no systemwide user directory, nor any way to receive a list of subscribers at a foreign server. You have to know the person's name and ensure that you spell it properly. Solutions to the directory problem are also promised.

Gateways are available from SoftArc and from third-party vendors for communicating with a number of other messaging systems. Microsoft Mail, QuickMail, fax, and FidoNet gateways are available. Third-party vendors provide Internet and UUCP connections that support E-mail and network news.

SoftArc claims that MHS (Message Handling Service), AppleLink, and CompuServe gateways are also in the works. But if you desperately need an interface to some system that is not currently supported, SoftArc provides a series of toolkits for building gateways and other interfaces to messaging systems.

About the Product

FirstClass
Five-user base system.....$395
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FirstClass Upgrade

FirstClass is a mail and conferencing system fully deserving of its name. It is easy to set up and use and does not require a lot of computing power for a small or medium system. I ran a small network using a Mac Color Classic as the server. However, having a larger system will come in useful as the number of concurrent clients grows. SoftArc actually recommends old Mac II systems as servers since they have a large number of available expansion slots that can be filled with multiport modem cards.

FirstClass is fast, provides an intuitive interface for users, and is a regrettably rare example of a useful piece of software. Unfortunately, the current version won't scale up easily for very large WAN (wide-area network) systems. The next release should address some of the directory and multiserver issues. In any case, if you are setting up a mail system for your business, I can't stress how much a well-designed system like FirstClass, especially with its sophisticated conferencing features, can boost productivity over simple E-mail. ■

Raymond GA Côté is a consultant, freelance writer, and publisher of The Robot Explorer *newsletter. He has extensive experience in Macintosh and Windows program development. You can reach Ray on BIX as "rgacote" and on the Internet at rgacote@bytepb.byte.com.*

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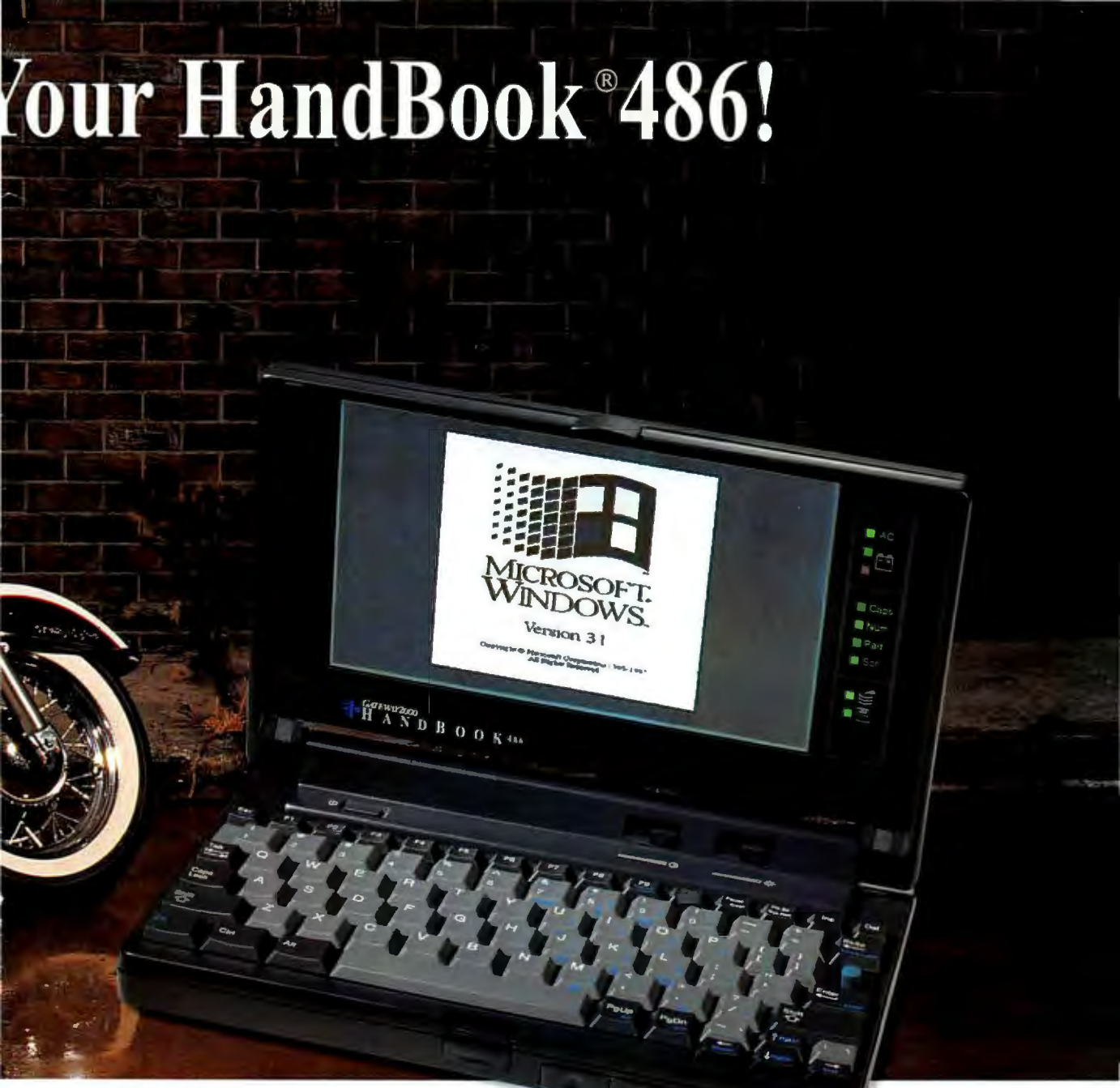

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People using the original HandBook asked for more power. They asked for a HandBook that would run Windows.™ We gave them both in the HandBook 486. It's the smallest Windows PC in the world — and when using a 486DX2 processor, the HandBook 486 is by far the most powerful PC of its size. New HandBook models include Intel's 3.3v 486 processors and come with 4MB RAM, expandable to 20MB, and large hard drives.

Backlit VGA, Built-In Pointer, PCMCIA

Users asked for VGA. The new HandBook's screen is a black-and-white VGA display, backlit for use in any lighting situation. No need to carry a mouse with your HandBook 486. The built-in pointing device is convenient and easy-to-use. The HandBook 486 also includes one PCMCIA Type II slot, and the card fits entirely within the footprint of the HandBook.

The Bottom Line

HandBook 486 models start at only $1,495, an extraordinary value even by Gateway's standards — and we wrote the book on value! We have a reputation for offering the best prices on high-quality products with exceptional service from friendly folks in the Midwest. Give us a call. Once you get your hands on a HandBook, you'll wonder how you ever lived without one!

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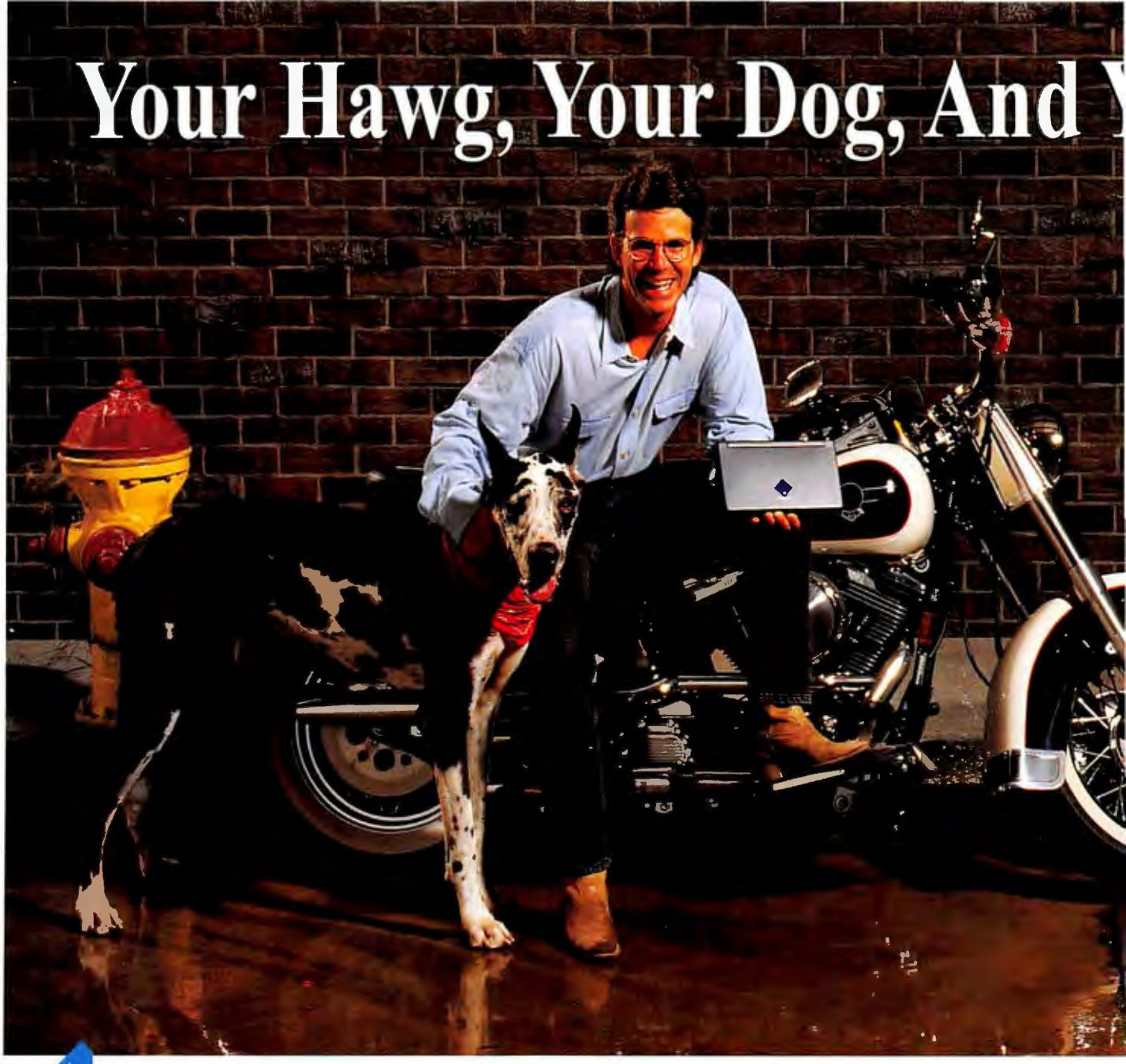

"You'll have to pry my cold, dead fingers off to get it away from me." That's what an editor told us once about the Gateway 2000™ HandBook we sent him for evaluation.

A journalist covering the conflict in Somalia called to tell us his HandBook was so popular among his colleagues that he could sell dozens of them for us.

Another user wrote, "The HandBook has changed my life in a way that only a few other products ever have. I take it everywhere with me — something I never did with other notebooks."

This is a tiny sampling of the response to the original HandBook. Clearly, the HandBook — the pioneer product in an entirely new category dubbed "subnotebook" computers — inspired the kind of loyalty usually reserved for Harley-Davidson® motorcycles and man's best friend.

Introducing The HandBook 486

Now we are proud to introduce the next generation of the HandBook — the HandBook 486. Since we began marketing the original HandBook a little over a year ago, we've been asking customers to finish this statement: "I'd like my HandBook better if _____." The HandBook 486 includes most everything anybody asked for while retaining all the things people love.

The HandBook 486 still weighs under three pounds and is smaller than the day planners many people carry. The new HandBook still has a great keyboard, excellent battery life, a backlit screen, and that wonderful HandBook suspend/resume feature. But the new HandBook has some important features the original didn't have.

Introducing The HandBook® 486!

The HandBook 486 has a handy, integrated pointing device.

Even though the HandBook is very small, it has an excellent, touch-type keyboard. You'll also appreciate the sturdy, heavy-duty plastics used in the case.

Options: PCMCIA fax/modem cards, PCMCIA VGA card, PCMCIA network cards, external floppy drive, 4MB or 16MB RAM upgrades, alkaline battery pack, carrying case and extra NiMH batteries. Call for details.

FEATURES

Size

The difference between a 3-pound portable and a 4-pound portable doesn't sound like very much until you lug one around for hours. Then every ounce counts! HandBook users swear by the size of this product. It's big enough to be fully functional, but small enough to take anywhere effortlessly.

Intel® 486SX or DX2 Processor

Your HandBook 486 includes a genuine 32-bit Intel 486 processor — not some chip that's *almost* a 486. Those who crunch numbers will love the high-performance numeric coprocessor in the DX2.

Backlit VGA Display

The HandBook's VGA display is easy on your eyes. The screen is backlit for use in all lighting situations so you won't ever be left in the dark.

PCMCIA Type II Slot

A PCMCIA slot is a great way to add a modem, network card or any of dozens of available PCMCIA-compatible peripherals.

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Video Machine: True Desktop Video

Video Machine's professional tools support video editing, audio mixing, titling, and digital effects

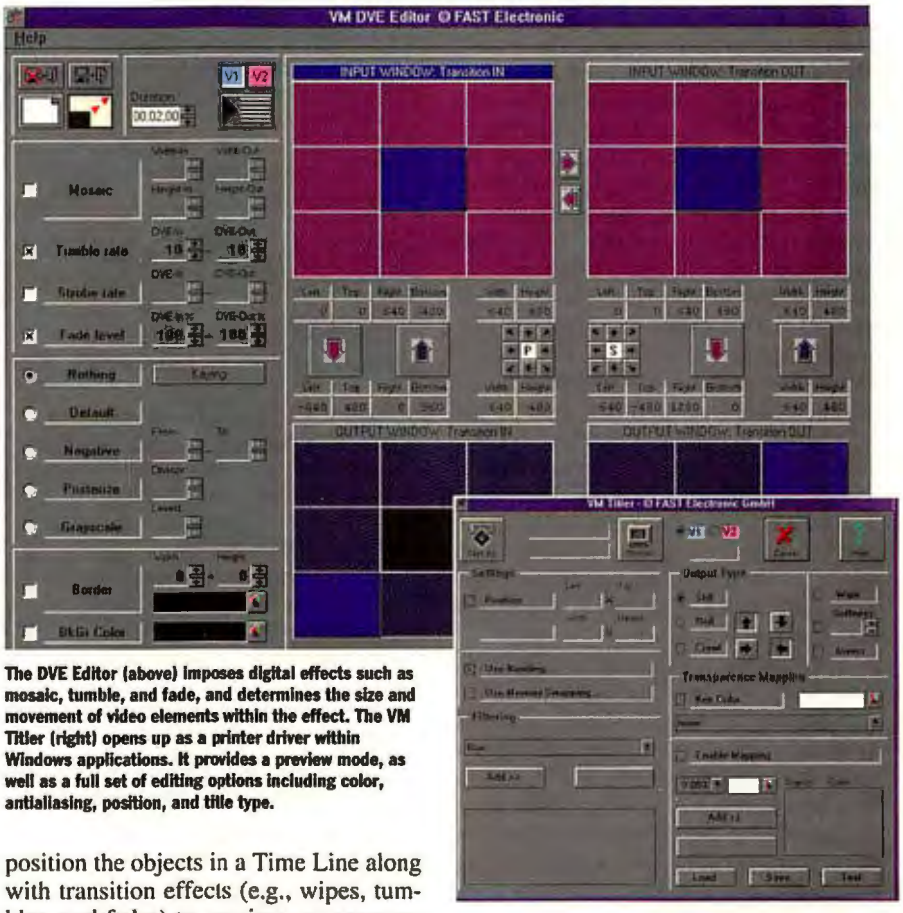
BOB LINDSTROM

Don't confuse desktop video with the jerky, grainy, animated postage stamps that Apple's QuickTime and Microsoft's Video for Windows put on your computer screen. While this emerging technology will eventually become a staple of personal computing, it still isn't ready for prime time. The image quality just isn't there.

True desktop video brings high-quality video production to the personal computer. A desktop video system should support on-line and off-line A/B roll editing (i.e., two players feeding into a single recorder), digital effects, audio mixing, titling, and graphics generation. Most of all, it should provide professional quality at a relatively affordable price.

Desktop video systems appeared initially on the Commodore Amiga in the form of NewTek's Video Toaster, and then on the Apple Macintosh. Now Fast Electronic of Munich, Germany, has developed the Video Machine (VM for short), a software/hardware combination that links with VCRs and video monitors to turn a PC into a Windows-based desktop video editing system and effects generator.

VM's overall concept and design are excellent, although the software betrays some first-version instability. Still, with a few fixes to the software, VM will challenge the competition with a powerful professional desktop video solution.



The DVE Editor (above) imposes digital effects such as mosaic, tumble, and fade, and determines the size and movement of video elements within the effect. The VM Titler (right) opens up as a printer driver within Windows applications. It provides a preview mode, as well as a full set of editing options including color, antialiasing, position, and title type.

Video Time Line

VM is a fully equipped audio/video editing and mixing suite. In addition to a 386 or higher PC with 4 MB of RAM, you'll need Windows 3.1, two video players, and a video recorder to flesh out an A/B roll setup. VM can drive the VCRs using Control-L/Control-S or five-pin Syncro Edit control protocols. An optional Multi I/O option adds three high-speed RS-232/RS-422 serial ports for controlling the video decks.

VM streamlines the drudgery of video editing. The software helps you create and organize source material as objects. These objects may be video or audio clips, still graphics, titles, or screen captures. You position the objects in a Time Line along with transition effects (e.g., wipes, tumbles, and fades) to preview your presentation. When the prototype is satisfactory, VM assumes control of your VCRs and automatically assembles the final edit.

But VM does much more than turn VCRs on and off on cue. It is also a DVE (digital video effects) editor and character generator capable of producing title crawls and rolls, tumbles, fades, dissolves, slides, and other effects. In addition, the board contains a genlock, a chroma key, a digital frame capture, and a mixer controlling four stereo pairs of audio.

Making the Connections

The VM hardware is a 16-bit ISA-bus board that occupies a single slot in the PC. The optional RS-232/RS-422 interface mounts to a second position on your backplane and connects to the main board by a small cable. Audio/video and sync connections to external devices are handled by a 62-pin cable splitter that plugs into the VM board and feeds out an octopus of cables for VM's inputs and outputs.

The cable splitter boasts no less than 17 female connectors, all of which are active and accessible by the system: four S-video inputs, two BNC composite inputs, one S-video output, one BNC composite output, one BNC external sync input, four stereo miniplugs for stereo audio inputs (eight channels in all), one stereo miniplug for stereo audio output, and three miniplugs for A/B-roll VCR control outputs.

A significant plus for VM is its two onboard frame synchronizers, which function as TBCs (timebase correctors). As owners of NewTek's Video Toaster discovered, the Toaster is not plug-and-play unless you plug in TBCs, too. While the VM costs $1500 more than a Video Toaster, its integral TBC functionality makes it

more convenient as a desktop video system. But VM is not a slave to its internal sync. As the sync-in connector implies, VM can be synched to an external source.

With everything connected, you'll have quite a tangle of cables behind the PC. Fast Electronic plans to sell an optional Studio Control Box that will consolidate all connections into an outboard black box with balanced audio inputs. The Studio Control option will also support linear time code, a capability missing in the standard version of VM. Note, though, that out of the box, VM supports VITC (both SMPTE and EBU), RCTC, and Rapid Time Code. VM will write VITC code to the master recorder even if the recorder lacks time-code hardware. The optional control box will also provide two video preview outputs. The stock VM lacks any preview outputs, but you will probably want to use the preview outputs of your professional-level video players anyway.

VM is compatible with PAL, NTSC, and SECAM input. The board outputs NTSC and PAL signals to a full 5.5-MHz bandwidth, with screens of up to 625 lines at 576 pixels per line. I tested it only with NTSC. VM can also accept mixed video standards during editing or convert from one standard to another.

I verified that VM can edit to half-frame accuracy when attached to capable video equipment. Although VM does not support true digital video recording (other than single-frame capture), Fast Electronic says that it hopes to offer digital, nonlinear editing capabilities as an option. That option will include a digital JPEG video-compression board.

Putting the Pieces Together

A presentation in VM begins with the Project Manager. In this window, you prepare and organize the raw resources for the project: video clips, still images, titles, audio, special effects, and so on. Each object has its own editor that lets you define the object and attach pertinent settings to it (e.g., tweaking color temperature in a video clip).

For instance, using the Clip Editor, you might define as a clip a 10-second segment on videotape starting at 04:23:28 and customize playback parameters including color saturation, brightness, and contrast. You then attach a name and explanatory notes. The newly defined clip is placed in a window assigned to the specified videotape segment. Thumbnails of the Mark-In image for the clip are displayed in the reel window for later visual identification. During assembly, if your clip length doesn't quite fit the presentation, you can alter the Mark-In/Mark-Out settings for that clip without changing the basic clip definition.

If you need still video images, you can capture them directly from source material using the Graphic Editor. You choose the source and click on Capture. The Editor grabs individual frames and stores them in a wide variety of graphics formats, from PCX to BMP to JPEG, in color resolutions up to 32-bit. Like video clips, these screen captures are placed in a graphics group window and displayed as thumbnails. When capturing images in less than true-color resolutions, VM optionally can calculate custom palettes and apply Floyd-Steinberg and Bayer dithering techniques to maximize image quality.

All objects can be organized into racks. For example, you might want to place all the objects for a single scene into a scene rack. By assigning audio/video settings to each rack, you can not only match clip appearance but also establish an overall video "look" for a particular scene.

A Few Terms

NTSC: National Television Standards Committee; U.S. video standard.

Off-line editing: A process in which the final product is an edit list that can be assembled later.

On-line editing: A process in which the final product is committed to tape.

PAL: Phase alternate line; European video standard.

RCTC: Time code used with Hi-8 camcorders.

SECAM: Sequential Color and Memory; the French video standard.

SMPTE: Society of Motion Picture & Television Engineers; sets time-code standards for the U.S. broadcast industry (EBU is the European equivalent).

Time code: An encoding scheme where each frame on the tape is assigned an 8-digit code for hours, minutes, seconds, and frames (00:00:00:00).

VITC: Vertical Interval Time Code; time code embedded vertically into each frame for enhanced accuracy.

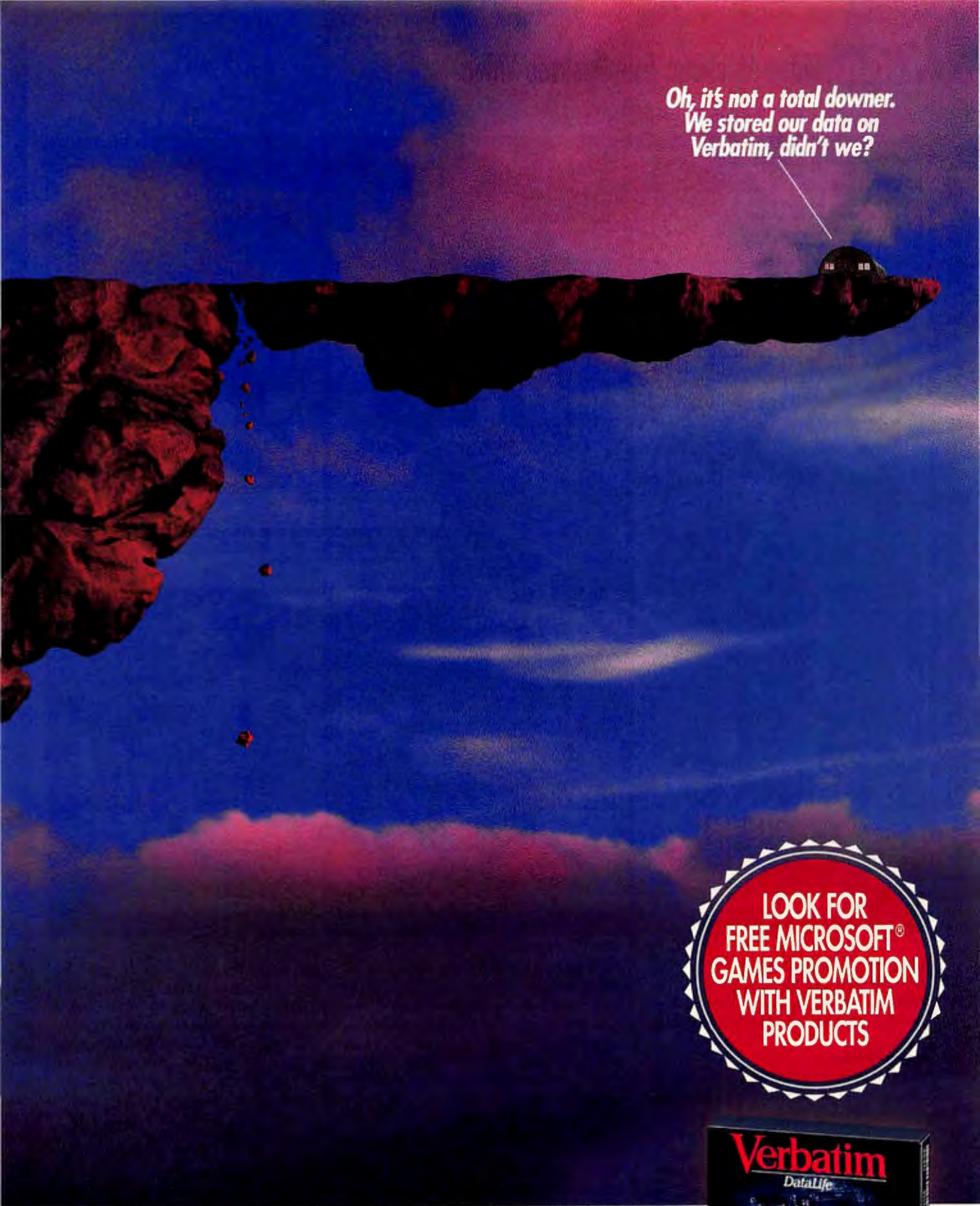
Special Effects

With the pertinent objects for a scene readied, you're almost prepared to assemble the scene. However, you can also select the DVEs you'll frequently use for the scene and place them in a selection bar for easy access and editing. VM comes with dozens of prefabricated effects, from wipes to dissolves to elaborate zooms and picture-in-picture trailing effects. Even so, you'll quickly find some effect that wasn't included. Hopefully, Fast Electronic will make more DVEs available in the future.

Until then, you can design or edit DVEs in VM's DVE Editor (see the screen on page 153). The Graphical Effects Editor provides four adjustable screen-aspect ratios: two for the effect creation and two to represent the effect's appearance on-screen. Although the DVE Editor doesn't provide tools to design all the effects that VM can produce (most of the tools are based on squares and rectangles and therefore could not generate some of the effects bundled with VM), it does let you customize fades, tumbles, strobes, wipes, and so on. You can preview the results with a preview button in the Editor or with a T-bar emulator in the Time Line. Note that VM does not support true 3-D digital effects (e.g., spinning cubes with video images), although some simulated 3-D effects are available.

Fast Electronic arrived at a unique solution for the Titler module (see the screen on page 153). It is attached to the Windows environment as a printer driver. You create titles by entering any Windows-based word processor or graphics editor and identifying the VM Fast system as the printer driver. You create your choice of graphic or text and then print the results. The Fast Titler screen appears, with available settings for color, type of title (e.g., still, crawl, or roll), wipe, antialiasing, position, transparency, and so forth. A preview mode lets you see the title against a video background if the VM software is multitasking in Windows. When you have the correct results, the driver saves the object to disk.

The VM Titler provides real flexibility by making an object of almost anything. In addition to the normal titling functions, for instance, you can produce logos or other small graphics to superimpose on the screen. Flexible color-mapping controls let you assign different levels of transparency to color groups, opening the door to a wide variety of color/chroma-key-like effects. The drawback is that the Titler requires you to leave VM, load another



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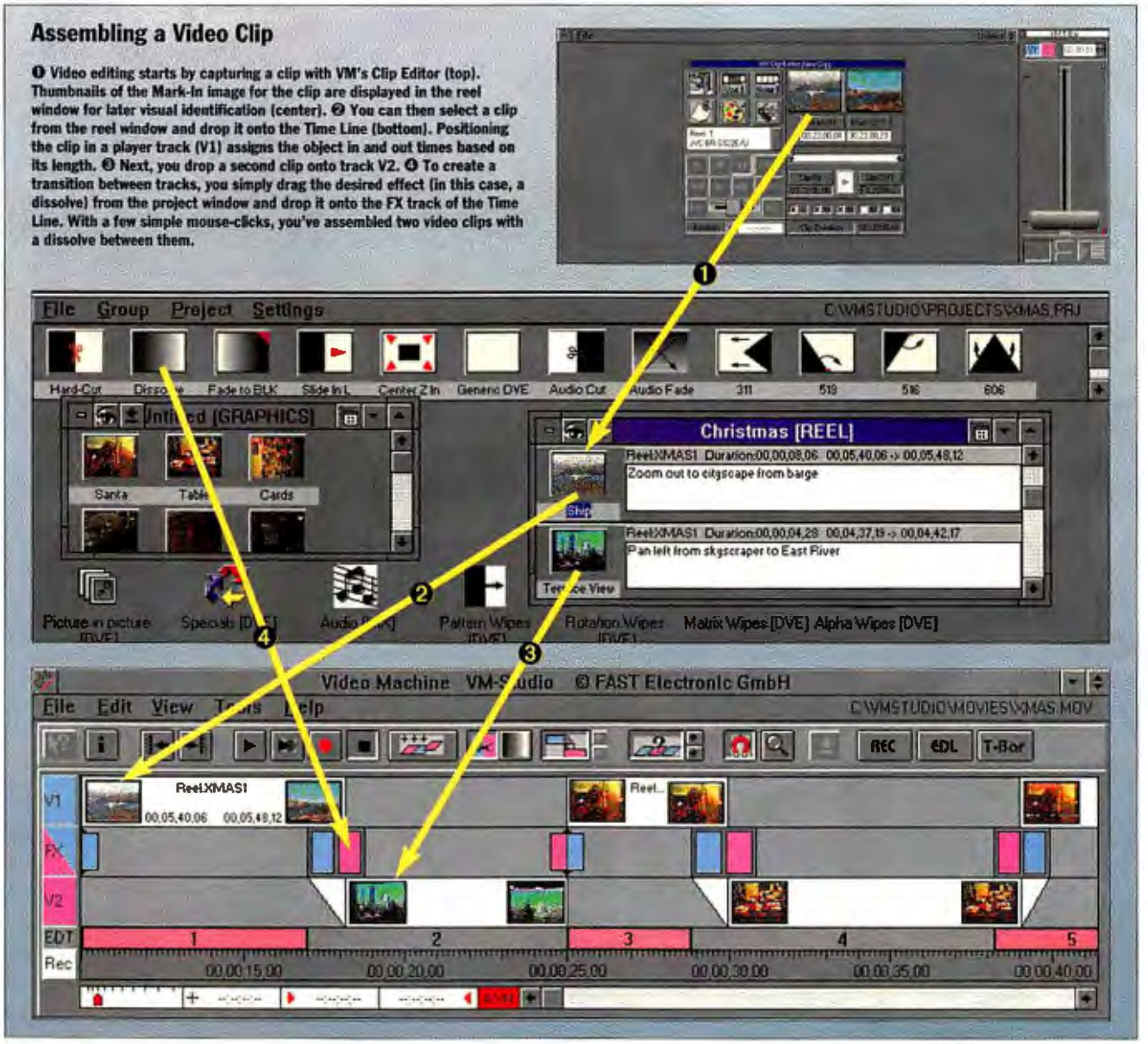

program, and move between applications to create a simple title or graphic. Despite its output flexibility, I'd have preferred an integral titler within the VM environment.

Perfect Timing

With clips, racks, and DVEs prepared, creating a video production is almost as easy as drag-and-drop. While VM has the power to satisfy video professionals, its basic design puts the techniques of video editing well within the grasp of newcomers.

To place an item into a presentation, you use the mouse to click and drag objects from the Project Manager into tracks in the Time Line window (see "Assembling a Video Clip" above). The tracks represent the two video player sources, a DVE track, and the audio tracks, which can be linked to video tracks in stereo pairs. (You cannot access the audio mixer as eight discrete inputs, only as four stereo pairs.)

Positioning an object in a player track will assign the object in and out times based on its length. The process is aided by options in the toolbar, such as a "magnet" tool that automatically butts Mark-Out times of an object to the Mark-In time of the next object. To create transitions between objects, you drag a DVE into the track in which you want the effect to end.

For example, to dissolve between V1 (Video 1) and V2 (Video 2) at 10 seconds, you drag the dissolve DVE icon into the V2 track at 00:00:10:00. The program places it in the DVE track with instructions to begin with V1 and dissolve to V2. You can lengthen the effect by dragging its right end further along the Time Line, or you can relocate the effect entirely.

With the Time Line complete, you can preview the work or commit it to tape. Click the record symbol, and the computer does the final edit.

Video Performance

To test VM, I put together an A/B roll system using professional hardware from JVC, including the BR-S525U player and the BR-S822U and BR-S622U recorders. These are S-video units designed for studio use. VM supports a thorough cross section of video hardware from several manufacturers.

continued

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Video Machine: True Desktop Video

I connected the devices through the optional RS-422 ports. Inexpensive preview monitors were attached to the VCRs' composite video preview ports. The master monitor was the JVC TM-1400SU, an S-video studio monitor. I assembled a variety of source objects and developed a half-dozen test presentations.

The Project Manager editors worked smoothly. VM exhibited seamless VCR control as I browsed tapes, creating video clips with two mouse-clicks to set the in and out points. I rate the object-creation process as one of VM's best features.

Less satisfactory was the Time Line. The editing and assembly software exposes VM as a first-generation product. Automated assembly was inconsistent and unpredictable, particularly during DVEs. In one case, a dissolve previewed properly but only flickered the screen during final edit. Some special effects edited correctly to the S622U but not the S822U (the two models have different VM setups and so are controlled somewhat differently, but the effects should work the same on both). Some effects functioned during one assembly and not during another, even though I made no change in the Time Line. During one session, the toolbar disappeared entirely and returned only after I reloaded the program.

The VM manual could be improved by more thorough explanations of setup and operation, as well as by adding an introductory walk-through.

My features wish list includes the ability to use VM as a video output card for laying animations to tape, support for playing back animations as objects, and the ability to use the VCR controller to record single-frame animation (currently listed as a future option).

About the Product

Video Machine for PC: $3995

Video Machine with Multi I/O Professional:.. $4995

Studio Control Box: $2500

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The Final Cut

Video professionals who use VM at this point will be opting for a pioneer experience, with all the joy and frustration that implies. During my evaluation, however, as evidence that it is sincere about perfecting and improving the system, Fast Electronic released a major software update that added several new features, including the VITC striping.

Despite some flaws in this initial release, VM's overall execution is sound, well designed, and effective. The automated editing seems like magic and can produce stunning results.

VM is an outstanding achievement with tremendous potential. Its future success is linked to those necessary software upgrades; if they proceed efficiently, Fast Electronic's Video Machine looks like a sure bet to make the video-editing PC an essential part of professional and semi-professional video studios. ■

Bob Lindstrom (Eugene, OR) is a nationally syndicated columnist and composer. He is a former creative director for Dynamix. You can reach him on BIX c/o "editors."

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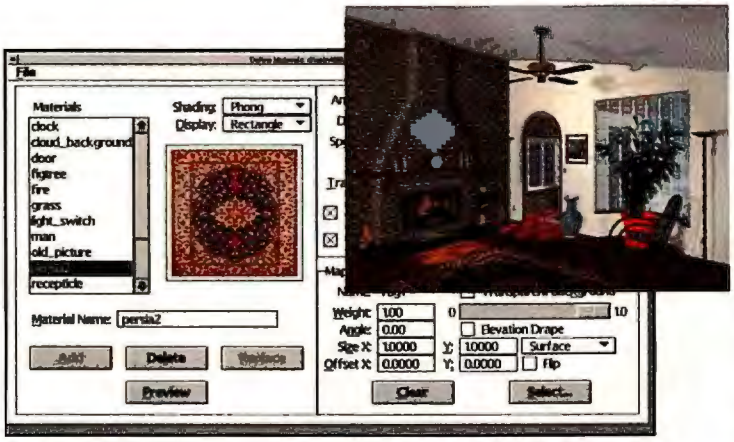

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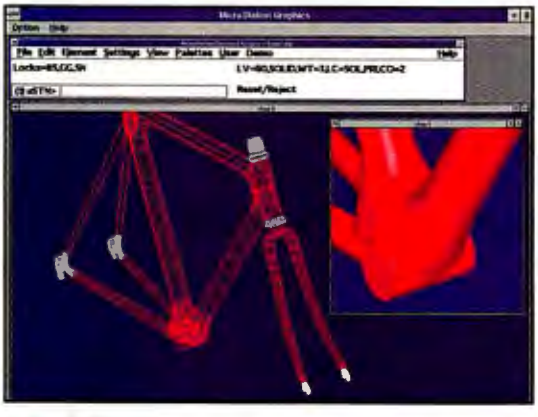

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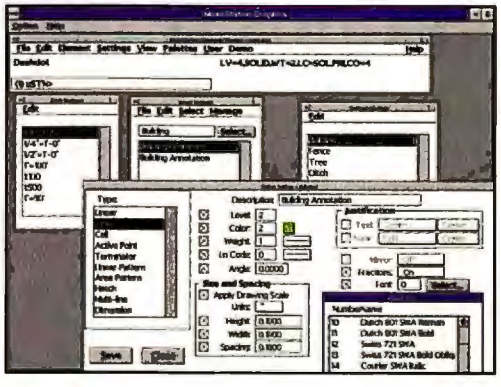

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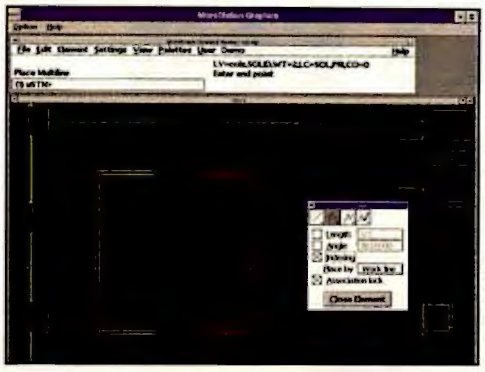

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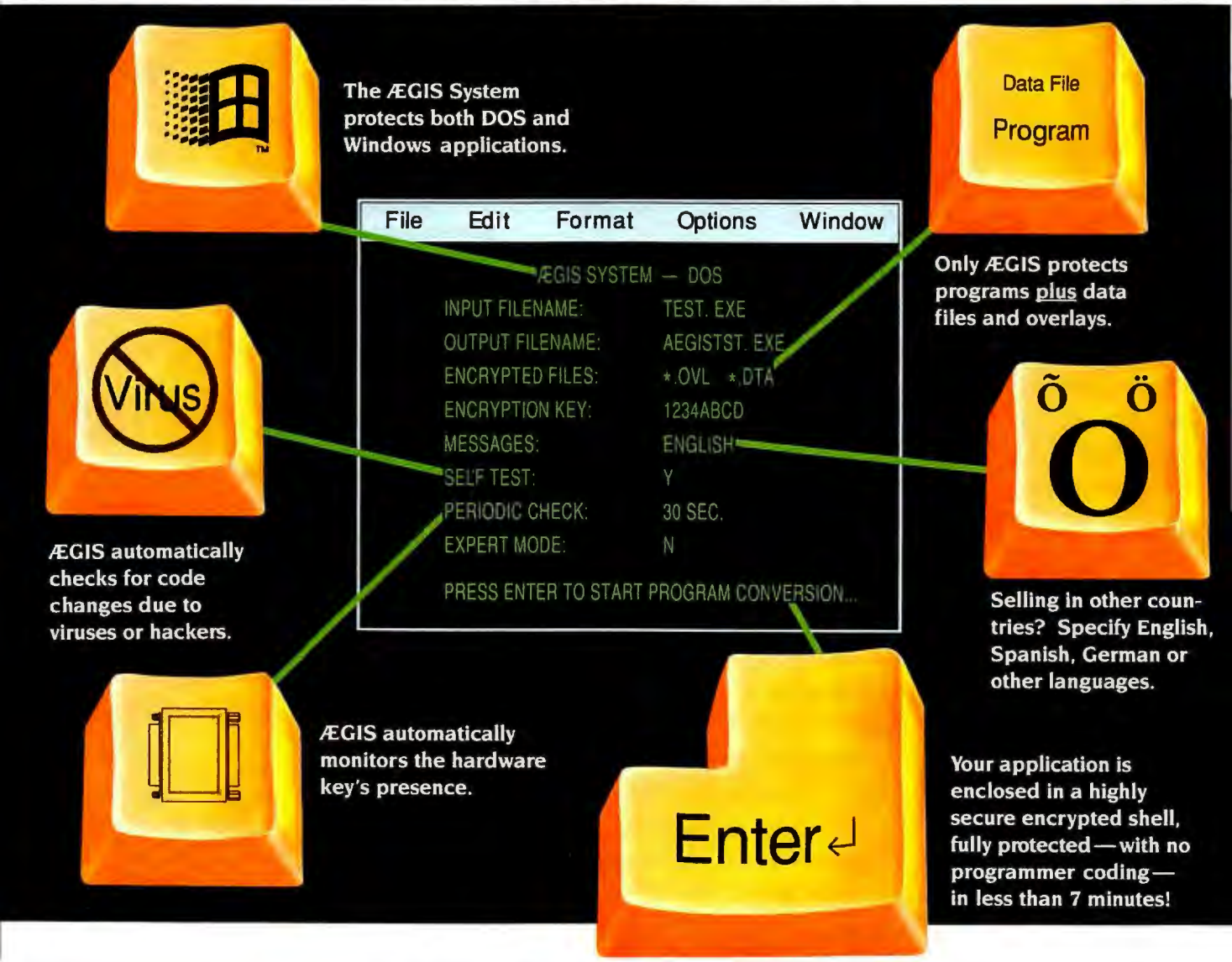

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LANtastic 5.0 vs. Invisible LAN 3.4

Upgraded peer-to-peer LANs with high performance and capable Windows clients reduce the strain of networking Windows workstations

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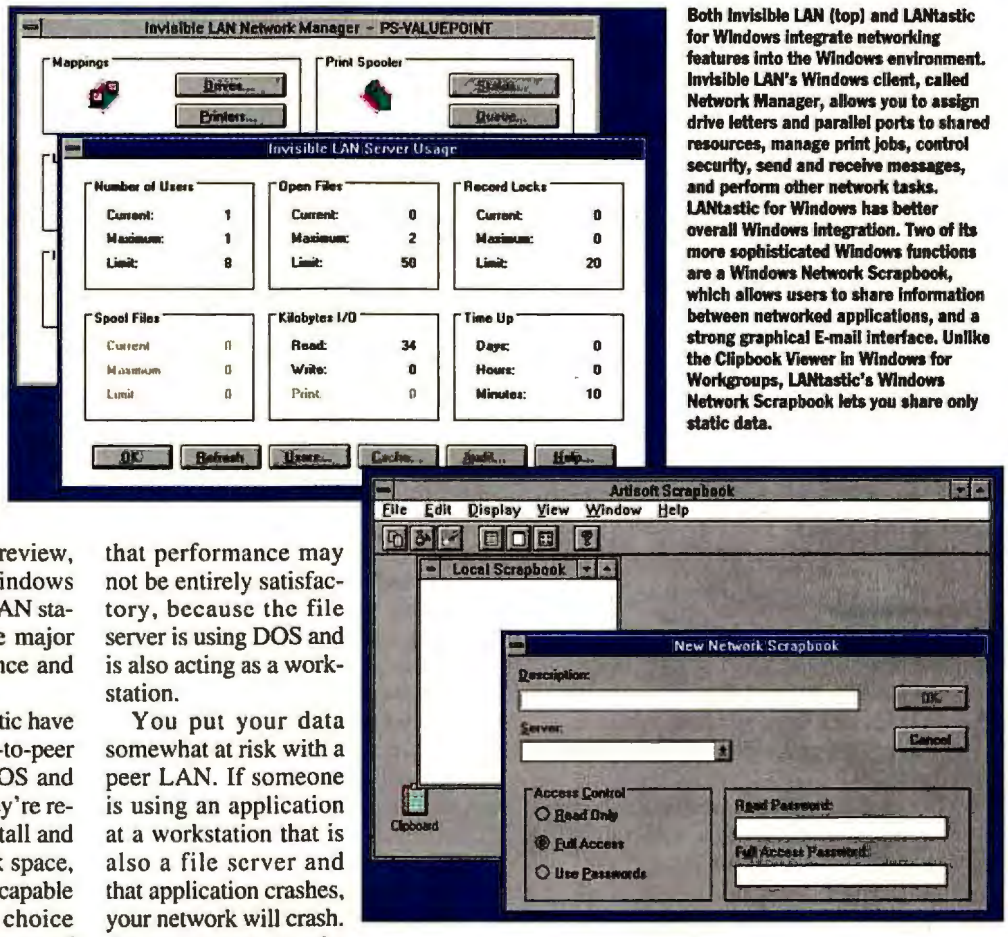


Both Invisible LAN (top) and LANtastic for Windows integrate networking features into the Windows environment. Invisible LAN's Windows client, called Network Manager, allows you to assign drive letters and parallel ports to shared resources, manage print jobs, control security, send and receive messages, and perform other network tasks. LANtastic for Windows has better overall Windows integration. Two of its more sophisticated Windows functions are a Windows Network Scrapbook, which allows users to share information between networked applications, and a strong graphical E-mail interface. Unlike the Clipbook Viewer in Windows for Workgroups, LANtastic's Windows Network Scrapbook lets you share only static data.

Windows for Workgroups has kindled a higher level of competition in the peer-to-peer LAN marketplace. Only a year ago, people talked about Windows and networks as if they were oil and water. Now, Windows and LANs seem inseparable.

But you have choices other than Windows for Workgroups. You can, of course, choose a server-based system for high performance and the highest level of reliability. For smaller LANs, however, especially where price is a primary consideration, a peer-to-peer solution makes more sense. In this review, I'll look at LANtastic 5.0 for Windows and Invisible LAN 3.4, two peer-LAN staples that have recently undergone major revisions for improved performance and better Windows integration.

Both Invisible LAN and LANtastic have features that make them good peer-to-peer network operating systems for DOS and DOS/Windows environments. They're reliable and more or less easy to install and use. Both are good at sharing disk space, files, and printers. Both come with capable E-mail systems. In the end, the choice comes down to the high performance of Invisible LAN 3.4 versus the easier configuration and use of LANtastic 5.0.

Distinguishing Features

Both Artisoft and Invisible Software offer starter kits (which include hardware) as well as software-only packages; I evaluate only the software in this review. Starter kits are convenient, but Ethernet cards and cables are cheap and plentiful. It's the software features that distinguish peer-LAN products.

On a server-based network, a separate, unattended computer acts as a file server. On smaller LANs, a workstation can be a file server and a workstation at the same time. This is a peer-to-peer LAN, or peer network. If you are on a tight budget, you can save the cost of a separate file server by using a peer LAN. Be aware, though, that performance may not be entirely satisfactory, because the file server is using DOS and is also acting as a workstation.

You put your data somewhat at risk with a peer LAN. If someone is using an application at a workstation that is also a file server and that application crashes, your network will crash. However, you can make a peer-LAN node a dedicated server just by not using it as a workstation.

A peer LAN has to support shared resources properly. The first thing I checked in both products was support for file sharing, record locking, and machine name identification, as well as proper functioning during the concurrent transfer of large files and files with odd sizes (e.g., copying a 65,536-byte file). LANtastic and Invisible LAN passed these tests with flying colors. You can share resources and run multiuser applications on these networks with confidence.

INVISIBLE LAN 3.4

Invisible LAN is a simple, fast, peer-LAN operating system. Although it lacks the frills of LANtastic 5.0, Invisible LAN offers better performance and a "server" option for speed-sensitive or larger peer environments.

Invisible LAN includes a Windows interface program called Network Manager. To install Network Manager, you run the DOS-mode Windows setup utility and then manually add the program and its icon to a Windows program group. Network Manager offers six categories of management tasks—Mappings, Local Station, Information, Print Spooler, Administration, and Electronic Mail. It allows you to share drive letters and parallel ports, manage print jobs, send and receive messages, and control security from within Windows. Invisible LAN doesn't install in a Windows environment as automatically as LANtastic does, but the process

LANtastic 5.0 vs. Invisible LAN 3.4

INVISIBLE LAN 3.4	LANTASTIC 5.0
• 250-node maximum	• 500-node maximum
• 45 KB for workstation, 65 KB for server, 100 KB for combination	• 27 KB for workstation, 53 KB for combined workstation/server
• Works with a dozen Ethernet and Token Ring cards	• Supports NDIS network adapters
• Supports CD-ROM sharing and UPSes	• Supports CD-ROM sharing and UPSes
• Automatic reconnect	• Automatic reconnect
• Outstanding performance	• Better Windows integration
• Ultra Server option twice as fast as LANtastic for Windows	• Scrapbook for communication between networked applications
• Conferencing system	• Sophisticated security
• High-performance protocol	• Mac connectivity
	• Routable protocol

is not difficult if you follow the manual.

The Invisible LAN installation program offers simple (default) and advanced modes. During advanced-mode installation, you edit a configuration file. Invisible LAN uses the parameters in the file to control just about every feature of the network operating system. You can create multiple configuration files for different setups.

Administration

LAN administrators work with two Invisible LAN utilities, one for DOS and another for Windows. Administrators perform tasks such as customizing and tuning initialization settings through a DOS-based setup utility.

For monitoring and modifying shared resources, administrators turn to Network Manager. To maintain the roster of people authorized to use the network, the administrator creates log-on accounts and assigns these accounts to groups. Each person uses a log-on account and a password to gain access to the LAN.

A shared resource can have one of six different access rights: read, write, create, list, execute, and share. Invisible LAN controls a workstation's access to resources with access rights assigned for each shared resource in a group. Initially, each user has full rights to all the shared files on each server. To implement privacy and security, the administrator must systematically deny a group or user access to a shared resource, by setting restrictions on a group or individual or by limiting the access rights available for a named shared resource.

Workstations running Invisible LAN can be part of a larger NetWare LAN by using third-party Crynwr (formerly Clarkson) packet drivers to run dual Invisible LAN/IPX stacks. Support for Microsoft LAN Manager and IBM LAN Server is built into Invisible LAN. Macintoshes can't connect to Invisible LAN at all.

High Performance

The $399 Ultra Server option for Invisible LAN helps the product make up for a lack of administrative niceties. Ultra Server is a 32-bit file management module that is licensed on a per-network basis. Theoretically, you can use Ultra Server on a nondedicated machine, but in most cases you'll want to turn one PC into an unattended file-sharing engine. The performance will be worth the cost of the extra PC. Ultra Server boosts performance in a variety of ways, including 32-bit, protected-mode hard disk access and fast disk caching. As measured by benchmark tests, Ultra Server doubles Invisible LAN's performance.

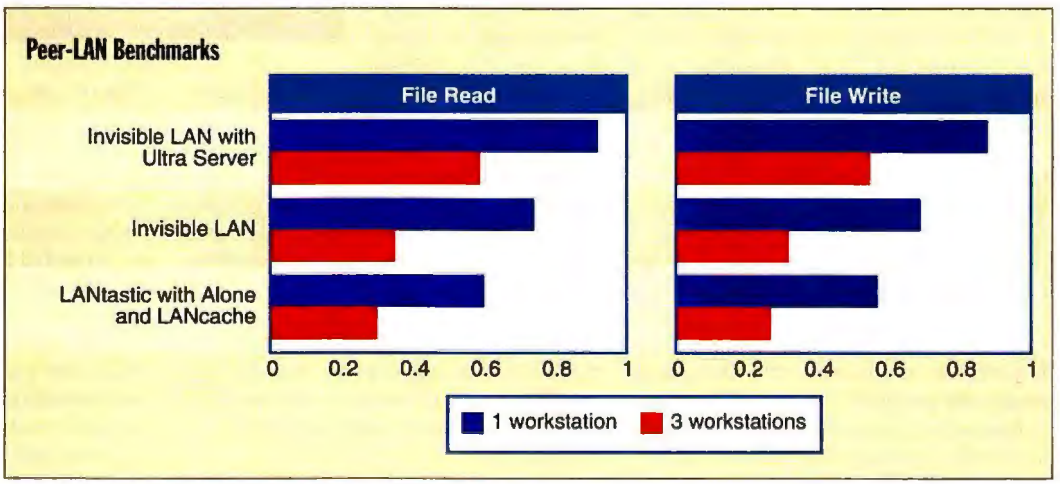
Invisible LAN uses a network protocol called TransBIOS, which is much like the IBM/Microsoft NetBEUI standard. TransBIOS negotiates a packet window between workstations and servers. The window is the number of file-read packets the server can send to a workstation, or the number of file-write packets the workstation can send to a file server, without requiring acknowledgment from the other party. This mechanism lets Invisible LAN transfer more information in a given amount of time, thus improving performance.

User's View

Invisible LAN offers a reasonable set of printing, mail, and conferencing features to each client. Network users can monitor, hold, and reprioritize print jobs sent to shared network printers. Invisible LAN can display print jobs by job title, time, or size, and you can use Windows Print Manager to manage print jobs from your own workstation (but not those jobs submitted by other workstations).

When you want to communicate with your coworkers over the LAN, you can send E-mail or use Invisible LAN's BBS-style conferencing. Invisible LAN's E-mail system offers a text editor for creating electronic interoffice memos. In addition to sending and receiving over-the-wire correspondence, you can print, save, and reply to incoming mail.

With conferencing, you leave messages in a message base that the other team members can read; other participants can also attach comments to messages. The message base maintains threads among



I tested these operating systems *on a four-node peer LAN. The test configuration included four 25-MHz 486 machines (made by IBM and Compudyne) running Windows 3.1 on DOS 5.0 or DOS 6.0, and four Noderunner Ethernet adapters (made by Artisoft) hooked up through thin-wire Ethernet. The benchmark results are shown as file I/O performance relative to a stand-alone machine; therefore, 1.0 represents a perfect score. I found Invisible LAN slightly faster than LANtastic (with both LANcache and Alone) when I didn't use Invisible Software's Ultra Server option. With Ultra Server, however, Invisible LAN was—amazingly—twice as fast as LANtastic.*

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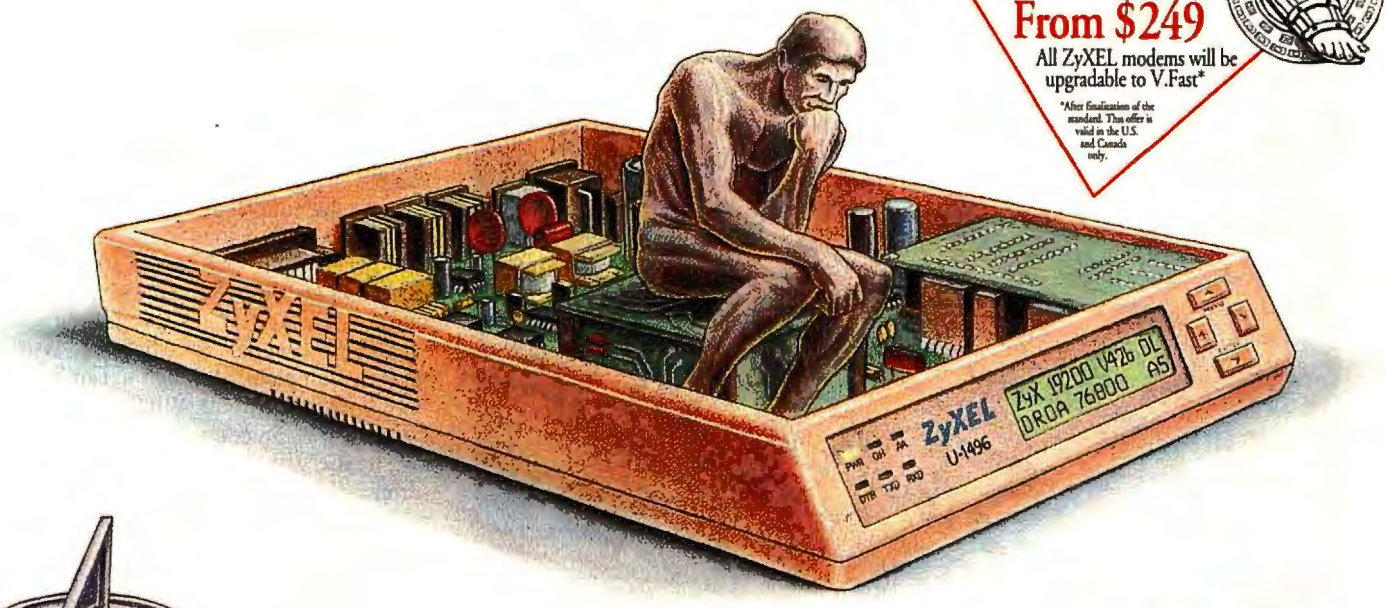

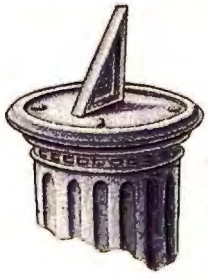

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messages, so you can easily find comments to a particular message. You can address a conference message to a single person or to a group. Conferencing is available only under Windows.

LANTASTIC 5.0

LANtastic has been a market leader for a number of years, and with good reason. LANtastic isn't the fastest network you can buy, but the software is easy to install, easy to use, and feature-rich. I review LANtastic for Windows here, but Artisoft sells a DOS-only version for a little less ($119 versus $139 for a single workstation).

Artisoft's support for Microsoft Windows is complete, although not quite as highly integrated with Windows as Microsoft's own Windows for Workgroups. LANtastic gives you an over-the-wire scrapbook for the Windows environment, called Windows Network Scrapbook, that works something like Microsoft's Clipbook Viewer. You can share text, image, and sound files with other Windows clients.

The LANtastic scrapbook is static, not dynamic: Other workstations get a copy of the data you want to share, not a connection to the original data on your PC. In contrast, Windows for Workgroups' NetDDE feature allows dynamic, real-time data connections between Windows applications running on different systems. To its credit, LANtastic's Windows Network Scrapbook can send messages that include a DDE macro that launches a given application when the recipient opens his or her mail.

The Windows E-mail component of LANtastic provides automatic notification of incoming mail, drag-and-drop capabilities, and cut-and-paste functions in the text editor. You can attach only a single file to an E-mail message.

Under Windows, you connect to a shared printer by simply clicking on the printer's icon and then clicking on the parallel port icon. You can monitor print jobs in the queue or those print jobs currently being serviced (i.e., printed). You can see printer status (on-line or off-line) and the estimated time to finish the printout. You can prioritize, hold, or delete print jobs, and even schedule print jobs for off-hours printing. With a feature called *immediate despooling*, a print server can begin printing a spool file even before the workstation completes the print operation.

continued

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Reviews LANtastic 5.0 vs. Invisible LAN 3.4

Significant Features

Artisoft includes with LANtastic a disk-caching utility called LANcache. LANcache boosted LANtastic's performance in my tests, but not nearly as much as Ultra Server did for Invisible LAN. Artisoft also bundles Alone, a module that allows you to dedicate a PC as a LANtastic server. Alone restricts users from running applications on dedicated machines.

Although Alone and LANcache together don't add up to Invisible LAN with Ultra Server, LANtastic has connectivity features that more than make up for its lack of speed. For example, LANtastic's NetBIOS packets are routable—through readily available IPX routers. According to Artisoft, LANtastic NetBIOS packets contain source and destination ID data at the same packet offset at which the information would reside in an IPX packet. I didn't test it, but the company claims that the packet structure makes LANtastic routable through any device that can route IPX.

LANtastic workstations can also share modems, using NetBIOS-aware communications software, through Artisoft's optional Articom Modem Sharing product. Artisoft offers gateways to NetWare and to TCP/IP networks. Last but not least, a version of LANtastic runs on Macs, although connecting Mac and PC LANtastic nodes requires a dedicated PC.

However, the most notable feature of LANtastic is its sophisticated file-by-file security. You administer LANtastic security through ACL (access control list) groups. These groups let you assign and change access rights for a group of users at a time. If you wish, you can designate file-access permissions for a particular user. You can set access rights at the directory level (affecting all files in the directory) or for a given file. The access rights you set include permissions to read, write, create, and modify files. By default, the rights are in effect 24 hours a day; however, you can also set up time-of-day and duration-specific rights. LANtastic's security system can force users to change passwords periodically and can encrypt passwords over the wire.

LANtastic also includes some nice administrative touches. A LANtastic network administrator can operate a LANtastic file server through remote control. The administrator can set up log-on accounts on one server and have all workstations authenticate against that central directory. The administrator doesn't have to add a new log-on account to every file server, as would be necessary under systems like NetWare 3.11.

Between Peers

How do LANtastic for Windows and Invisible LAN play against Windows for Workgroups? Windows for Workgroups has much better overall integration with Windows than either of these products, with a more capable NetDDE and seamless linking to File Manager and Print Manager. It also includes scheduling and other productivity applications. But Windows for Workgroups is much slower on all but the most trivial networks.

If your organization is new to LANs and you have users who aren't comfortable with DOS, I recommend that you buy LANtastic 5.0 for Windows. You'll also want to get LANtastic instead of Invisible LAN if you have Macs or if the peer LAN you create is part of a larger NetWare network.

If your group is already familiar with DOS and will forgo some of the niceties of point-and-click for pure speed and responsiveness, you'll definitely want to buy Invisible LAN with the Ultra Server option. LANtastic is a Cadillac, but Invisible LAN is a hot rod (and Ultra Server is a fuel-injection and turbocharger option). Both peer LANs are reliable and handle the basics well, and pricing is similar; choosing between the two is mostly a matter of deciding between speed and comfort. ■

About the Products

Invisible LAN 3.4
Single workstation: $149
Five or more workstations: $99 each
Ultra Server: $399
(other configurations available)

Invisible Software, Inc.
1215 North Highway 427, Suite 135
Longwood, FL 32750
(800) 982-2962
(407) 260-5200
fax: (407) 260-1841
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LANtastic 5.0 for Windows
Single workstation: $139
Six-user version: $779
(other configurations available)

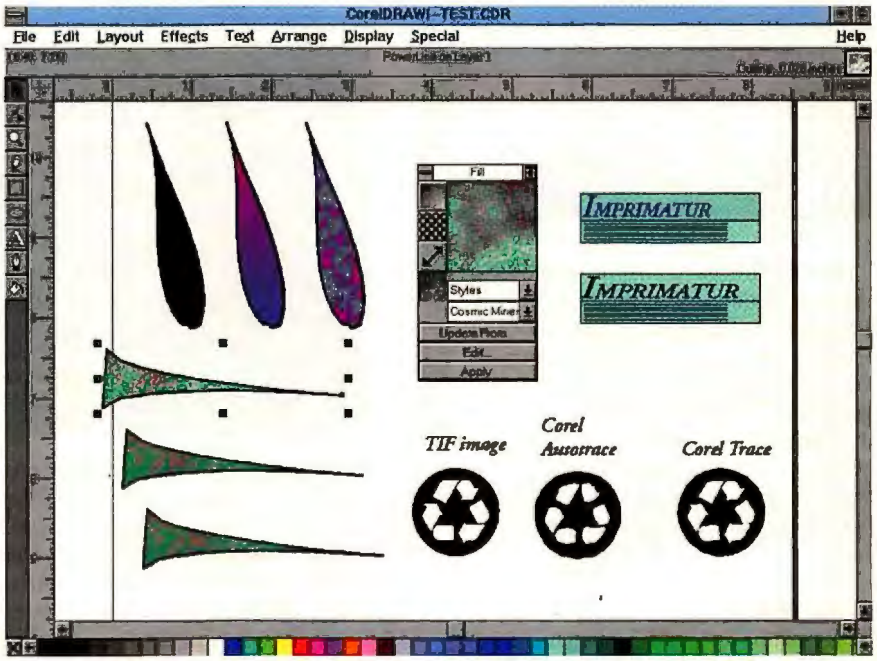
Artisoft, Inc.
2202 North Forbes Ave.
Tucson, AZ 85745
(800) 846-9726
(602) 670-7100
fax: (602) 670-7101
Circle 1078 on Inquiry Card.

Barry Nance, a programmer for the past 20 years and a BYTE contributing editor, is the author of Using OS/2 2.1 *(Que, 1993),* Network Programming in C *(Que, 1990), and* Introduction to Networking *(Que, 1992). Barry is the Exchange Editor for the IBM Exchange on BIX, where you can reach him as "barryn."*

CorelDraw 4.0: The Word Is More

Path-based animation, multiple pages, an object database, and even OCR and forms generation: The latest CorelDraw packs in the features

G. ARMOUR VAN HORN



Powerlines can create teardrops and trumpets. The screen shows these objects with solid, graduated, and fractal fills, along with the fill rollup. In the lower right corner, note the tracing results from CorelDraw's autotrace and from CorelTrace. The original TIF image serves as a reference. The author's logo shows simple text, line, and rectangle styling.

More. That's the central theme of CorelDraw 4.0, the market-leading illustration software for Windows—more fonts, more clip art, more modules, more common interface among modules, and more pages. The box includes two CD-ROM disks, but the video tour that introduced new users to the program for the last two versions had to be eliminated—there just wasn't room for it.

For many professionals, CorelDraw 4.0 ($595) will be the first choice for graphics creation and editing. Corel will continue to offer CorelDraw 3.0 at $199 for those who don't require quite so much "more."

The 12 1.44-MB floppy disks install about 36 MB of files on your hard drive, including Corel's seven modules, symbols, and a small number of fonts. If you are really voracious, you can install from the two CD-ROMs and get all 18,000 pieces of clip art and over 750 fonts. The font collection includes both TrueType and PostScript Type 1 formats. You can run CorelDraw 4.0 from a CD-ROM drive, reducing the hard disk space requirement to about 2 MB, but performance will suffer noticeably.

A Striking Resemblance

CorelDraw 4.0's interface has no immediately apparent differences from that of version 3.0: The status bar and menus appear across the top of the screen, nine tools run in a column down the left side, and the fill palette continues across the bottom of the screen. This should comfort experienced CorelDraw illustrators, because the new features and commands in version 4.0 require enough attention without a new interface to learn as well.

CorelDraw 4.0 maintains commands from earlier versions, which allow the creation of lines, shapes, and text, and still requires substantial mouse motion and keyboard exercise for the commonly used commands. Relatively few common commands are available as mnemonic keyboard shortcuts, so you'll either have to memorize Shift, Control, or Alt combinations with the F1 to F12 keys or make many trips to the toolbox or menus. Version 3.0's pick, shape, and alignment tools are also included in the new version.

With so many like features between the two versions, you could work in version 4.0 and not notice the differences at all—until you undo a change. Unlike in CorelDraw 3.0 where you only have one level of Undo, version 4.0 defaults to four levels of Undo, and it's configurable to up to 99 levels.

NEW FEATURES

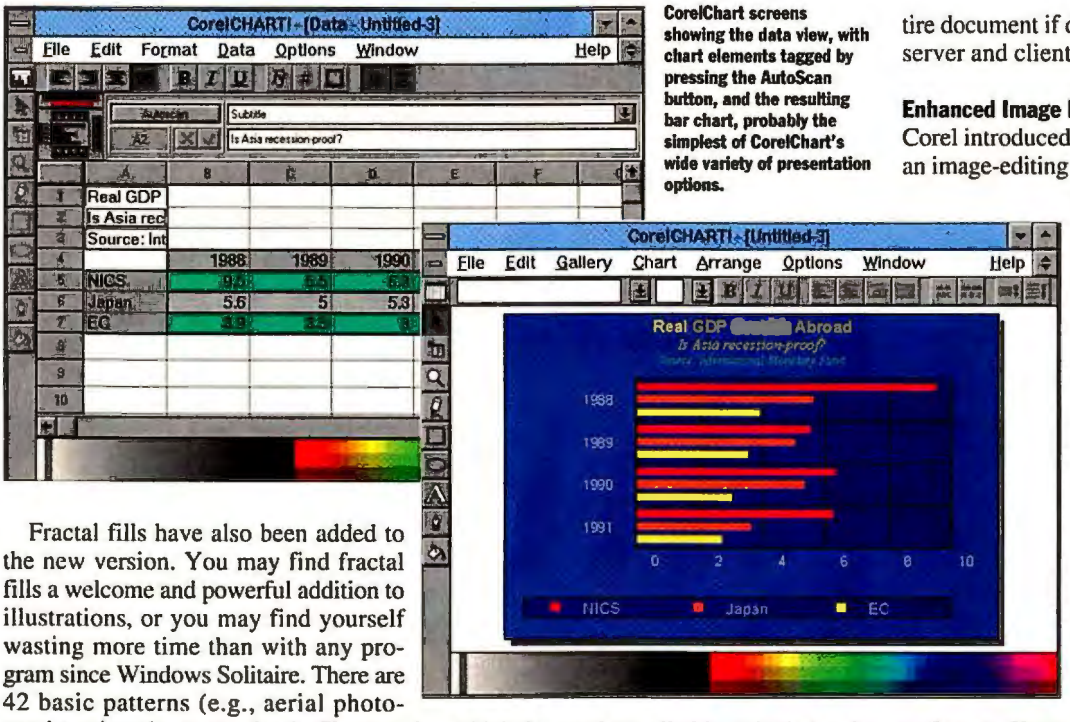
- **up to 999 pages per file**
- **99 levels of Undo**
- **powerlines—customized shapes from the pen tool**
- **fractal fills**
- **755 fonts and 18,000 pieces of clip art**

Another bonus feature in CorelDraw 4.0 is an Insert Pages command in the layout menu, which allows up to 999 pages in a single file. CorelDraw can work as a simple page-layout program for the occasional brochure, but the speed with which it manipulates text will not threaten QuarkXPress or PageMaker. Multiple pages are convenient for assembling a series of ads for a customer or for generating several variations of a single illustration, largely making up for the lack of an MDI (Multiple Document Interface).

Offering convenience and power with minimal screen clutter, CorelDraw 4.0's *rollups* now control more features. These floating palettes allow you to specify many attributes of an object; at the press of a button, the palettes roll up into a simple bar showing only the title and the control box. Rollups control text, layers, styles, text envelopes, powerlines, contours, node editing, symbols, and data.

Powerlines are an outgrowth of the effects available with pressure-sensitive tablets (but you do not need a tablet to take advantage of powerlines). Woodcut shapes, teardrops, bullets, and trumpets are available at the stroke of the pen tool. Once you have created a shape with powerlines, control handles let you edit it.

CorelDraw 4.0: The Word Is More



CorelChart screens showing the data view, with chart elements tagged by pressing the AutoScan button, and the resulting bar chart, probably the simplest of CorelChart's wide variety of presentation options.

Fractal fills have also been added to the new version. You may find fractal fills a welcome and powerful addition to illustrations, or you may find yourself wasting more time than with any program since Windows Solitaire. There are 42 basic patterns (e.g., aerial photographs, minerals, paper, clouds, fibers, and flames), and each has a range of editable options for a total pattern count in the millions.

Stylish Text

Text creation and modification has always been powerful in earlier versions of CorelDraw, featuring editable text envelopes, spelling and thesaurus, extrusion, and the ability to convert text to curves. CorelDraw 4.0 dramatically expands text handling. It delves into the realm of desktop publishing with a staggering variety of automatic bullets and better control over tabs, indents, and character spacing. If you need to work with large bodies of text, version 4.0 lets you export blocks of text for editing in your favorite Windows word processor; you then can merge the text back into the illustration file, and most text attributes will remain intact.

NEW FEATURES

- automatic bullets
- text and graphics styles
- merge from Windows word processors
- object database
- more floating palettes (Corel rollups)

The right mouse button exposes other new features. You can create styles for both text and graphics for specifying fills, outlines, fonts, tabs, indents, bullets, and spacing. Clicking on any object with the right mouse button adds its characteristics to your style sheet, or you can apply an existing style to the object. With an existing style selected in the style menu, clicking on an object with different characteristics presents the Update Style option, which then updates all objects in that style to match. Not only is it a powerful tool for editing complex files, but it's fun to watch. The Control + numeral combinations can rapidly apply your 10 most common styles.

An object-database feature has also been added, again only noticeable if you click on an item with the right button. You can associate part numbers, costs, dates, and text with drawing elements and display them in a spreadsheet. Alas, you can't export the spreadsheet to other applications.

CorelDraw 4.0 can import most common formats, including JPEG compressed images and Kodak's Photo CD format. Although the program can open only its own files, it can import Adobe Illustrator, Micrografx Draw, Windows metafile, and WordPerfect graphics files directly. CorelDraw can turn Mac EPS files that Adobe Illustrator creates into editable illustrations. You can place EPS files that other Mac applications create in a Corel document, but the files aren't editable. The distinction between importing and placing a file is not well documented.

CorelDraw 4.0 can export all the formats it can import, and it can export selected items only rather than the entire document if desired. It is both an OLE server and client.

Enhanced Image Editing and Charting

Corel introduced the Photo-Paint module, an image-editing package based on PhotoFinish from ZSoft, in CorelDraw 3.0. In that version, the ZSoft module was bundled with few changes. Now, in version 4.0, the toolbox is on the left, and many editing options appear as rollups. Photo-Paint has direct scanning controls for common scanners and acts as an OLE server.

Effects filters include emboss, motion blurs, psychedelic, solarize, sharpen, unsharp mask, rotation, color-balance controls, and Van Gogh or Seurat effects. Although the default file format is PCX, Photo-Paint can read and write BMP, GIF, Targa, and TIFF files, as well as save EPS files and read some JPEG compressed files. The image editor works only with RGB format files, but it supports color separation and prepress functions and can save CMYK files for process color printing.

CorelChart is a module that creates 18 different chart types (the same amount that's in version 3.0) and includes a minimal—although expanded—spreadsheet for arranging data. You can now apply fills, patterns, and textures to charts from any other module. CorelChart is an OLE server, allowing other applications to use the resulting charts; therefore, you can establish DDE links to any Windows spreadsheet to build charts quickly from existing data. You can export CorelChart's data sheets to Excel, Lotus, and several ASCII formats.

CorelShow, a presentation module, creates overhead transparencies, 35mm slides, and on-screen presentations. New features include branching to different slides depending on audience response and setting transitions for different elements on an object-by-object basis instead of slide-to-slide. The CorelShow module is an OLE client and ships with a run-time component, allowing you to provide

NEW FEATURES

- direct scanning control
- special-effects filters
- fills, patterns, and textures available in charts
- graphical time line in CorelShow
- transitional effects applied to any object

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Reviews CorelDraw 4.0: The Word Is More

stand-alone presentations to Windows users without CorelDraw 4.0.

Trace, Mosaic, and Move

CorelTrace, the module for importing bit maps and generating vector images that CorelDraw can manipulate, has changed substantially for version 4.0. In addition to including the outline and centerline options of the previous version, CorelTrace generates silhouettes of bit-map images, an interesting woodcut effect that looks more like a coarse line screen, and supports two options for OCR.

NEW FEATURES

- **bit-map silhouettes**
- **OCR capability and forms creation**
- **drag-and-drop file management**
- **path-based animation**

The basic OCR process converts a scanned document to text, and CorelTrace does a reasonable job of it. A Form method goes even further: It first recognizes text, then scans lines, and finally traces other objects. This allows rapid development of replacement forms in CorelDraw, perhaps the most direct and efficient process I've seen.

CorelMosaic is a module that creates thumbnail images of any files you edit in the other modules and saves them in catalogs. You can attach text to catalog entries, and CorelMosaic can search across multiple catalogs. While preparing files for the catalog, CorelMosaic compresses any file that is not already in a compressed format. You manage files by simply dragging and dropping them.

The new version also adds a slick animation module called CorelMove. You can start with any "actor" or "prop" from a bundled library or create your own in CorelDraw or Photo-Paint. By using version 4.0's blend feature, you can automatically create a series of steps for your actor. A CorelMove checkbox lets you assign these steps to animation cels. The actors travel along a path you create. Nodes on the path can be added, deleted, or automatically smoothed for a less jerky motion. You can customize WAV sound files with the CorelMove Sound Editor and attach them to the animation, and you can export the final creation to .FLC or AVI (Audio Video Interleave) format or distribute it with a stand-alone player.

The Kitchen Sink

It is almost criminal to purchase version 4.0 without using a CD-ROM drive. Without either a CD-ROM player or lots of hard disk space, the 489-page catalog of color and black-and-white clip art is just a tease. There are 755 fonts on the CD-ROM disks; installing from floppy disk limits you to about 50 TrueType fonts.

Despite so many new features, CorelDraw 4.0 still does not support multiple-open documents, a significant deficiency. In a welcome accommodation to Windows 3.x, Corel has finally adopted the Windows conventions for common editing commands, although the old commands are still available.

Corel has always supported many operating platforms and was expected to support the Macintosh by this time. The program's designers decided to take advantage of features in Apple's promised QuickDraw GX but delays in the release of Apple's upgrade derailed development of the Mac version of CorelDraw. To make significant moves into the professional graphic-arts market, CorelDraw will need to operate on both Windows and the Mac, and Corel intends to take that direction. A good first step would be to allow the Windows version to export Mac EPS files (and vice versa when the time comes). Corel's previewless EPS files appear only as gray rectangles when placed in Mac layouts.

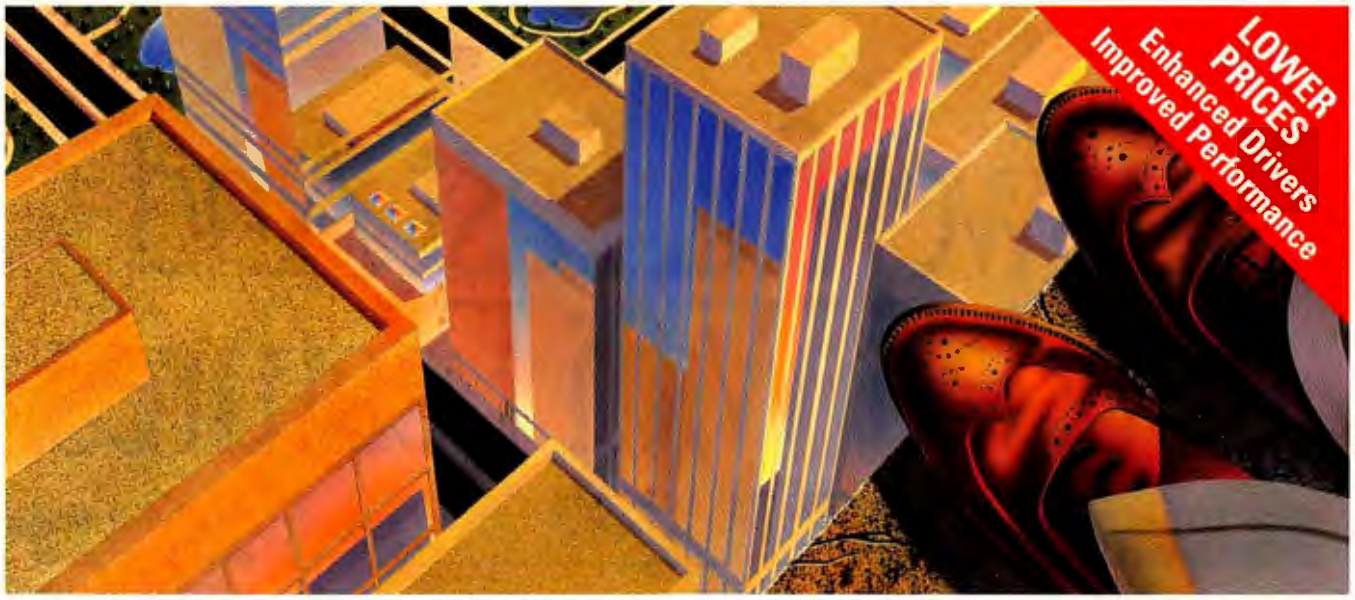
I ran into two significant problems when installing CorelDraw 4.0. Besides space for the Corel program files, the installer requires space on the drive with your Windows directory for TrueType fonts. I discovered that you can't install the program without having enough room on the Windows drive to place the 50 TrueType fonts; if you don't, you will never get to the selection dialog box to deselect enough fonts to make the program fit. Also, it turned out to be impossible to install from a floppy drive across Windows for Workgroups, a problem that Corel plans to address in a maintenance upgrade. Corel has an excellent record, however, for supporting early buyers with free maintenance upgrades.

For a number of professionals, CorelDraw 4.0 will be a valuable toolbox. No other program comes close to offering this range of function at Corel's price. CorelDraw 4.0 is an impressive piece of work. ■

About the Product

CorelDraw 4.0.....$595
Corel Corp.
The Corel Building
1600 Carling Ave.
Ottawa, Ontario,
Canada K1Z 8R7
(613) 728-8200
fax: (613) 728-9790
Circle 976 on Inquiry Card.

G. Armour Van Horn is a writer and graphics consultant in Freeland, Washington. He can be contacted on BIX as "vanhorn."



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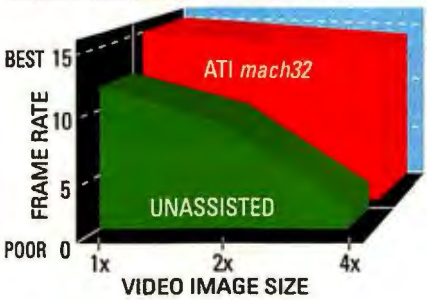

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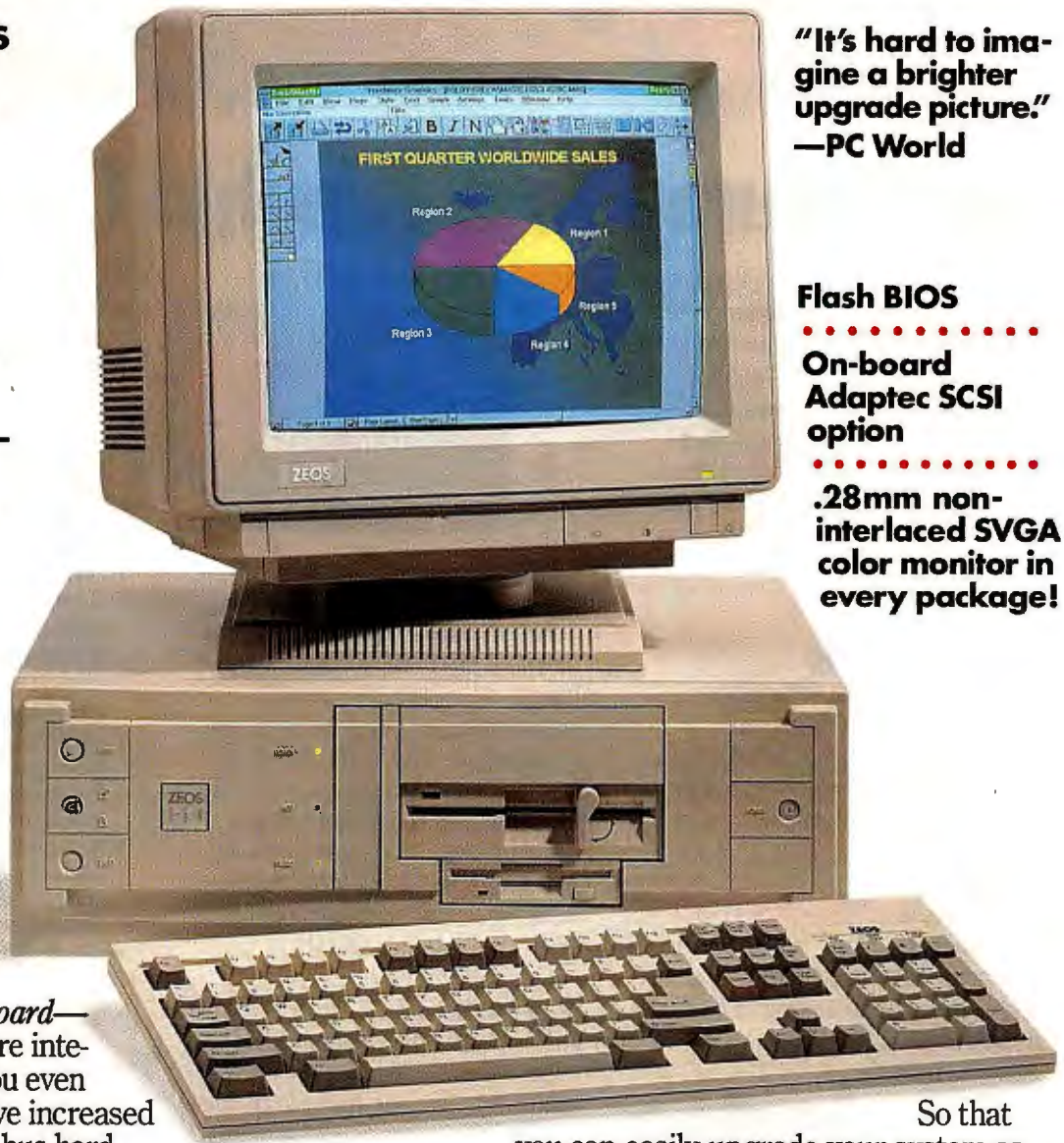

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SYSTEM HIGHLIGHTS	PACKAGE 1	PACKAGE 2	PACKAGE 3	PACKAGE 4
NOW: Hard drives up to 528MB and new lower prices!	■ ZIF socket upgradability to Pentium OverDrive CPU ■ 2MB high-speed RAM ■ 107MB local bus IDE hard drive w/32K cache ■ Windows-accelerated VL local bus video with 1MB RAM ■ Your choice of floppy drives ■ MS DOS 6.0 plus Enhanced Tools	■ ZIF socket upgradability to Pentium OverDrive CPU ■ 4MB high-speed RAM ■ 214MB local bus IDE hard drive w/128K cache ■ Windows-accelerated VL local bus video with 1MB RAM ■ Both 1.2MB and 1.44MB floppy drives ■ MS DOS 6.0, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows applications	■ ZIF socket upgradability to Pentium OverDrive CPU ■ 8MB high-speed RAM ■ **426MB,** 13ms local bus IDE hard drive w/128K cache ■ Windows-accelerated VL local bus video with 1MB RAM ■ Both 1.2MB and 1.44MB floppy drives ■ MS DOS 6.0, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows applications	■ ZIF socket upgradability to Pentium OverDrive CPU ■ 16MB high-speed RAM ■ **528MB,** 12ms local bus IDE hard drive w/256K cache ■ Windows-accelerated VL local bus video with 1MB RAM ■ Both 1.2MB and 1.44MB floppy drives ■ MS DOS 6.0, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows applications
486SX-25	**$1395**	**$1695**	**$1995**	**$2495**
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HANDS-ON

32 HIGH-SPEED HARD DRIVES

New benchmarks identify the best SCSI and IDE hard drives from 250 MB to 2 GB

HELEN HOLZBAUR AND JIM HURD

Fast hard drives at affordable prices: From the diminutive 2½-inch Maxtor 7245AT to the screamingly fast Seagate ST12550N (also known as the Barracuda), the class of '93 has pushed the envelope on speed and capacity. We stress-tested 32 IDE and SCSI hard drives ranging in capacities from 250 MB to 2 GB to find the leading performers, whether you're expanding your current storage capacity or specifying a hard drive for a new PC, workstation, or Macintosh.

We rank the performance of each drive using a suite of custom benchmarks that identifies the fastest drives in three capacity classes. The benchmark suite consists of 24 tests that run the gamut from simple reads and writes to multithreaded tasks that challenge a drive's caching abilities.

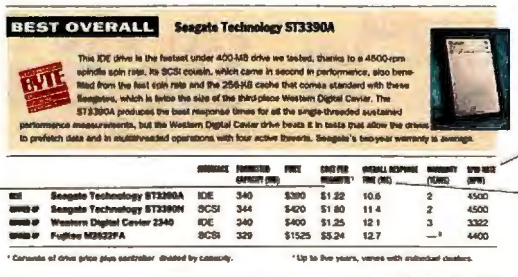
The BYTE Lab Reports rate the best products based on application rather than product categories. But for hard drives, we decided there were no clear-cut ways to typify how hard drives are used, because even single-application computer users will need to read and write sequential and random data over the course of a day. Instead, we built a model based on DOS, Windows, Unix, and Macintosh applications and from that made the following assumptions: You run your hard drive with a disk cache, the ratio of reads to writes is 60 to 40, and your drive won't be so fragmented that your data is scattered randomly across the disk. Even if this

How to use this guide

To find the right hard drive, compare the drives ranked in the capacity categories that match your requirements. In each category, we select best overall, best low-cost, and best IDE and SCSI drives. In each category, we also list a number of close competitors. If you are not sure which interface to use, see "IDE and SCSI: Contrasting Styles" on page 190.

All performance measurements are in milliseconds. For response times, lower numbers indicate better performance. A 10 percent difference in performance between drives is almost indistinguishable, while a 30 percent or greater performance difference will be noticeable to most users in real-world conditions.

For IDE drives, the cost per megabyte consists of retail drive price plus $25 (for controller), divided by capacity; for SCSI drives, the cost equals retail drive price plus $200 (for controller), divided by capacity.


BEST OVERALL Seagate Technology ST3390A

This IDE drive is the fastest under 400-MB drive we tested, thanks to a 4500-rpm spindle spin rate, its SCSI cousin, which came in second in performance, also benefited from the fast spin rate and the 256-KB cache that comes standard with these Seagates, which is twice the size of the third-place Western Digital Caviar. The ST3390A produces the best response times for all the single-threaded sustained performance measurements, but the Western Digital Caviar drive beats it in tests that allow the drives to prefetch data and in multithreaded operations with four active threads. Seagate's two-year warranty is average.

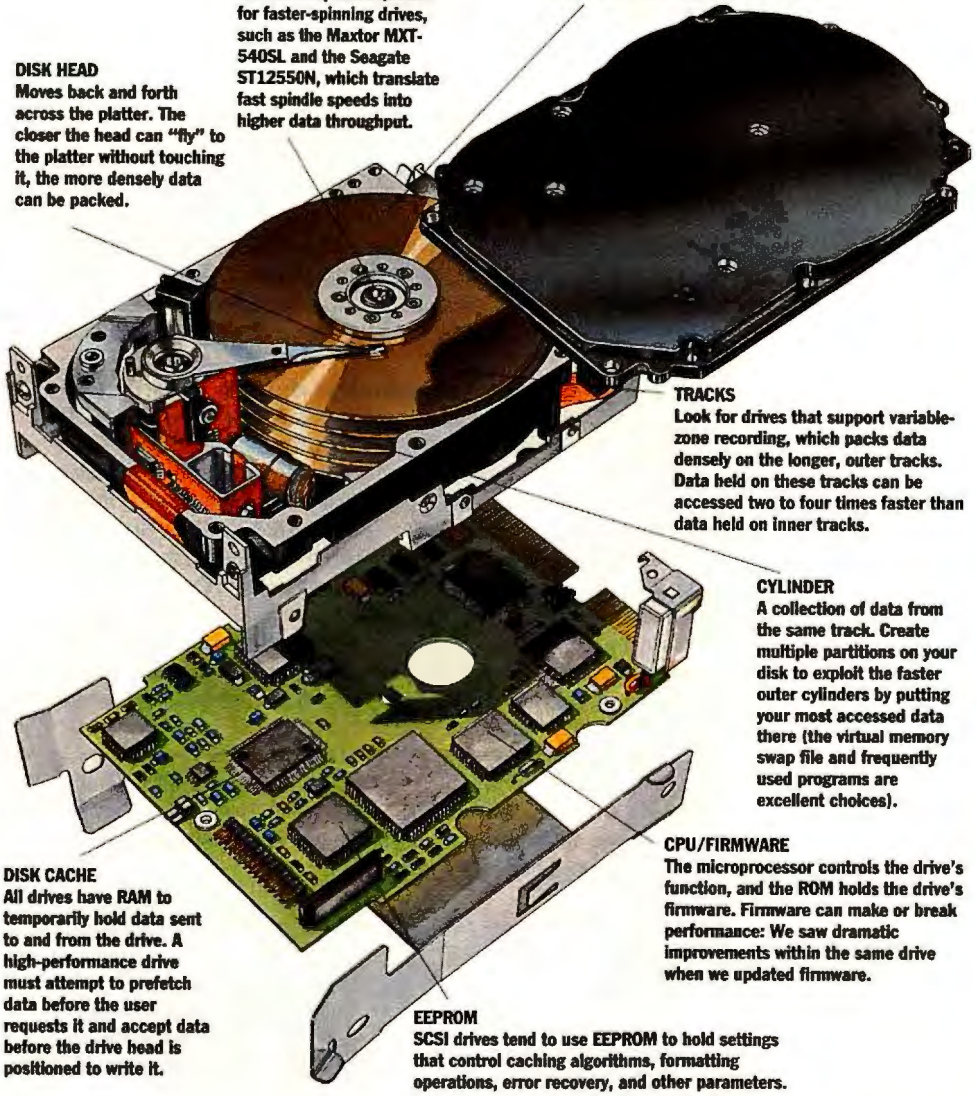
BEST	Seagate Technology ST3390A	IDE	340	$390	$1.22	10.6	2	4500
BEST BUY	Seagate Technology ST3390N	SCSI	344	$420	$1.80	11.4	2	4500
BEST BUY	Western Digital Caviar 2340	IDE	340	$400	$1.25	12.1	3	3322
BEST BUY	Fujitsu M2622FA	SCSI	329	$1525	$5.24	12.7	—*	4400

* Consists of drive price plus controller divided by capacity. * Up to five years, varies with individual dealers.

Rotational speed of the drive platters.

A composite measurement based on 24 different tests and weighted according to a profile of DOS and Windows use.

Hard Drive Essentials



SPINDLE
Fast spindle speeds mean short latency times (i.e., the time the drive must wait for the platter to spin into the correct position). Look for faster-spinning drives, such as the Maxtor MXT-540SL and the Seagate ST12550N, which translate fast spindle speeds into higher data throughput.

DISK PLATTER
Typically made from aluminum. Some companies (e.g., Areal and Maxtor) are moving to glass substrate, which can improve data density and drive performance.

DISK HEAD
Moves back and forth across the platter. The closer the head can "fly" to the platter without touching it, the more densely data can be packed.

TRACKS
Look for drives that support variable-zone recording, which packs data densely on the longer, outer tracks. Data held on these tracks can be accessed two to four times faster than data held on inner tracks.

CYLINDER
A collection of data from the same track. Create multiple partitions on your disk to exploit the faster outer cylinders by putting your most accessed data there (the virtual memory swap file and frequently used programs are excellent choices).

CPU/FIRMWARE
The microprocessor controls the drive's function, and the ROM holds the drive's firmware. Firmware can make or break performance: We saw dramatic improvements within the same drive when we updated firmware.

DISK CACHE
All drives have RAM to temporarily hold data sent to and from the drive. A high-performance drive must attempt to prefetch data before the user requests it and accept data before the drive head is positioned to write it.

EEPROM
SCSI drives tend to use EEPROM to hold settings that control caching algorithms, formatting operations, error recovery, and other parameters.

doesn't fit you exactly, remember that a fast hard drive remains fast no matter how you use it.

Our tests showed that today's drives are the best-performing hard drives ever. Over 80 percent of the drives we tested operate at spindle rates greater than the traditional 3600 rpm. Fast spin rates mean you spend less time waiting for the disk to position itself correctly to read or write data. Thanks to its 7200-rpm spin rate, the 2-GB Barracuda ran more than 15 percent faster than its closest competitor, the 6300-rpm Maxtor MXT-1240S, a 1.2-GB SCSI drive.

Today's drives use write caching to improve performance (within our main sample, only Seagate's 245-MB ST3283A IDE drive and Hitachi's 418-MB DK314C SCSI drive did not support write caching). But 15 SCSI and four IDE drives arrived with write caching disabled, and enabling it usually required firmware updates.

The long-term durability of today's faster spinning drives remains a question. The high spin speeds mean harder impact whenever a head hits a platter. Faster hard drives can run hot. It's wise to choose a drive with a multiyear warranty (a third of our test sample offered five years).

Many IDE drives can run five times faster than what a standard ISA bus can handle. Local-bus interfaces promise an end to this bottleneck, but some drives in our sample showed only minor performance improvements with local-bus technology (see "Local-Bus IDE" on page 180).

We only tested drives from manufacturers, rather than from VARs that relabel OEM drives. We believe this gives you the best basis for comparing hard drive performance. Note that Quantum and Hewlett-Packard declined to participate in this evaluation because they couldn't supply their new drives in time for testing.

SEPTEMBER 1993 BYTE BEST HARD DRIVES

BEST

250 TO 350 MB

Seagate Technology ST3390A

The 4500-rpm spin rate of this 340-MB IDE drive was among the highest in this capacity class, which translates into fast response time when the disk head positions itself for reading or writing data. The spin rate, along with a cache twice the size of many competitors, helped the ST3390A log the fastest overall response time in this group. With a cost per megabyte of $1.22, this was the most economical drive in this class.
PAGE 179

400 TO 600 MB

Maxtor MXT-540SL

The Maxtor MXT-540SL, like other speed leaders in this category, took advantage of such performance-improving techniques as voice-coil head positioning. This drive differentiated itself by also offering a spin rate of 6300 rpms, which only one other drive in our entire test sample could beat. This 546-MB SCSI drive's overall response time outperformed the next fastest runner-up by 1.2 ms, which was one of the largest speed differences we saw. This is an excellent high-performance drive for PC, Mac, and Unix users.
PAGE 185

1 TO 2 GB

Seagate Technology ST12550N (Barracuda)

Aided by a 7200-rpm spin rate and an average latency time of only 4.2 ms, this 2.1-GB SCSI drive is in a performance class by itself. In many tests, the Barracuda accessed random data faster than many of its competitors accessed sequential data. What's more, the drive's value extends beyond raw performance: The cost per megabyte of $1.05 is the lowest of any drive we tested, and the drive comes with a five-year warranty.
PAGE 189

THE BEST DRIVES IN CAPACITIES FROM

250 TO 350 MB

This capacity is the size of choice for entry-level and general-business PCs and Macs. Because of their mass-market appeal, these drives often favor low price at the expense of performance.

In each of the "Best" categories, we ranked winners based on their performance scores. Low-cost winners and runners-up are those with the lowest cost per megabyte.

On the PC side, IDE remains the standard interface for low-range and midrange systems, and not surprisingly, seven of the 10 drives we tested in this class were IDE-based. Cache sizes tend to be small to limit cost; many of the drives provide just 64 KB of cache. Contrast this with the usual 128- or 256-KB caches on higher-capacity drives.

The Seagate ST3390 IDE and SCSI drive series includes the fastest-spinning drives (4500 rpm) and provides the largest caches (256 KB); not concidentally, these hard drives proved to be the best-performing drives throughout this category. Although the Seagate ST3283 drives have the same spin rates as that of their larger cousins, they are two of the slowest drives in this category. The ST3283A (IDE) performance is particularly bad due to its lack of write caching. Only the 251-MB Samsung 3122A is slower. The ST3283N's performance is good, but its relatively small capacity for a SCSI drive puts it at a performance disadvantage compared to large SCSI drives, which can pack data more densely. Nevertheless, its performance was faster than all the IDE drives except that of the Seagate ST3390A.

Western Digital's 340-MB Caviar 2340 is second in speed only to the two Micropolis drives among all IDE drives in reads using four threads. Excellent four-segment performance is important to database applications, as well as for multitasking multiple applications using OS/2 or Unix.

Conner's CP-30254 is the fastest IDE drive under 300 MB, and it even outperformed the 345-MB Maxtor 7345AT. The Conner's speed is partly due to its spin rate: 4542 rpm, the fastest in this capacity class. The Conner drive implements write caching, which boosts its performance significantly over noncaching drives like the Seagate ST3283A. The Conner was also one of the most improved drives when used with local bus; it was 30 percent faster on sustained reads using local-bus IDE.

GLASS-PLATTER DRIVES

We tested two 2½-inch IDE drives that use new glass-platter technology: the 180-MB Areal A180 and the 251-MB Maxtor 25252A. Areal has been a force in bringing glass-platter drives to market and makes only glass drives. The Maxtor 25252A hard drive marks Maxtor's first glass product.

Glass platters are lighter and stiffer than aluminum platters. As low-fly heights of modern drives make head-to-platter impacts inevitable, the smoother and stiffer glass platter may be better suited to survive these impacts. Glass is particularly useful for notebooks and other portables, where head impacts are more likely to occur, and in fast-spinning drives, where the head impacts the platter with much more energy. Glass platters are also lightweight, so it takes less energy and time to spin them, which are advantages in notebooks and for "green" PCs.

Our tests showed the Areal drive to be optimized for cost, while the Maxtor drive focuses on performance. However, the Maxtor drive's performance could easily be better: it currently doesn't offer write caching. Maxtor says it plans to add this in the near future, which could put the performance of this little drive close to that of the top-ranked Conner CP-30254. In its present design, the Maxtor drive averaged 15.8 ms in our composite test scores, which places it in the performance midrange of 250-MB IDE drives. The Areal drive, which offers lower capacity for $90 less, achieved a composite score of 19 ms, which places it among the slower low-capacity drives we tested.

The glass platters in the Areal A180 (left) and the Maxtor 25252A drives work well with today's faster spin rates.

Fujitsu's 329-MB M2622FA SCSI drive is the only other fast-spinning drive in this capacity class, but it could not sustain good write performance in our tests. Fujitsu is aware of the problem but could not deliver a fix in time for testing. On the plus side, this and the higher-capacity Fujitsu drives all have high drive-to-host data transfer rates for prefetched data. The Fujitsu M2622FA transferred data over 50 percent faster than the Seagate ST3390N. All the Fujitsu drives handle two- and four-threaded operations flawlessly; the only drives faster than the Fujitsu M2622FA at the four-threaded read tests were the bigger Fujitsu drives. Some Fujitsu drives also offer five-year warranties, which is tops in this category.

Clearly, Maxtor is seeking to optimize price and not performance in its 245- and 345-MB drives. The 64-KB cache is too small to efficiently handle segmented operations (e.g., file compares). The relatively slow spin rate of 3551 rpm translates into slower performance on nonsequential operations typical of database operations, virus scanning, and defragmentation. The company claims the highest MTBF (mean time between failures) at 300,000 hours (over 34 years) but warrants this drive for only one of those years.

The Maxtor drives are not without strengths, however. They are notable for their unique jumper-selectable write cache (other IDE drives require special software to change write-cache settings). Maxtor also packs many modern IDE-drive features into its products, including block mode, write reallocation, power management, and automatic geometry translation.

As the slowest drive in this class, we can't recommend the 251-MB Samsung 3122A IDE drive. While random access times were nearly equal to that of the 245-MB Maxtor drive, the sequential operations took nearly twice as long. This suggests that the drive controller is not doing a good job of managing the host-to-drive interface.

BYTE BEST — 250 TO 350 MB

Is speed essential?

BEST OVERALL — Seagate Technology ST3390A

This IDE drive is the fastest under 400-MB drive we tested, thanks to a 4500-rpm spindle spin rate. Its SCSI cousin, which came in second in performance, also benefited from the fast spin rate and the 256-KB cache that comes standard with these Seagates, which is twice the size of the third-place Western Digital Caviar. The ST3390A produces the best response times for all the single-threaded sustained performance measurements, but the Western Digital Caviar drive beats it in tests that allow the drives to prefetch data and in multithreaded operations with four active threads. Seagate's two-year warranty is average.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST3390A	IDE	340	$390	$1.22	10.6	2	4500
RUNNER-UP	Seagate Technology ST3390N	SCSI	344	$420	$1.80	11.4	2	4500
RUNNER-UP	Western Digital Caviar 2340	IDE	340	$400	$1.25	12.1	3	3322
RUNNER-UP	Fujitsu M2622FA	SCSI	329	$1525	$5.24	12.7	—[2]	4400

Want the best for Macs, Unix, and SCSI PCs?

BEST SCSI — Seagate Technology ST3390N

The ST3390N's performance lags behind that of its IDE sibling by half a millisecond. The ST3390N narrowly defeats the Fujitsu in single-threaded sustained performance measurements, except in sustained writes, where the ST3390N was over three times faster. The Fujitsu M2622FA was faster than the ST3390N when the drives prefetched data.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST3390N	SCSI	344	$420	$1.80	11.4	2	4500
RUNNER-UP	Fujitsu M2622FA	SCSI	329	$1525	$5.24	12.7	—[2]	4400
RUNNER-UP	Seagate Technology ST3283N	SCSI	249	$320	$2.08	13.6	1	4500

The best for standard PCs?

BEST IDE — Seagate Technology ST3390A

The performance results that make this the Best Overall winner in this capacity class helped the ST3390A also take top honors for IDE drives, although the competition was strong. Western Digital's Caviar 2340 (340 MB) manages its four-segment, 128-KB cache well, and the Conner Peripherals CP-30254 (251 MB) offers the fastest spin rate of all drives in this category.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST3390A	IDE	340	$390	$1.22	10.6	2	4500
RUNNER-UP	Western Digital Caviar 2340	IDE	340	$400	$1.25	12.1	3	3322
RUNNER-UP	Conner Peripherals CP-30254	IDE	251	$375	$1.59	13.5	2	4542

Which drive offers the most economy?

LOW COST — Seagate Technology ST3390A

The Seagate ST3390 series sweeps this capacity class thanks to the IDE version's ability to combine unexcelled performance and a low cost per megabyte of $1.22.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST3390A	IDE	340	$390	$1.22	10.6	2	4500
RUNNER-UP	Western Digital Caviar 2340	IDE	340	$400	$1.25	12.1	3	3322
RUNNER-UP	Seagate Technology ST3283A	IDE	245	$300	$1.33	16.0	1	4500
RUNNER-UP	Maxtor 7345AT	IDE	345	$445	$1.36	14.4	1	3551
RUNNER-UP	Maxtor 7245AT	IDE	245	$343	$1.47	15.7	2	3551

[1] Consists of drive price plus controller, divided by capacity.

[2] Up to five years, varies with individual dealers.

How to Choose a Hard Drive

1 Buy a hard drive with at least 250 MB for your primary system and at least 120 MB on a notebook. Beyond that, buy the largest capacity and fastest hard drive you can afford. It's safe to assume that you will always wish you had more storage space.

2 Don't assume that local-bus IDE will deliver better performance. Our tests show that drives designed to take advantage of local-bus technology ran 30 percent faster than with standard IDE connections, but not every drive was able to take advantage of local-bus technology.

3 Don't pay for performance you can't use. Match the speed of the controller and the drive; slow controllers can seriously degrade performance of fast drives, but 32-bit bus-master controllers can't make slow drives any faster. For fast SCSI drives, you will need an adapter that can support SCSI-2 fast speeds. The built-in SCSI support in many Macs can't support SCSI-2. Several companies make fast SCSI-2 adapters for PCs and Macs with NuBus slots. You will need a 32-bit PC bus (i.e., EISA, Micro Channel architecture, or VL-Bus) to take full advantage of the fastest drives.

4 Watch out for vendor throughput claims that are based on transferring data from the drive cache to the host memory or from the host memory to the drive cache. For example, the SCSI-bus bandwidth may be 5 MBps to up to 40 MBps, but few drives can sustain throughput at this level. Look for sustained throughput speed to get a good picture of drive performance. Access-time calculations also vary from manufacturer to manufacturer, so you will want to know how the access time is calculated. The most accurate way is to measure command service times by performing actual reads and writes.

5 Choose a drive that can write cache as well as cache more than one segment. Write caching noticeably improves performance, especially in the DOS, Windows, and Mac environments. A segmented cache allows the drive to effectively prefetch when an application simultaneously accesses more than one file at a time. (Be sure to turn off write caching on database servers and be cautious on network servers, which may use logging and rollback for network information.)

6 IDE drives that support a write cache typically come with the write cache enabled. If you do not want to use write caching, you may want to request that the dealer disable it. It is rarely as simple as moving a jumper and generally requires a special program from the manufacturer.

7 For digital audio and video applications, you need fast, large-capacity drives (e.g., the Micropolis 2217) that smoothly handle TCAL (thermal recalibration). Sustained throughput numbers will not necessarily tell you anything about the frequency of TCAL glitches, but your eyes will tell you when you play back jumpy video.

8 SCSI cabling and termination can be troublesome, and for the uninitiated, a task that the dealer may best handle.

9 IDE drives from different manufacturers can be troublesome to get to work together, although progress is being made on standards. If you need multiple drives, you may be better off with SCSI.

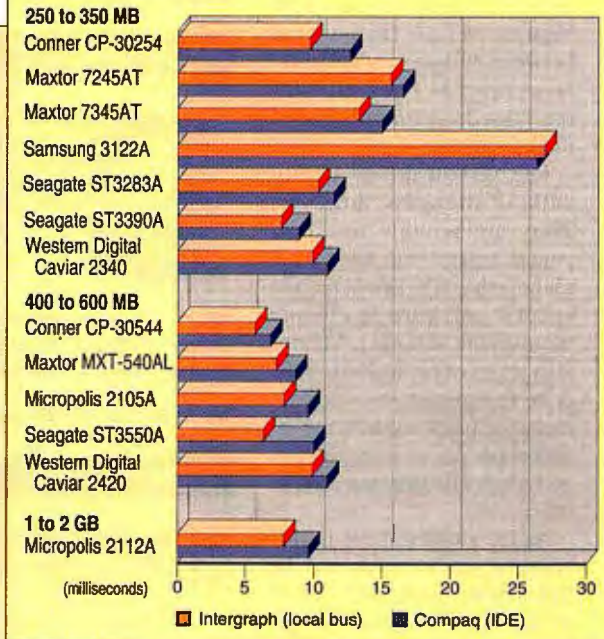
10 Consider using a small-capacity IDE drive to boot from, along with larger SCSI drives for storage. This takes maximum advantage of IDE compatibility and SCSI flexibility and performance. SCSI drives are also faster if you don't boot from them, because SCSI controllers have to imitate the standard PC drive interface for compatibility when the drive is configured as a boot drive. This slows performance.

LOCAL-BUS IDE

Modern drives can produce data faster than the ISA bus can transfer it. Local-bus technology promises to close this gap by accelerating data transfer rates from the 2-MBps rate of ISA-based IDE to 10 MBps. This could make IDE drives faster than SCSI, but for now, standards in this area are lacking.

Several of the drives we tested are capable of operating at speeds faster than standard ISA. We used an Appian local-bus interface in an Intergraph 486 system to test drives to determine maximum data transfer rates under local bus. Future versions of the IDE command set will include a protocol for querying an IDE's optimal speed. For now, the Appian device driver attempts to determine the optimum speed by trying several different speeds.

Local Not Necessarily Faster



The Conner CP-30254 and the Seagate ST3550A show significant gains from local bus. But many drives showed only minor or no improvement, including the Maxtor 7245AT and the Samsung 3122A.

"So there I was, playing with my Nintendo® and Dad was all spazzed out. No one at his office thought they could handle one of those storage

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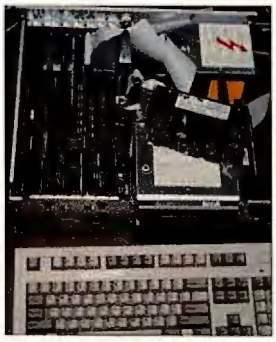
How We Tested

Testing hard drives is complex: Variable-zone recording contributes to dramatic performance changes over the surface of the same disk; thermal recalibration can kick in to cause a temporary but sharp increase in response time; the biggest drives have 512 KB of cache that can be tuned with more than a dozen parameters. Write and read performance varies dramatically depending on how or if write caching is enabled.



Our test-bed handled 10-MBps data transfers.

To account for this complexity, we designed a set of custom benchmarks called PLATT (Page Level Availability Time Test)—so named because it models hard disks as a linear array of "pages," which are the units of reads and writes. Most modern operating systems, including DOS and System 7, view the disk in this fashion (Berkeley Unix is a prominent exception; its file system uses a more complex disk model in terms of cylinders and tracks). We call PLATT an availability test, because it measures response time from when a command is issued until the time when data is available in system memory. PLATT closely models a 486 machine running DOS 5.0, Smartdrive 4.0, and a combination of DOS and Windows applications.

We tested every hard drive on a Compaq Deskpro/M 66-MHz 486. For IDE drives, we used the built-in interface; for SCSI drives, we used an Adaptec 1742 EISA bus-master adapter. The 1742 is capable of 10-MBps drive transfer and 33 MBps across the EISA bus. We also tested using an Intergraph 66-MHz 486 system with an Appian local-bus IDE adapter. Our Mac Quadra 700 test system ran with a SCSI-2 FWB JackHammer Nu-Bus adapter.

Testing team (from left): Helen Holzbaur, Jim Hurd, and Alan Joch

ADDITIONAL TESTS

In addition to PLATT, we ran BYTE's disk benchmarks, which evaluate drives at the DOS file level. We were able to configure these benchmarks to run an infinite variety of profiles; we ran a profile created to model typical DOS use and a second one to model typical Unix use. We also ran BYTE's file-level benchmark tests, which perform common operations such as creating, deleting, opening, closing, reading, and writing files. Our profile description specifies the number of times each operation is run, as well as the size of reads and writes. We tested using profiles developed to simulate typical DOS usage and Unix usage.

Finally, for the IDE drives, we ran QBench, a low-level test that accesses the drive through the ROM BIOS and measures time for reading and writing for a variety of block sizes spread across the disk. QBench is too low level for testing high-end SCSI drives; these drives are faster when used without BIOS support.

OTHER CONSIDERATIONS

Because this roundup includes only "bare" hard drives that are not necessarily intended for retail channels, features and ease-of-use considerations typical of our other BYTE Lab Reports could not be weighted here. By comparing bare drives, end users can specify their models of choice from system vendors and companies that package OEM drives as external subsystems or in upgrade kits.

Our Core Benchmarks

PLATT (PAGE LEVEL AVAILABILITY TIME TEST)

This custom benchmark suite, consisting of 24 tests, measures hard drive response time from when a command is issued to the computer to when data is available in system memory. The suite evaluates hard drives in three important areas:

Processor delays

The periods of time when the computer is not requesting anything from the hard drive. The drive should use this time to continue to read ahead so that data is ready should the processor request it. If a write has been cached, these pauses can be used to flush the cache and get ready for the next write.

Localized access

Swap files, databases, help files, and applications directories are examples of localized areas that tend to receive bursts of nonsequential activity. These localized regions do not grow in relationship to the size of the disk. For example, a swap file grows in relation to system RAM. Also, doubling the number of platters in a drive does not improve the random-access time of the drive, but it can cut localized access times in half because the same locality spans half the number of cylinders.

Segmented sequential activity

Hard drives are designed with a strong tendency to read the next sequential block, even when it is not read on the next operation. For example, a DOS file compare is a common operation that interleaves two file loads. Good cache management can speed this activity through prefetching and then maintain the data until it is requested.

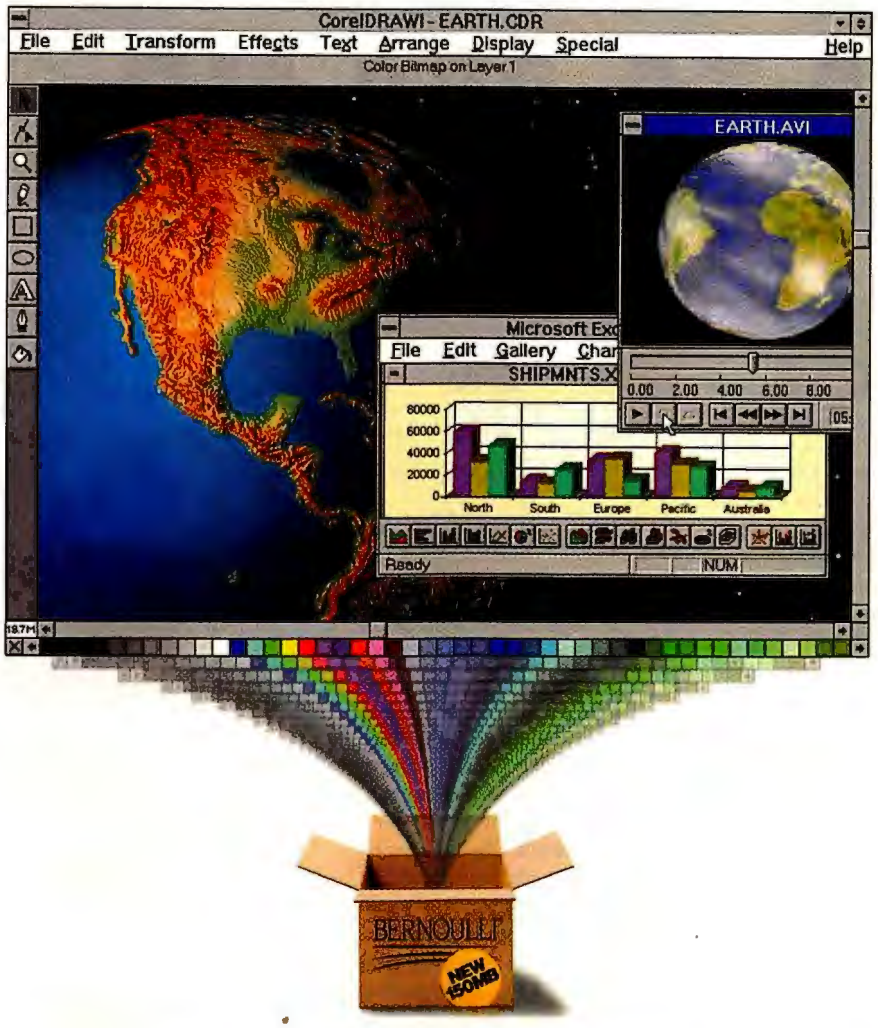
Our Test Team

Helen Holzbaur, *Project Manager/NSTL, became proficient with storage products as a network manager and systems administrator for Temple University.*

Jim Hurd, *Vice President of Research and Development/NSTL, has directed evaluations of storage and other hardware products, as well as operating systems and applications software, during the last 10 years at NSTL.*

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.



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THE BEST DRIVES IN CAPACITIES FROM

400 TO 600 MB

Drives in this class fell into two categories: 500-MB and higher drives, which offer fast spin rates, large caches, and awesome speed, versus 400- to 450-MB drives, which favor low cost per megabyte over absolute performance. (As further proof of cost-consciousness in the 400-MB hard drive market, our tests showed the 424-MB Western Digital Caviar to be marginally slower than its 340-MB sibling, the Caviar 2340.) For example, the slowest drive above 500 MB is faster than the fastest 400-MB drive. What's more, SCSI dominates in the drives above 500 MB (due to its fast data transfer rates), while most 400-MB hard drives were IDE-based.

Winners and runners-up in each category were those drives with the fastest response times. The low-cost winners were those with the lowest cost per megabyte.

We found that drive makers in the 400- to 600-MB range share implementations of voice-coil head-positioning technology and similar recording technology, so the performance winners differentiated themselves with the fastest spindle spin rates, which cuts drive latency times. The 6300-rpm Maxtor MXT-540SL SCSI drive was Best Overall.

Both of the Conner SCSI drives we tested contained a firmware bug that prevented write caching from being effective when the SCSI drive is not allowed to disconnect. Conner acknowledged the bug and will have a fix by the time you read this; however, it was not available at the time of testing. Mac users will want to upgrade to the fixed firmware since the Mac SCSI manager does not support disconnect.

The Adaptec 1742 adapter used for testing didn't work with Conner's firmware; the adapter's enhanced-mode BIOS does not allow the drive to disconnect even when configured to do so. To allow the Conner CP-30540 to disconnect, we configured the 1742 into its standard mode. Using standard mode and allowing disconnect would normally degrade performance, but the CP-30540's performance improved dramatically due to write caching: 300 percent in the case of sequential writes.

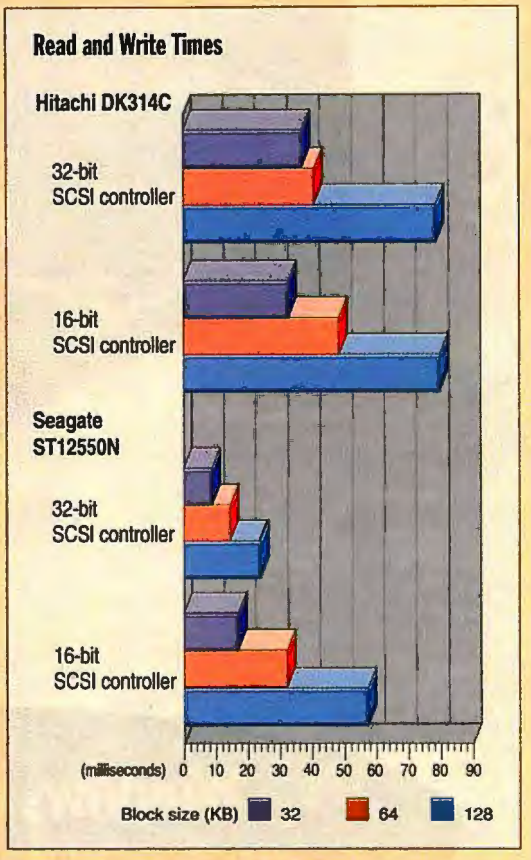
Among the IDE drives, the Maxtor MXT-540AL fails to equal the Conner drive's ability to squeeze data through the IDE bus. Driving the Maxtor IDE drive through our local-bus IDE didn't help much; presumably, the Maxtor engineers didn't have local-bus speeds in mind when they created the MXT-540AL. The drive is clearly not configured to do multithreaded sequential operations.

The Micropolis 2105A was the slowest of the 5400-rpm IDE drives, but it was considerably faster than any of the slower-spinning IDE drives. The Micropolis drive's data transfer rate was worse than that of the Conner's but roughly equal to the Maxtor's. This stayed consistent using local-bus IDE; each drive improved by approximately 20 percent. The Micropolis drive was the only one of the three configured with four cache segments: It was 65 percent faster than the Conner drive at four-segment activity, such as a four-file database join.

The Seagate ST3550A and ST3655A drives have similar performance. Each scored well considering their 4500-rpm spin rate, but their performance was noticeably slower than the faster-spinning drives. Both do well with two sequential threads (e.g., a file compare) but poorly with four-segment tasks (e.g., Unix multitasking).

MATCHING DRIVE AND ADAPTER PERFORMANCE

Matching the performance of your drive and SCSI adapter is important for getting the best bang for your buck. We tested both a slow and a fast drive using an Adaptec 1542, a popular 16-bit ISA SCSI adapter, and a 1742, a top-of-the-line 32-bit EISA bus-mastering model. Note that the 16-bit adapter is a good match for the Hitachi: The difference in speed between 16- and 32-bit performance for each block size is minimal. But the 16-bit adapter strangles the faster Seagate ST12550N: The difference between 16- and 32-bit performance in each block size is more than double.



The Fujitsu drives are looking long in the tooth. Fujitsu was one of the first vendors to ship faster-spinning drives to the marketplace, but its 4400-rpm speed is slow compared to the 5400- and 6300-rpm speeds of its competition. We also saw slow response times for sustained writes to the disk, although this problem goes away if delays are inserted after each write. This problem is consistent with the smaller-capacity Fujitsu drives we tested, but it is not evident in the Fujitsu 1-GB M2694ESA. Fujitsu was aware of the problem but couldn't provide a fix in time for this report.

The Western Digital Caviar 2420 is nearly identical in design and performance to the smaller-capacity Caviar 2340. They have similar spin rates, a 128-KB cache, and excellent firmware. Western Digital appears to have taken the Caviar 2340 drive and tweaked it to pack as much data as possible onto the same basic design; the Caviar 2420 uses the same number of heads (four) but nearly 500 more tracks.

The slightly slower spin rate of the Caviar 2420 (3314 versus 3322 rpm for the Caviar 2340) probably allows the 2420 to use more aggressive variable-zone recording; the Caviar 2420 packs 396 sectors on the first 324 cylinders where the Caviar 2340 puts 356 to 384 sectors on the same cylinders.

This aggressive packing of data pays off in the short-stroke scores; the Caviar 2340 is 1 to 2 ms faster on localized drive activity than its smaller sibling. The Caviar 2340 can't compete with faster-spinning drives due to its conservative 3314-rpm spin rate; however, it produces well-balanced performance overall. The Caviar 2340 excelled in the four-segment tests due to its four-segment cache design. The Caviar drives were second only to the Micropolis drives among IDE drives in reads using four threads.

The Hitachi drive produces some of the worst response times of any drive we tested. It does not use write caching, so sustained write performance is abysmal.

BYTE BEST — 400 TO 600 MB

Need high performance for PC, Mac, or Unix?

BEST OVERALL — Maxtor MXT-540SL

The MXT-540SL is the fastest drive in this size range, and it ties for the third-fastest drive on the entire test sample. It is especially fast for random and sequential reads and writes and short stroking. It also excelled in multithreaded operations (i.e., after we tweaked its cache table size up to four).

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Maxtor MXT-540SL	SCSI	546	$1077	$2.34	7.2	2	6300
RUNNER-UP	Conner Peripherals CP-30544	IDE	527	$816	$1.60	8.6	2	5400
RUNNER-UP	Maxtor MXT-540AL	IDE	527	$1077	$2.09	8.4	2	6300

When only SCSI will do...

BEST SCSI — Maxtor MXT-540SL

This drive's overall response time clearly distinguished it from its two closest competitors and was more than three times faster than the slowest drive in this class, Hitachi's 418-MB DK314C. However, the Maxtor drive's cost per megabyte ($2.34) is significantly higher than the second-place Conner's ($1.86).

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Maxtor MXT-540SL	SCSI	546	$1077	$2.34	7.2	2	6300
RUNNER-UP	Conner Peripherals CP-30540	SCSI	545	$816	$1.86	9.0	2	5400
RUNNER-UP	Seagate Technology 3600N	SCSI	524	$900	$2.59	9.1	2	4500

No-compromise IDE...

BEST IDE — Conner Peripherals CP-30544

The Conner engineers are masters of squeezing performance out of the IDE interface. Among Conner's IDE performance-improving techniques is interrupt staging: The time from data availability in the drive buffer to interrupting the PC is less than 40 nanosecond. The Conner CP-30544 provides the fastest sustained sequential throughput of any IDE; its throughput using a local-bus adapter rivals a fast SCSI drive.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Conner Peripherals CP-30544	IDE	527	$816	$1.60	8.6	2	5400
RUNNER-UP	Maxtor MXT-540AL	IDE	527	$1077	$2.09	8.4	2	6300
RUNNER-UP	Micropolis 2105A	IDE	557	$1172	$2.64	9.6	5	5400

Price conscious?

LOW COST — Seagate Technology ST3550A

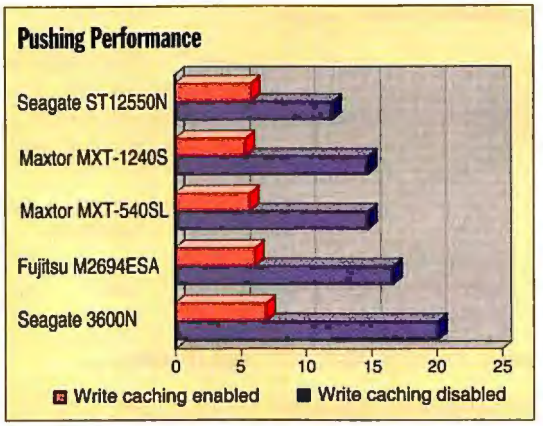
The ST3550A was the fastest IDE drive under 500 MB we tested. With a cost per megabyte of $1.12, the ST3550A delivers exceptional price/performance for this range of drives. Besides low cost, the two Conner drives are among the fastest drives in this category for sequential operations, such as loading or saving files.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE[1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST3550A	IDE	451	$480	$1.12	10.5	2	4500
RUNNER-UP	Western Digital Caviar 2420	IDE	424	$550	$1.36	12.6	3	3314
RUNNER-UP	Seagate Technology ST3655A	IDE	527	$800	$1.57	10.2	2	4500
RUNNER-UP	Conner Peripherals CP-30544	IDE	527	$816	$1.60	8.6	2	5400
RUNNER-UP	Conner Peripherals CP-30540	SCSI	545	$816	$1.86	9.0	2	5400

[1] Consists of drive price plus controller, divided by capacity.

Write Caching: Boon or Threat?

Caching writes on a hard drive has become a standard feature on most new hard drives. Write caching can double speeds in single-tasking systems like DOS and the Mac OS, and it even achieves better performance in more advanced multithreaded systems like NetWare, OS/2, Windows NT, and Unix.



Write caching can more than double performance on PCs and Macs.

A standard write operation begins with the computer signaling the drive that it has begun a write operation. Immediately, the drive begins to reposition the drive heads to the correct location. Concurrently, the system copies the data from memory to the memory on the drive. When the system completes this copy operation, it is free to do other things. The drive signals the system when it completes the actual write operation.

On a PC, disk operations are usually handled through the INT 13 ROM BIOS routine. All popular ROM BIOSes offer only simple implementations of INT 13—the routine simply does not return until the drive signals that the write is complete and the system has safely stored the data on the disk. After the computer copies the data to the drive, it waits for the operation to complete, which can mean that the computer spends a fair amount of time idly looping instead of getting real work done. A similar situation exists for those running a Mac.

Two approaches have been used to get around this delay. One is to attack the problem at its root: Have INT 13 return as soon as the system copies the data to the drive and not wait for write completion.

A higher-performance approach is to adapt the hard drive to the limitations of DOS by caching writes on the drive. The drive signals the completion of the write immediately after it receives the data and before the data is actually written to the disk. The system then continues to process data while the hard disk is actually writing the data. Performance is significantly better, because subsequent write operations can overlap getting data from the system to actually storing the cached information on disk. This approach allows subsequent sequential writes to be recorded without unnecessary drive rotations.

For most applications, caching writes poses no danger of data loss. The data write is not delayed, so data is written to disk at least as quickly as noncached drives.

Hard Drive Glossary

ATA (AT Attachment) Interface The formal name for what is popularly called the IDE interface. ATA is the dominant form of interfacing hard drives to PCs.

ARRE (Auto Read Reallocation) The ability of a drive to move data to a spare location when it detects a (correctable) read error (see sparing).

AWRE (Auto Write Reallocation) A drive's ability to remap sectors to spare locations when it detects a write error (see sparing).

command queuing A SCSI feature that allows the computer to send multiple commands to the SCSI peripheral and control the order in which they are processed. The computer can specify that a command be placed at the front of the queue, or it can allow the drive to do commands in any order.

contingent allegiance A SCSI feature to allow the drive to report deferred errors (i.e., errors that occurred after the drive reported "good," which is possible with write caching).

differential SCSI A SCSI variant that allows cables up to 75 feet long by signaling with voltage differences between two wires.

IDE Formally any drive that integrates the drive controller onto the drive itself. In popular usage, IDE refers to the ATA form.

latency The time in which the drive must wait for the correct sector to spin under the drive head.

SCSI An evolving international standard communication protocol between computers and peripherals.

segmented cache A drive cache that can maintain prefetched data for several areas on the disk. An unsegmented cache will overwrite prefetched data whenever the disk head is repositioned. A typical operation that can benefit from a segmented cache is a database join that reads from two files simultaneously.

single-ended SCSI The standard form of SCSI cabling.

sparing A formatting scheme where spare sectors and tracks are allocated to replace sectors that go bad during use. When formatting the disk, spare sectors are allocated and hidden from the user.

TCAL (thermal recalibration) A periodic procedure where the drive recalibrates for mechanical changes due to changes in the internal drive temperature.

transaction processing Transaction-processing algorithms guarantee that a group of changes are always made in an all-or-nothing fashion: Either all changes are made or none of them are made. For example, a common banking transaction requires subtracting money from one account and adding it to another. A hardware failure (e.g., a power loss) can interrupt a transaction but will never leave it partially completed.

variable-zone recording See ZBR (zoned-bit recording).

zero latency read An interesting feature that could have a big impact on performance if widely adopted. When a drive is instructed to perform a zero latency read, it starts the read as soon as any block of the request passes under the head, rather than wait for a particular block to spin around. When the system is requesting an entire track as a cache might, it is guaranteed that read will start right away, hence, the name. (Note that the read is zero latency only if the system is requesting an entire track; the latency of accessing a particular block is a physical reality that cannot be changed.)

ZBR (zoned-bit recording) A technique for storing more information on the longer outer tracks by pulsing the drive electronics faster. Since the outer tracks are "longer" than the inner tracks, using ZBR allows the disk electronics to place more information on the outer tracks.

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THE BEST DRIVES FOR CAPACITIES FROM

1 TO 2 GB

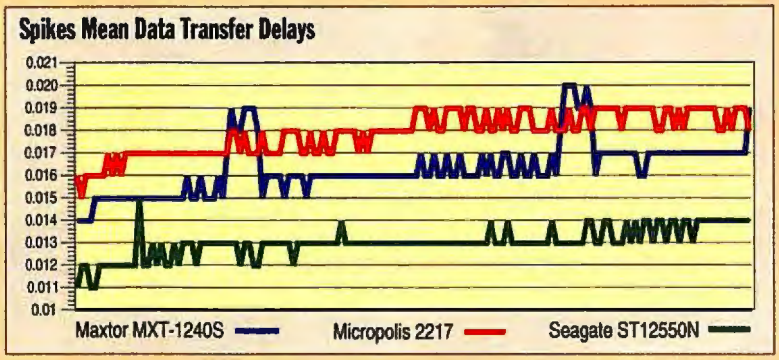
Seagate Technology has thrown down a gauntlet with the 2-GB ST12550N SCSI drive (also known as Barracuda). Based on our tests, this is the fastest drive on the market.

Although the Barracuda's sequential performance is good, where the drive really distinguishes itself is in how quickly it accesses data from 64-MB "localized" regions throughout the disk. In our tests of reads to localized regions, the drive produces response times of 13.1 ms for a 16-KB read and 10.3 ms for a 16-KB write. To put this in perspective, the fastest 250-MB drive we tested produced response times of 12.6 and 14.7 ms for sequential reads and writes.

The 1.2-GB Maxtor MXT-1240S was the second-fastest-spinning drive at 6300 rpm and the second highest-performing drive in this category. It is essentially the 546-MB MXT-540SL with twice the platters for double the capacity. The MXT-1240S's nonsequential performance is a little better than the MXT-540SL's, because the extra platters allow the drive to access more data without moving the head. Other performance gains over the MXT-540SL reflect the fact that we tested 1-GB and greater drives with the SCSI BIOS disabled, which speeds up the drives because compatibility translation overhead is eliminated. The downside of disabling the BIOS is that you cannot boot from the drive. To get the most from these drives, we recommend you boot from a floppy drive or, better yet, from a small inexpensive IDE drive. This isn't practical for applications that require small-capacity drives, but it's cost-effective for gigabyte-class drives.

All other SCSI drives in this class spun at 5400 rpm and produced similar performance. The relatively small-capacity 1-GB Fujitsu M2694ESA was unsurpassed in multithreaded operations, which explains its popularity in Unix machines. The 1.4-GB Conner CP-31370 and the two Micropolis drives (the 1-GB 2112A and the 1.8-GB 2217) were the slowest of the group due to poor results in

THERMAL RECALIBRATION



The heat generated by drive activity can force the drive controller to adjust its operations periodically, a process called thermal recalibration, or TCAL. While a drive is doing TCAL, it is unavailable to process commands from the host. TCAL takes place periodically, usually at 2 to 10 minute intervals and can disrupt data transfer for up to half a second. While these brief interruptions are rarely noticed for most applications, they represent serious problems to digital-video applications like QuickTime. Drive firmware varies widely in its handling of TCAL.

Part of the problem stems from the single-threaded nature of DOS and the Macintosh SCSI Manager. In theory, a digital-video application such as QuickTime should be able to buffer data in memory to hold it through TCAL pauses in the data stream. But with just a single thread at work, the system ends up waiting for the drive to finish TCAL. TCAL pauses translate directly into lost video frames.

The easiest TCAL algorithm to implement is a straight timer approach. This approach causes the drive to simply recalibrate all its heads at regular time intervals. For example, the Seagate ST3390N typically takes 100 ms to recalibrate itself every 2 minutes. For a drive with many heads, this can result in significant gaps in the data stream. If you're running full-motion video at 30 frames per second, this 100-ms recalibration time represents a loss of three frames.

Big drives with many heads tend to be more sophisticated about TCAL. The Seagate ST12400 family does TCAL on only one head at a time. In between head recalibrations, the host is serviced, limiting the worst-case pause to the time needed to recalibrate a single head. Recalibrations are also delayed if a command is currently being processed.

The Micropolis 2217 is a drive often specified for video applications because of its extremely polished approach to TCAL. The figure compares the response time during a seek "ramp" test of the 2217, the Seagate ST12550N, and the Maxtor MXT-1240S. The "wobble" in the scores is due to normal latency variations due to disk spinning, but the large spikes are due to TCAL. We did not note any spikes for the 2217 (ample time was given between operations for the 2217 to do its TCAL), but the spikes for the other two drives are obvious.

the multithreaded read tests. The Conner drive has a single-segment cache design, which makes it a poor choice for a multitasking or multithreaded operating system. The Micropolis drives were tested with two sets of firmware. The firmware that did great with multithreading tests performed poorly in the more heavily weighted single-threaded tests. The results shown in the summary tables are for the firmware that performs better in single-threaded activities because the overall scores were better.

The Micropolis 2217's performance is not as good as that of the faster-spinning Maxtor and Seagate drives, but it still offers response times within 20 percent of the performance-leading Seagate ST12550N. The Micropolis mechanism has been around longer and seen a lot of use in digital-video applications. The Micropolis hard drive is a favorite among video professionals because of its ability to maintain consistent response time even while undergoingTCAL (thermal recalibration).

In contrast, the Maxtor drives and the Seagate ST12550N drive exhibited periodic TCAL spikes in the performance. These short lapses in performance are meaningless in most applications, but for digital video any lapse can mean a missed frame and jerky motion.

In this capacity range, the Micropolis 2112A was the sole IDE drive we tested. As the summary tables show, the drive ran significantly slower than its SCSI counterparts. But Micropolis says it will offer a new version that could make the drive's performance more competitive with SCSI. For now, the 2112A is attractive for cost reasons. A high-performance SCSI system requires a wide bus such as EISA and a high-performance adapter such as the Adaptec 1742. This can add $900 to the cost of the system over an ISA design with built-in IDE.

We ranked winners and runners-up based on response time. "Low-Cost" winners were those with the lowest cost per megabyte.

BYTE BEST — 1 TO 2 GB

Want the top in size and performance?

BEST OVERALL — Seagate Technology ST12550N (Barracuda)

This drive is really in a class by itself as far as random-access performance is concerned. The fastest spin rate on the market helps: 7200 rpm means only 4.2-ms average latency. This low latency combined with a superfast actuator lets the drive access random data faster than many drives can access sequential data. Sequential performance is also very good, about the same as that of the smaller-capacity Maxtor drives.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE [1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST12550N	SCSI	2139	$2050	$1.05	5.6	5	7200
RUNNER-UP	Maxtor MXT-1240S	SCSI	1234	$1539	$1.41	6.2	3	6300
RUNNER-UP	Seagate Technology ST12400N	SCSI	2100	$1900	$1.00	6.7	5	5400
RUNNER-UP	DEC DSP-3160S	SCSI	1600	$1995	$1.37	6.7	5	5400
RUNNER-UP	Fujitsu M2694ESA	SCSI	1078	$2130	$2.16	6.9	—[2]	5400
RUNNER-UP	Micropolis 2217	SCSI	1777	$2170	$1.70	7.2	5	5400
RUNNER-UP	Conner Peripherals CP-31370	SCSI	1370	$2000	$1.61	7.3	2	5400

Need high capacity and IDE?

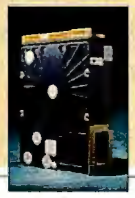
BEST IDE — Micropolis 2112A

The Micropolis drive was the only IDE drive we tested in excess of 1 GB. The drive is noticeably slower than the SCSI drives, even when used with a local-bus adapter. However, Micropolis is in the process of slashing interface timings to match the higher throughput of local-bus IDE. The next generation of this drive is expected to achieve double the data transfer rate, or 10 MBps, which is competitive with SCSI. The Micropolis five-year warranty is among the best available in this capacity range. The 2112A provided performance second only to that of the faster-spinning and smaller-capacity Maxtor MXT-540AL.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE [1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Micropolis 2112A	IDE	1048	$1775	$1.88	9.5	5	5400

Does economy matter?

LOW COST — Seagate Technology ST12550N

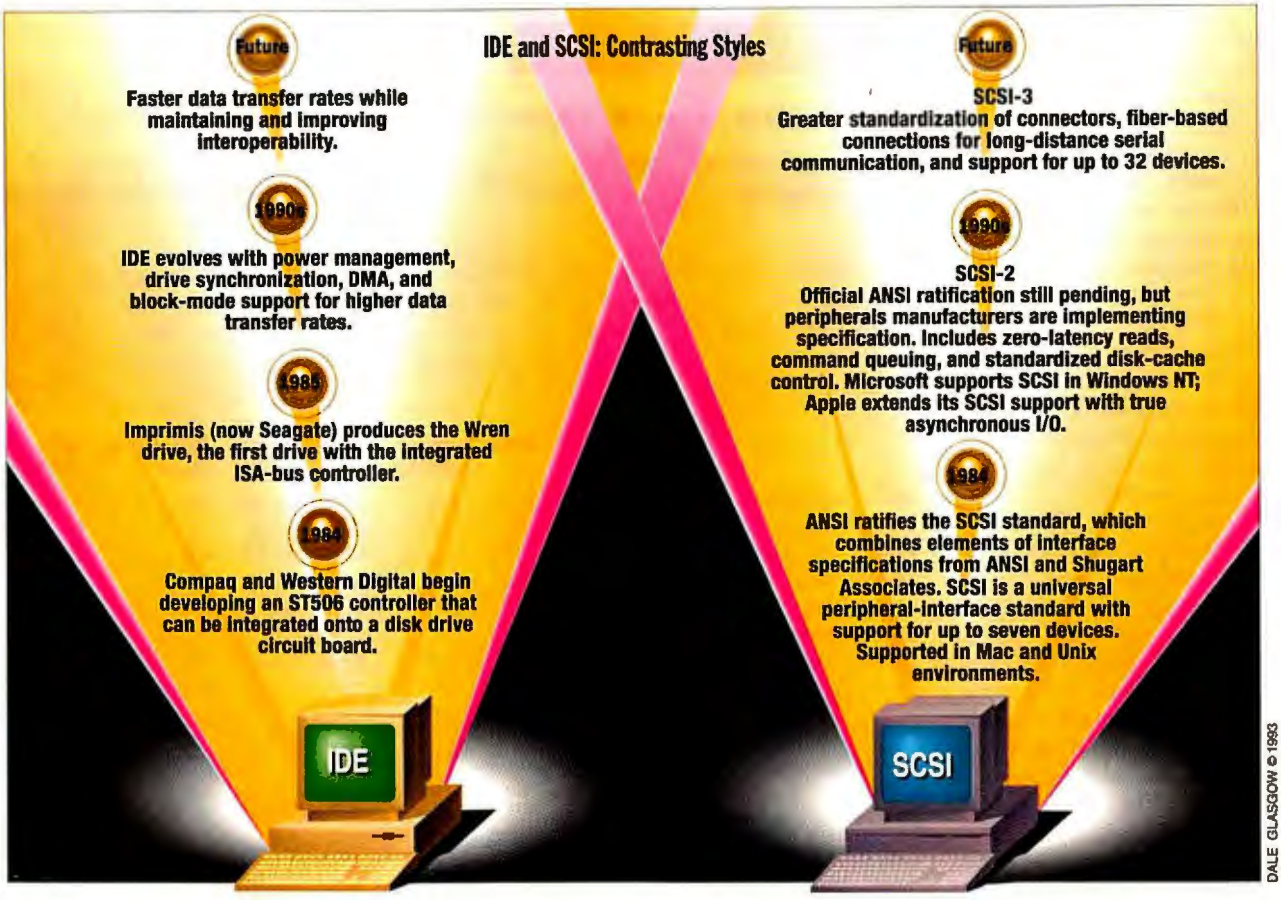


This Seagate drive sets the standard for hard drive performance; what's equally impressive is that this drive costs $1.05 per megabyte, which comes to a total cost of approximately $150 more than the most economical drive in this capacity range, Seagate's $1.00-per-megabyte, 2.1-GB ST12400N. Although less expensive, the latter drive runs an average of a millisecond slower than the ST12550N, a performance difference that outweighs the cost advantage in our eyes.

		INTERFACE	FORMATTED CAPACITY (MB)	PRICE	COST PER MEGABYTE [1]	OVERALL RESPONSE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)
BEST	Seagate Technology ST12550N	SCSI	2139	$2050	$1.05	5.6	5	7200
RUNNER-UP	Seagate Technology ST12400N	SCSI	2100	$1900	$1.00	6.7	5	5400
RUNNER-UP	DEC DSP-3160S	SCSI	1600	$1995	$1.37	6.7	5	5400
RUNNER-UP	Maxtor MXT-1240S	SCSI	1234	$1539	$1.41	6.2	3	6300
RUNNER-UP	Conner CP-31370	SCSI	1370	$2000	$1.61	7.3	2	5400
RUNNER-UP	Micropolis 2217	SCSI	1777	$2170	$1.70	7.2	5	5400
RUNNER-UP	Micropolis 2112A	IDE	1048	$1775	$1.88	9.5	5	5400

[1] Consists of drive price plus controller, divided by capacity.

[2] Up to five years, varies with individual dealers.



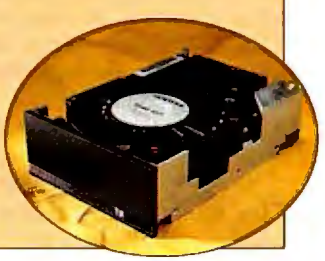
HONORABLE MENTIONS

At 7200 rpm, the Seagate ST12550N, or Barracuda, is the fastest-spinning and fastest-performing 3½-inch hard drive on the market. The drive is also notable for its flex-board circuitry that fits more controller electronics onto the board by wrapping the flexible printed circuit board around the drive mechanics. (This same technology is often found in notebook computers.)

The tiny 2½-inch Maxtor 25252A is a dynamo. It is markedly faster than any other notebook drive we have tested. This little overachiever could even find a place in your desktop—it was second only to the Conner CP-30254 among drives of any size with its 251-MB capacity.

Micropolis offers a five-year warranty on all its drives. Seagate offers a five-year warranty on its drives bigger than 1 GB. (Depending on individual dealers, some Fujitsu drives also carry a five-year warranty.) You are finally guaranteed a piece of equipment that will outlive its depreciation.

The Micropolis 2217 drive offers excellent all-around performance but is truly outstanding for its consistency. It is impossible to catch this drive taking a thermal-recalibration nap. This makes this drive a natural candidate for multimedia and digital-video applications.



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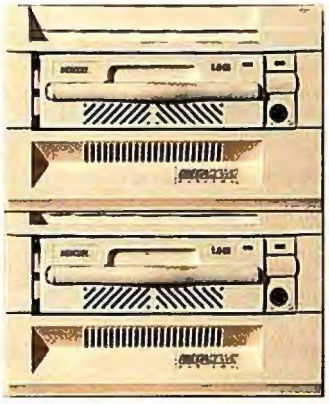

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Areal Technology	A180	IDE	181	$350	0.7	19.0	34.5	36.1
Maxtor	25252A	IDE	251	$595	0.7	15.8	28.4	26.4
Conner Peripherals	CP-30254	IDE	251	$375	1.0	13.5	31.1	27.7
Fujitsu Computer Products of America	M2622FA	SCSI	329	$1525	1.6	12.7	27.3	25.2
Maxtor	7245AT	IDE	245	$343	1.0	15.7	34.7	31.4
Maxtor	7345AT	IDE	345	$445	1.0	14.4	31.7	27.4
Samsung Electronics America, Inc.	3122A	IDE	251	$250	1.0	22.1	33.9	33.6
Seagate Technology, Inc.	ST3283A	IDE	245	$300	1.0	16.0	27.9	36.8
Seagate Technology, Inc.	ST3283N	SCSI	249	$320	1.0	13.6	30.7	26.3
BYTE Seagate Technology, Inc.	**ST3390A**	**IDE**	**340**	**$390**	**1.0**	**10.6**	**24.2**	**24.3**
Seagate Technology, Inc.	ST3390N	SCSI	344	$420	1.0	11.4	25.9	23.1
Western Digital Corp.	Caviar 2340	IDE	340	$400	1.0	12.1	28.1	28.4

400 TO 600 MB

Conner Peripherals	CP-30540	SCSI	545	$816	1.0	9.0	20.8	18.6
Conner Peripherals	CP-30544	IDE	527	$816	1.0	8.6	20.3	22.2
Fujitsu Computer Products of America	M2623FA	SCSI	425	$1615	1.6	11.8	25.2	23.4
Fujitsu Computer Products of America	M2624FA	SCSI	520	$1700	1.6	11.8	25.3	23.9
Hitachi America	DK314C	SCSI	418	$995	1.6	21.6	40.5	43.5
Maxtor	MXT-540AL	IDE	527	$1077	1.0	8.4	17.9	13.6
BYTE Maxtor	**MXT-540SL**	**SCSI**	**546**	**$1077**	**1.0**	**7.2**	**17.2**	**13.9**
Micropolis	2105A	IDE	557	$1172	1.6	9.6	21.1	21.1
Seagate Technology, Inc.	3600N	SCSI	524	$900	1.0	9.1	22.0	18.8
Seagate Technology, Inc.	ST3550A	IDE	451	$480	1.0	10.5	23.8	23.7
Seagate Technology, Inc.	ST3655A	IDE	527	$800	1.0	10.2	22.6	23.7
Western Digital Corp.	Caviar 2420	IDE	424	$550	1.0	12.6	26.7	26.4

1 TO 2 GB

Conner Peripherals	CP-31370	SCSI	1370	$2000	1.6	7.3	18.1	17.6
DEC	DSP-3160S	SCSI	1600	$1995	1.6	6.7	16.8	14.2
Fujitsu Computer Products of America	M2694ESA	SCSI	1078	$2130	1.6	6.9	17.6	16.6
Maxtor	MXT-1240S	SCSI	1234	$1539	1.6	6.2	15.5	13.7
Micropolis	2112A	IDE	1048	$1775	1.6	9.5	20.4	20.9
Micropolis	2217	SCSI	1777	$2170	1.6	7.2	16.4	15.7
BYTE Seagate Technology, Inc.	**ST12550N**	**SCSI**	**2139**	**$2050**	**1.6**	**5.6**	**12.3**	**10.3**
Seagate Technology, Inc.	ST12400N	SCSI	2100	$1900	1.6	6.7	15.7	14.6

BYTE = BYTE Best.

[1] Up to five years, varies with individual dealers.

RANDOM READ TIME (MS)	RANDOM WRITE TIME (MS)	SEQUENTIAL READ TIME (MS)	SEQUENTIAL WRITE TIME (MS)	WARRANTY (YEARS)	SPIN RATE (RPM)	PHONE NO.	TOLL-FREE NO.	INQUIRY NO.
38.1	40.8	12.8	32.3	2	2981	(408) 436-6800	None	1105
33.0	30.5	13.5	24.1	1	4247	(408) 432-1700	(800) 262-9867	1106
35.1	31.1	12.6	14.7	2	4542	(408) 456-4500	(800) 426-6637	1107
30.8	28.3	7.8	21.0	—[1]	4400	(408) 432-6333	(800) 626-4686	1108
39.5	36.0	15.9	13.9	1	3551	(408) 432-1700	(800) 262-9867	1109
37.5	32.3	14.9	11.8	2	3551	(408) 432-1700	(800) 262-9867	1110
37.6	37.1	26.1	27.1	2	3600	(201) 347-8004	(800) 446-0262	1111
32.0	40.0	11.7	28.5	1	4500	(408) 438-6550	None	1112
35.0	29.7	11.2	14.5	1	4500	(408) 438-6550	None	1113
28.6	29.0	8.8	9.2	2	4500	(408) 438-6550	None	1114
31.5	27.8	6.9	6.4	2	4500	(408) 438-6550	None	1115
33.4	34.0	10.6	12.1	3	3322	(714) 932-5000	(800) 832-4778	1116
24.5	21.0	6.0	5.8	2	5400	(408) 456-4500	(800) 426-6637	1117
23.0	25.6	6.8	8.0	2	5400	(408) 456-4500	(800) 426-6637	1118
28.9	26.7	7.6	21.0	—[1]	4400	(408) 432-6333	(800) 626-4686	1119
29.0	27.7	7.6	21.0	—[1]	4400	(408) 432-6333	(800) 626-4686	1120
45.6	47.9	17.5	30.2	5	3600	(415) 589-8300	(800) 448-2244	1121
22.6	18.0	9.0	8.9	2	6300	(408) 432-1700	(800) 262-9867	1122
21.2	18.1	5.4	5.9	2	6300	(408) 432-1700	(800) 262-9867	1123
26.0	26.2	9.6	9.8	5	5400	(818) 709-3300	(800) 395-3748	1124
25.7	23.9	6.3	7.1	2	4500	(408) 438-6550	None	1125
28.6	27.8	8.7	8.9	2	4500	(408) 438-6550	None	1126
29.6	29.1	8.7	8.9	2	4500	(408) 438-6550	None	1127
33.3	33.0	12.1	12.8	3	3314	(714) 932-5000	(800) 832-4778	1128
22.1	21.6	5.1	4.8	2	5400	(408) 456-4501	(800) 426-6637	1129
22.0	19.5	5.3	4.8	5	5400	(508) 841-6330	None	1130
22.5	21.1	5.0	4.8	—[1]	5400	(408) 432-6333	(800) 626-4686	1346
19.7	18.0	4.8	5.5	3	6300	(408) 432-1700	(800) 262-9867	1347
25.7	26.4	9.6	9.7	5	5400	(818) 709-3300	(800) 395-3748	1348
21.1	20.4	4.7	4.9	5	5400	(818) 709-3300	(800) 395-3748	1349
17.5	16.6	3.8	4.8	5	7200	(408) 438-6550	None	1350
21.6	20.4	4.6	5.2	5	5400	(408) 438-6550	None	1351

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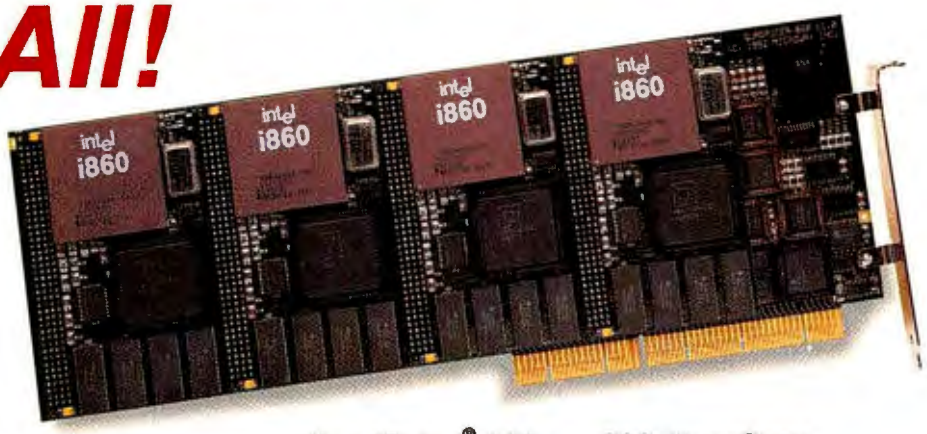

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Pentium: More RISC Than CISC

The Pentium moves Intel closer to true RISC, but 80x86 compatibility has forced some compromises

DICK POUNTAIN

Since the launch of the 486 in 1989, all of Intel's high-end competitors have been won over to the RISC computing philosophy. Each has designed its own RISC processor from scratch, and each has reaped substantial performance gains, as demonstrated by DEC's 200-MHz, 40-MFLOPS Alpha AXP architecture.

When Intel's engineers sat down to design the Pentium, they had their work cut out for them. And they might have felt a bit boxed in by the success of the 80x86. In a world where workstations and multimedia PCs have converged, Intel's Pentium had to offer a performance boost that could compete with RISC. But Intel didn't have the luxury of starting from scratch: Any new chip had to be binary-compatible with Intel's CISC 80x86 predecessors.

This is more than a matter of ethics for Intel, because the ability to run the hundreds of thousands of already-existing PC applications is also a powerful marketing weapon. RISC processors such as the Alpha, the PowerPC, and the SuperSparc have so far been locked out of the lucrative desktop PC market because they're not 80x86 compatible.

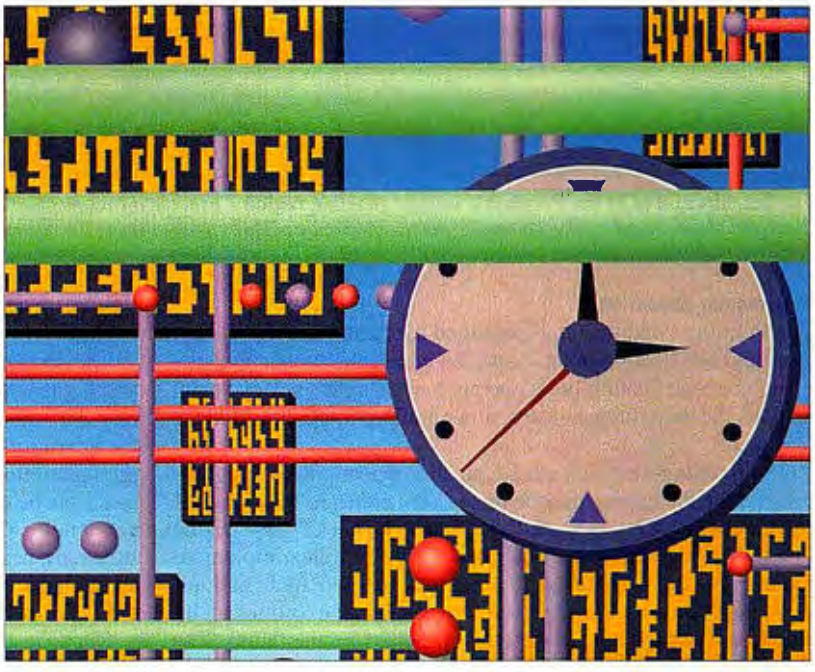
The design that Intel's Pentium team finally arrived at is a canny compromise that adopts as much RISC technology as possible without sacrificing 80x86 compatibility. And it yields a worthwhile, though not spectacular, performance boost of around 100 percent over that of a 486DX2 (at the same internal 66-MHz clock rate).

The 486 borrowed a few RISC ideas, such as on-chip caches and highly pipelined execution, so you might say that it's a CISC processor with RISC-like aspects. The Pentium tips the scales even further; its RISC-like aspects have shoved the CISC aspects (literally) into a corner; nearly all the silicon real estate on the Pentium die is devoted to caches and pipelined execution units. Only 3 percent of it is devoted to complex instruction support for microcoded instructions.

The most important RISC technique that the Pentium adopts is *superscalar execution*, the ability to execute more than one instruction at once. Only RISC-like simple instructions (discussed later) can be issued in parallel, so while the Pentium remains fully 80x86 compatible, it separates the 80x86 instruction set into fast-executing and slower-executing instructions.

New optimizing compilers that make proper use of simple instructions are crucial to extracting the full potential speed increase. Borland has already updated its C++ compiler to support Pentium optimizations, and Microsoft will soon follow suit. A speed increase of roughly 30 percent can be attained by merely recompiling existing applications to exploit the Pentium's superscalar execution.

The one area where the Pentium does not follow RISC practice is in its register-file architecture. Where RISC processors always incorporate large register files—which typically consist of 32 integer and 32 floating-point registers—the Pentium has to maintain the AX/BX/CX/DX register structure that is common to the entire 80x86 family of microprocessors.



ROBERT BURGER © 1993

BYTE presented an overview of the Pentium in the May issue (see "Intel Launches Rocket in a Socket"). In this article I will discuss the RISC-like elements of the Pentium's architecture in more detail: its superscalar execution units, caches, and branch-prediction logic. I will also compare these elements with those of the 486 and RISC competitors such as the IBM/Motorola PowerPC 601, the DEC Alpha AXP, and the Sun Microsystems/Texas Instruments SuperSparc.

continued

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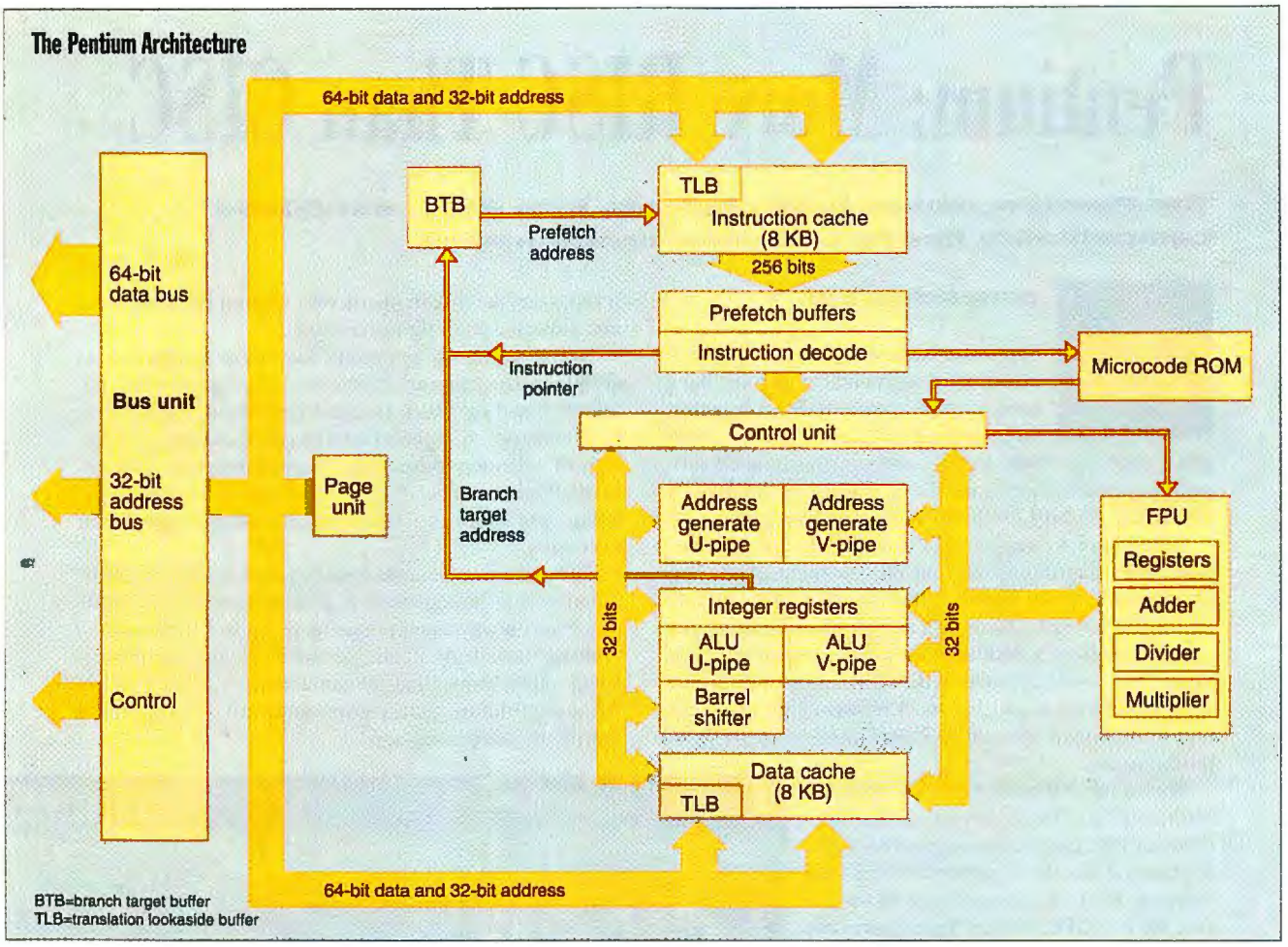

The bus structures in the Pentium's integer pipeline region—*between the control unit and the data cache—have been greatly simplified in this diagram to more clearly show the branch-prediction circuits. These circuits predict the outcome of conditional branch instructions before they even enter the pipeline and so reduce delays caused by bubbles. The predictions are based on the previous execution history.*

Superscalar Execution

The Pentium contains three pipelined execution units—two integer and one floating-point—and can issue either two integer operations or one floating-point operation in a single clock cycle. Intel calls the twin integer-instruction pipelines the U-pipe and the V-pipe.

The five stages of each integer pipeline perform the same functions on the Pentium as they do on the 486: prefetch (PF), decode1 (D1), decode2 (D2), execute (EX), and write back (WB). On the Pentium, however, these stages have more complex implementations. For example, each pipeline has its own ALU and address-generation logic and is therefore capable of executing an instruction independently of the other pipeline (see the figure "The Pentium Architecture").

A pipelined execution unit works just like a Detroit production line; it doesn't reduce the total time needed to perform an individual operation, but it overlaps several operations simultaneously to increase overall throughput. Once filled, a five-stage pipeline can issue a new instruction and produce a finished result every cycle, even though each instruction takes five cycles to complete. The Pentium's twin pipelines can produce two results per cycle (see the figure "The Pentium's Instruction Flow"). The downside to this, however, is that anything that interrupts the flow of instructions into the pipeline causes a delay of several cycles.

The decision to issue two instructions simultaneously in the U- and V-pipes occurs at the D1 decoding stage, where two parallel decoders determine whether the two current instructions meet the Pentium's pairing rules. Several conditions must be met for the instructions to execute in parallel: Both instructions in the pair must be simple (as defined below); there must be no data dependencies (via either memory or registers) between the instructions; neither instruction may contain both a displacement and an immediate value; and instructions with prefixes can be issued only in the U-pipe.

Simple instructions are those that are hard-wired, require no microcode support, and execute in one clock cycle. These instructions include register-to-register ALU operations; `movs`, `inc`, `dec`, `push`, `pop`, `lea`, and `nop`; and the `near jmps`, `calls`, and `jccs`. In addition, all the ALU memory-to-register and register-to-memory instructions (e.g., `add [BX],CX`) are considered simple, even though they require two or three clock cycles.

Special sequencing logic in the control unit stalls any single-cycle instructions that pair with multiple-cycle simple instructions; this keeps everything in step. Conditional and unconditional branches can only be the second of a pair—that is, they must

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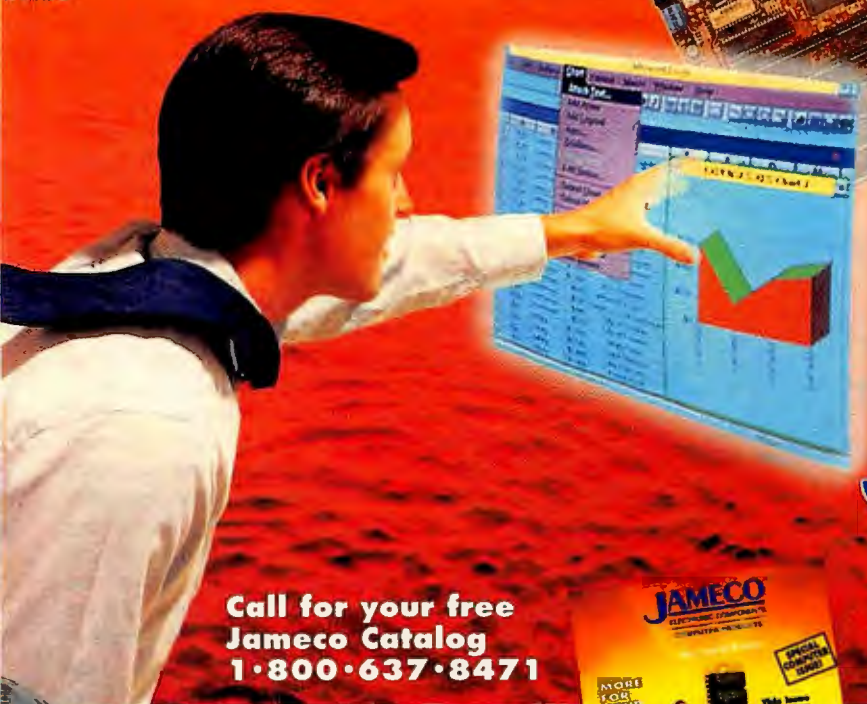

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execute in the V-pipe. The instruction-issue algorithm looks like the following in pseudocode:

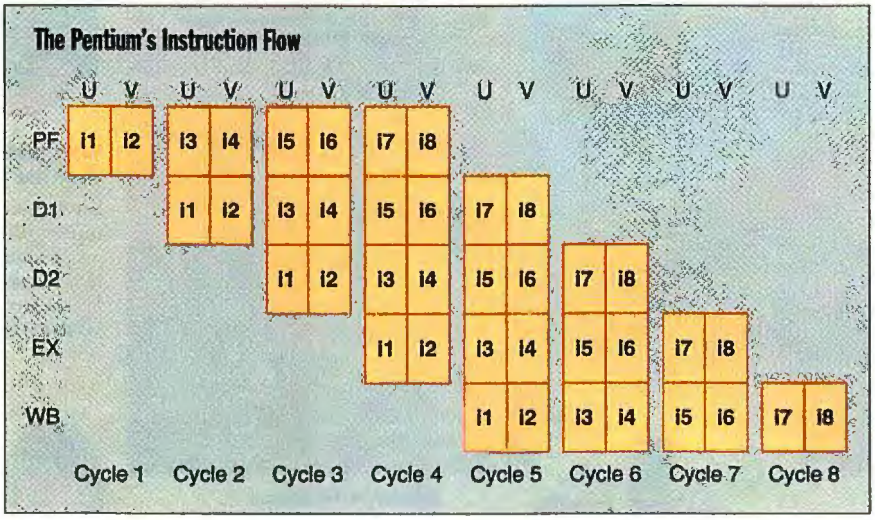
```
IF    I1 is simple
  AND I2 is simple
  AND I1 is not a JUMP
  AND Destination of I1 is not Source
      of I2
  AND Destination of I1 is not Destination
      of I2
THEN Issue I1 to U-pipe
     Issue I2 to V-pipe
ELSE Issue I1 to U-pipe
```

The "no data dependencies" rule is relaxed for `push/pop` pairs (which implicitly depend on the shared stack pointer) and for some commonly used compare/branch pairs.

If pairing fails and only the first instruction is issued to the U-pipe, the second instruction remains in D1 and gets tested against the next instruction to see if they are pairable. If not, the second instruction gets issued alone into the U-pipe (Pentium instructions can never be executed out of order).

The Pentium's EX stage, like its equivalent in the 486 pipeline, performs ALU operations and data fetches so that those instructions that require both will have to spend more than one clock cycle in EX. The pipelines are interlocked, so paired instructions always leave the decode stage and enter the execution stage in step. If one instruction stalls in any stage, for whatever reason, its partner gets held back by the logic so that both stay in step. Much of the Pentium compiler writer's art revolves around ordering instructions to avoid such stalls.

The Pentium's on-chip FPU is also deeply pipelined. It has eight stages, five of which are shared by both integer pipelines. The integer write-back (WB) stage doubles as the first floating-point execution stage X1, which converts floating-point numbers from external memory format and writes them to FPU registers. This is followed by a second execution stage, X2, then by rounding and write-back in WF, and finally by ER, where error reporting and status updating occur.



After a four-cycle latency *to fill the twin integer pipelines, two instructions are completed per cycle—so long as no instruction stalls.*

Both the integer ALUs work together to fetch a 64-bit double floating-point operand in a single cycle. Consequently, the Pentium cannot pair floating-point instructions with integer operations. Floating-point instructions cannot be paired together and must always execute in the U-pipe, with one exception: the FXCH instruction, which swaps the top of the floating-point stack with a lower item and can be paired with all the simple arithmetic operations (e.g., FADD, FSUB, FMUL, and FDIV) to speed up complex expression evaluations. A paired FXCH comes absolutely free—that is, it takes zero clock cycles.

So how does the Pentium's superscalar execution scheme stack it up against its RISC rivals? Unlike the Pentium, both the Alpha and the PowerPC can pair integer operations with floating-point operations, but neither can issue two integer instructions per cycle. Both the Alpha and the PowerPC support a limited degree of out-of-order execution and hence allow some parallel operations that the Pentium forbids. The SuperSparc can issue *three* instructions per cycle—two integer and one floating-point. It also features radical "cascaded" ALUs, which can execute two instructions in parallel, even when those instructions have a direct data dependency.

All three of these RISC processors make heavy use of register bypass, or *feed-forwarding*, to reduce the delays caused by data dependencies. Finished results get forwarded directly to waiting instructions earlier in the pipeline, bypassing the register file. This saves an extra cycle stall that reading the destination register would incur. The Pentium implements bypassing for the WF and X1 stages of its FPU, but not for its integer pipelines. The PowerPC does just the reverse, forwarding integer but not floating-point instructions.

Feeding the Pipeline

Benchmark results from both the BYTE Lab and Intel show that the Pentium performs almost exactly twice as fast as an equivalent 486 on integer code—just the improvement that you would expect from issuing two instructions at once. These numbers emphasize that the Pentium's twin superscalar pipelines are the processor's crucial architectural innovation. But there's absolutely no point in executing more instructions at once if you can't supply the instructions quickly enough to keep both units busy. Therefore, most of the other innovations in the Pentium exist to support the pipelines by increasing the available bandwidth into memory.

The Pentium doubles the width of the 486's data bus to 64 bits and replaces the 486's unified cache with separate instruction and data caches (a so-called Harvard architecture) so that the instruction fetch can proceed in parallel with data access. (On the 486, a cache data access would stall any instruction fetch attempted in the same cycle.) The Pentium's 8-KB instruction and data caches are organized into 32-byte lines—twice the size of the 486's lines—and the bus interface can fill these lines with a single burst-mode read of four 64-bit chunks from external memory. An ultrawide, 256-bit bus out of the instruction cache allows the 32-byte prefetch buffers to fill in a single cycle. Only the address bus and the

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integer-register file remain 32 bits wide.

The Pentium's instruction cache and data cache are two-way set-associative; they are subdivided into 128 two-line sets. Contrast that with the 486's single, four-way associative cache. Using larger sets (i.e., four-way rather than two-way) can improve the hit rate for a given cache size, because lines that are still useful need not be overwritten so often. But you need more search logic, and lookup is slower. The Pentium's caches are twice as large as the 486's, so they can maintain a similar hit rate with half the associativity.

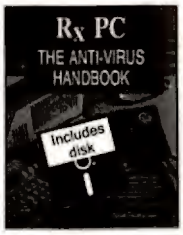
In an attempt to justify the above explanation, I checked on the cache associativity of some of the Pentium's RISC rivals. I found little comfort. Sun's SuperSparc uses a 20-KB, five-way instruction cache and a 16-KB, four-way data cache; DEC's Alpha 21064 uses 8-KB direct-mapped (i.e., not associative) instruction and data caches; and Motorola's PowerPC 601 uses a unified 32-KB, eight-way cache. From this I concluded that cache design is still one part mathematics and two parts magic (like audio speaker or racing-engine design), although, presumably, engineers prove all designs empirically by studying the results of many simulations.

The Pentium's caches use a write-back design to reduce external bus traffic, and since the chip is destined for use in shared-memory multiprocessors, the data cache supports the MESI (modified/exclusive/shared/invalid) cache-coherency protocol in hardware. MESI is a scheme for ensuring the consistency of a shared memory when several processors are holding cached copies of it; for more details, see "The Multiprocessor Solution," June BYTE. The data cache can also be configured to be write-through, on a line-by-line basis, by way of external hardware or software.

The MESI protocol maintains coherence between caches by *bus snooping*: The cache-control logic watches the external memory bus, looking for reads and writes from other processors (i.e., it "snoops" on bus transactions). When such a transaction is detected, the cache logic initiates an inquire cycle to find out whether there's a copy of the target address in its own cache. If there is, a write-back or an invalidation might be needed to maintain coherency. This means that up to three different agents may all be trying to access the Pentium's data cache in the same clock cycle because a pair of integer instructions might both want to fetch an operand during an inquire cycle.

To prevent such contention from stalling the Pentium's pipelines, the designers provided the data cache's tag memory with three ports. One port is devoted to snooping; the other two are used to look up data addresses for the pipelines. Everything happens in a single cycle. The cache's actual data memory is not dual-ported but interleaved in eight banks, on 4-byte boundaries. This enables two simultaneous data accesses to be made to the same cache line, so long as they fall in different banks. It also allows a bank-conflict detect gate to trap and resolve address dependencies between parallel instructions.

The Pentium's instruction cache is read-only to prevent code corruption, but this raises a potential problem for self-modifying



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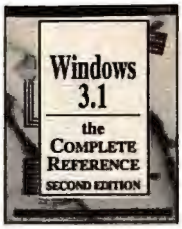

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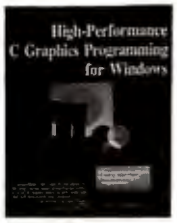

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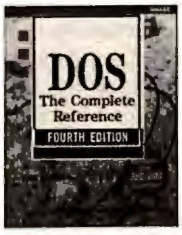

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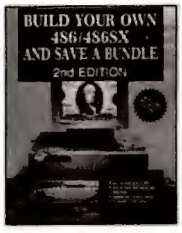

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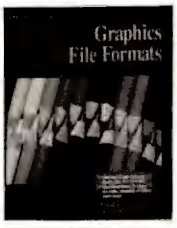

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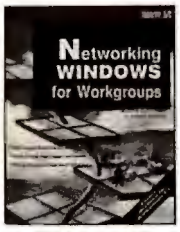

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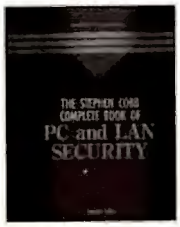

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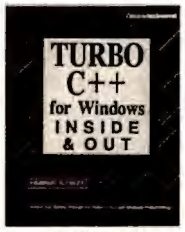

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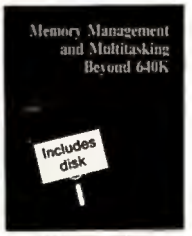

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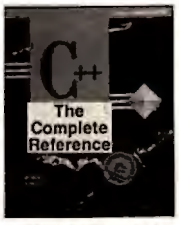

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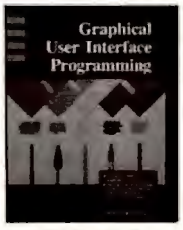

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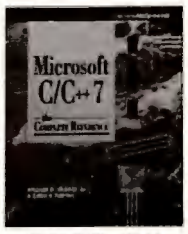

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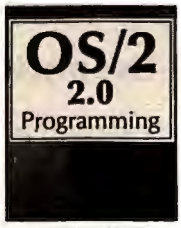

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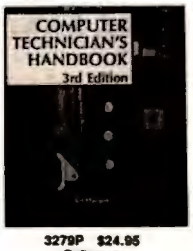

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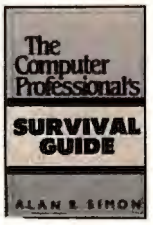

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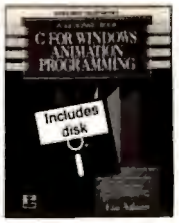

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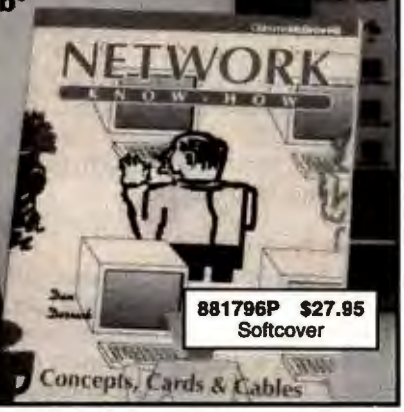

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programs. Code that's modified by a write to the data cache may also exist in the instruction cache in its unmodified form. To maintain consistency, the instruction cache snoops on the data cache using a subset of the MESI protocol (it uses just the shared and invalid states), and a write to any instruction invalidates it in the instruction cache. The Pentium also checks to see if the modified instruction has already been prefetched for execution. If this is the case, it flushes the prefetch queue. The instruction cache also sports triple-ported cache tags. One port is for snooping; the other two enable split line accesses.

The Pentium's architecture displays at least as much data parallelism as it does parallel execution. For example, during a single clock cycle, the processor can prefetch 32 bytes of instruction code, provide operands to two executing instructions, and snoop into both caches.

Branch Prediction

Flow-control changes are the enemy of efficient pipelining. When a branch instruction is taken, it renders all the following instructions—which may have already been prefetched and decoded—irrelevant. Flushing the pipeline to discard these instructions creates a "bubble" in the pipeline until valid instructions can be fetched from the branch target address. The deeper the pipeline, the more cycles are wasted.

Always prefetching the branch target as well as the next sequential instruction is only a partial cure, because one must still be discarded. The 486, for example, speculatively prefetches from conditional branch target addresses. But because there are two pipeline stages between prefetch and execution, the processor still incurs a two-cycle delay whenever the branch gets taken.

A better solution is to calculate the result of conditional branches earlier, before any unusable instructions have been prefetched. First-generation RISC processors achieved this by using delayed branches. With this method, the CPU always executes the single instruction that immediately follows a branch. This keeps the pipeline full while the CPU fetches a new instruction stream. Unfortunately, the introduction of superscalar execution and two-cycle instruction caches made delayed branching unworkable. The reason: So many instructions need to execute in the "delay slot" that more problems are raised than solved.

Today the preferred method is *branch prediction*—guessing which way a branch will go and then acting as if it has already happened. The prize for guessing right is zero branch overhead; the penalty for a wrong guess is a complete pipeline flush.

Static branch prediction is the simplest solution to implement. The most commonly used algorithm predicts that backward branches are always taken and forward branches are not. This makes sense because most backward branches represent conditional loops, which are taken for every iteration but the last. Forward branches are less obvious and require compiler technology.

Optimizing compilers try to arrange things such that, for an IF...THEN...ELSE structure, for example, the most frequent outcome is the one generated as in-line "fall-through" code. The less frequent outcome is placed at the branch target address. The

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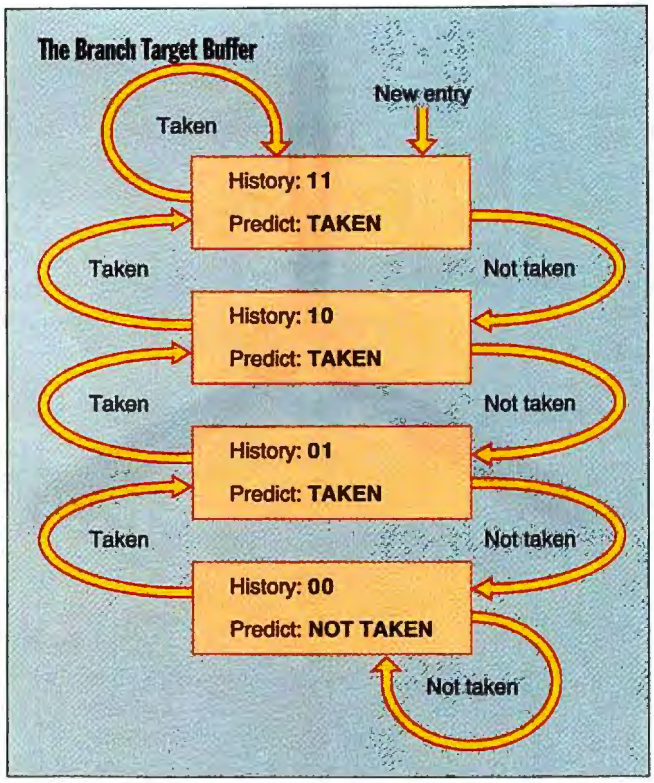

The BTB's history bits *operate as a finite state machine. Every time a branch in the buffer executes, its history bits are updated according to this state-transition diagram. Three of the four possible bit combinations (11, 01, and 10) predict that a branch will be taken; only 00 predicts that a branch will not be taken.*

PowerPC 601 and DEC Alpha use this type of static prediction.

A second level of compiler-assisted static-branch prediction uses spare bits in the branch instruction's op code to convey hints as to what the most likely branch target will be. The DEC Alpha makes 14 such bits available. That's not enough for a full target address, but it is sufficient to identify an offset within a page so that a read can be started several cycles before the exact target is known. One of the PowerPC 601's three superscalar execution units is a dedicated BPU (branch processing unit) that contains special registers so that conditional branches no longer depend on the main register file. Compilers can use a single hint bit to predict branches taken or not taken.

The Pentium eschews both these forms of static branch prediction in favor of a more radical dynamic prediction scheme. A dedicated BTB (branch target buffer) remembers the target address and the outcome of each branch and predicts their future direction on the basis of their execution history. The Pentium's U- and V-pipes actually have two 32-byte prefetch buffers each, only one of which is active at any time.

Normally the active buffer fetches sequential instructions, but when a branch instruction appears in the buffer, the BTB predicts which way it will go. If the prediction is "branch taken," then the second prefetch buffer becomes active and starts fetching instructions from the branch target address. If the BTB's guess is correct, then the pipeline carries on executing instructions; a wrong guess incurs a three- or four-clock delay, during which both pipelines are flushed and the correct target instruction is fetched.

The Pentium's BTB is actually another 1-KB, four-way set-associative cache with 256 lines, each holding a branch target address and 2 "history bits" and tagged by the address of the branch instruction. Whenever a new branch is taken, the Pentium puts its target address into the BTB, replacing an existing entry at random. Each history bit can have one of two values: 1, for taken, or 0, for not taken (see the figure "The Branch Target Buffer"). The four possible states of these 2 bits record what happened on the last two executions of that branch. A new entry's history gets set to 11, and each subsequent execution of the branch updates the history. The BTB predicts that a branch will be taken unless its history is 00 or it misses the BTB (i.e., it's not recorded there).

The Pentium's dynamic prediction scheme needs less compiler support than does static branch prediction, where an optimizing compiler may have to execute and profile the program code to get sensible hint information. The Pentium in effect profiles code on-the-fly in hardware and in its real-life environment.

Diminishing Returns

Intel quotes an amusing example to show off superscalar execution with branch prediction at its best. The inner loop of the Sieve of Eratosthenes, which BYTE used for many years as a benchmark, looks like this in C:

```
for(k = i + prime; k <= SIZE; k += prime)
    flags[k] = FALSE;
```

A popular C compiler generates the following assembly code from this fragment:

```
;; prime in ecx, k in edx, FALSE in al

inner_loop:
   mov byte ptr flags[edx],al
   add edx,ecx
   cmp edx, FALSE
   jle inner_loop
```

On a 486 system, this code consumes six clock cycles (of which two are due to the branch), but on the Pentium it runs in just two cycles. The `mov` and `add` instructions get paired and executed in parallel for one cycle, the `cmp` instruction pairs with `jle` for another cycle, and the BTB correctly predicts the branch taken, so it requires no cycles at all.

This threefold speedup represents only the most favorable possible case for the Pentium, however. On average it achieves twice the 486's speed on integer code, rising to around three times its speed for floating-point operations. Welcome though it is, this boost is the smallest performance step yet at the launch of a new generation of Intel products.

Future Pentiums will get faster as clock speeds rise above 100 MHz and feature sizes fall to the 0.65-micron level, but this was equally true with the 486 through its life cycle. With the Pentium, Intel may have reached a level of diminishing returns with the 80x86 architecture. Adding a third integer unit or a second FPU will probably not produce cost-effective improvements. Intel's next generation after the Pentium must be full-blooded RISC, with an 80x86-compatible subunit. ■

Dick Pountain is a BYTE consulting editor. He specializes in programming languages and system architectures. You can reach him on BIX as "dickp," or on the Internet at dickp@bix.com.

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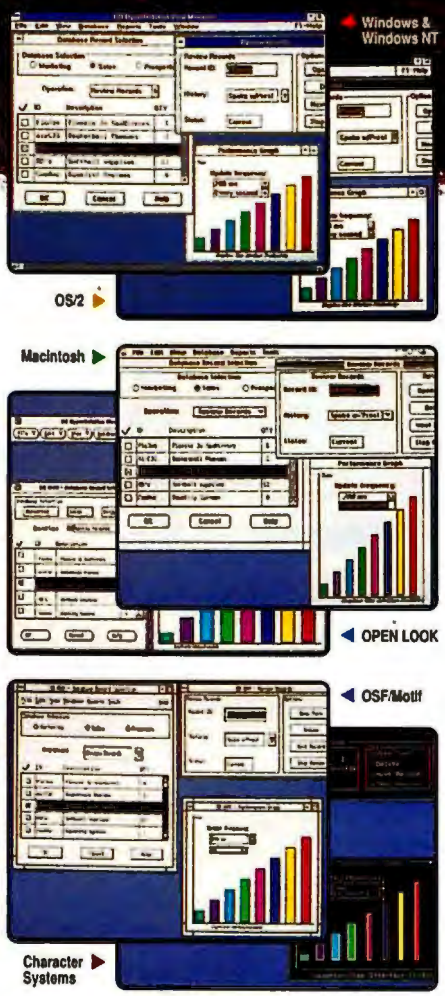

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Debugger Support in Windows 3.1

Good debugging support at the OS level is essential to writing good tools and applications. Here's how Windows 3.1 stacks up.

MATT PIETREK

Three years into the 1990s, DOS is finally starting to make its exit. A multitude of contenders stand ready to take its place as the new king of the operating-systems hill. These days, the primary contenders are Windows 3.1, Windows NT, and OS/2 2.1.

With each new operating system comes a new set of APIs to master. For the most part, an API call in one operating system has a counterpart in the others. However, when you get down to the level of the operating-system kernel, this rough equivalence starts to fall apart. This is particularly true in the case of operating-system support for debuggers.

I focus here on the system support for debuggers that is provided by Windows 3.1 (I'll cover OS/2 2.0 and Windows NT next month), but it's important to note that this information is relevant to more than just the small group of people who write debuggers. Having a good knowledge of debugging support is crucial for writing certain classes of tools and applications.

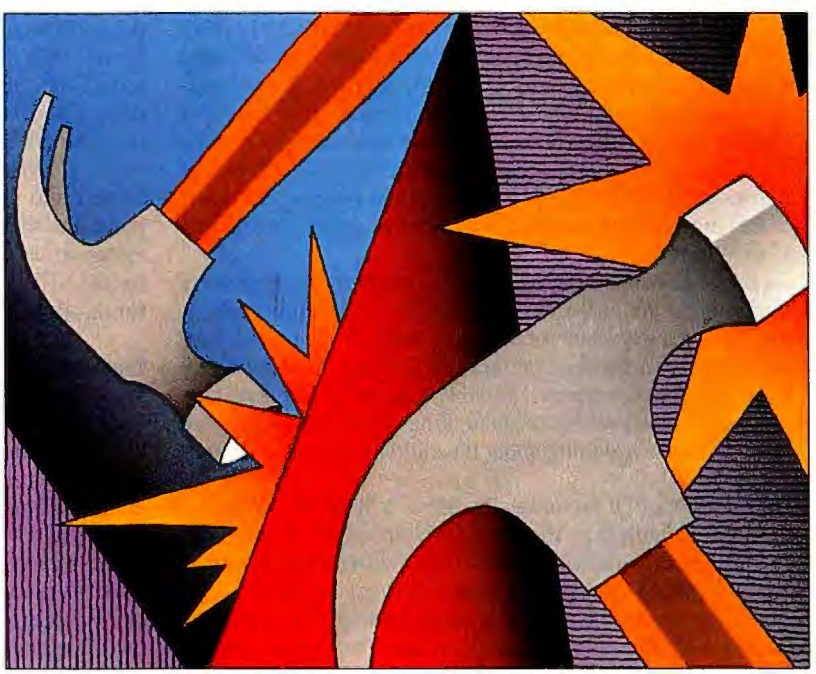
For example, under Windows 3.1 many programmers need a way to start another application and wait for it to finish before continuing the original program. The typical way of accomplishing this is to hook into the notification stream used by the debugger to know when a process exits, when a DLL loads, and so on.

The Basics

There are certain basic services that a debugger requires from any operating system. These services are relatively few in number, but they are absolutely essential for a usable debugger. For the purposes of this article, the basic operating-system support for debuggers includes the following services:

- loading a new process for debugging (known as the child process)
- execution control (the ability to make the child process step through instructions or run)
- reading and writing memory in the child process's address space
- reading and writing the register set of the child process
- notification of significant events (including DLL loads and unloads, the creation and destruction of child-process threads, and the termination of the child process)
- address mapping (the ability to convert a logical address in the debugging information to a real physical address as used by the child process)
- isolating the child process from external events when the process is stopped (primarily a concern for event-driven programs that process messages)
- miscellaneous support (hardware breakpoints, access to system data structures, and so on)

Much of what makes a truly outstanding debugger includes things that the debugger doesn't need the operating system for. Examples of such elements are the data inspectors and browsers that are becoming commonplace these days. The magic of these features is performed by sophisticated lookup mechanisms and manipulation of debugging information. No operating-system support is needed for these portions of the debugger.



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Another example is statement stepping. The CPU and the operating system know nothing about the C or C++ statements in your program. Instead, it's up to the debugger to interpret the debugging information. From this information, the debugger synthesizes a statement step out

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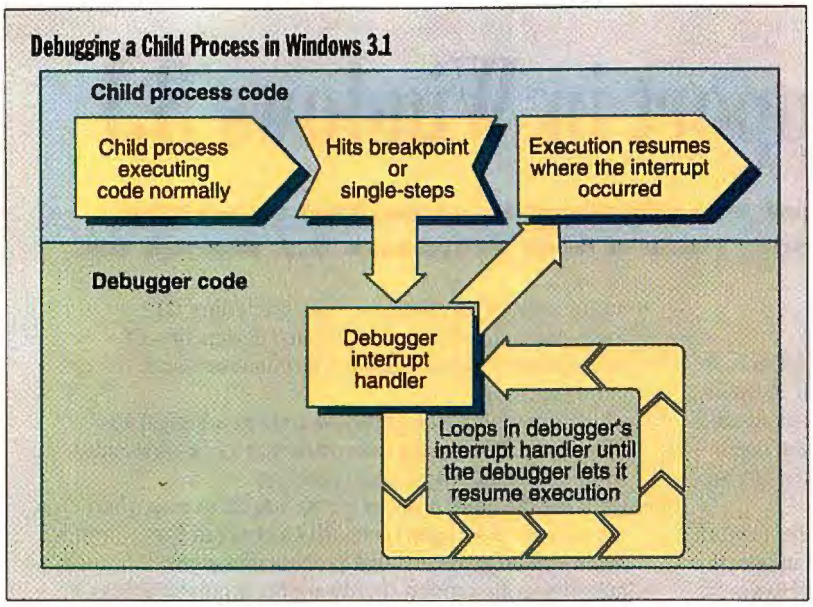

Flow control *during a breakpoint or single-step interrupt.*

of a series of instruction steps and lets the child process run until it hits a breakpoint.

The Windows 3.1 View

In some respects, writing a debugger under Windows 3.1 is not that different from writing a debugger under MS-DOS. In other words, there's not much operating-system support. The debugger is responsible for intercepting INT 1 for single-step and hardware breakpoints, and INT 3 for code breakpoints. As under DOS, all Windows 3.1 tasks share the same address space because they use a common LDT (local descriptor table). And because Windows and DOS are both 16-bit operating systems, debugger code that manipulates addresses can often be ported easily from DOS to Windows.

On the other hand, there are significant differences between a DOS debugger and a Windows debugger. A Windows debugger has to be acutely aware of protected mode. If the user of a debugger inspects a garbage pointer, the debugger can't blindly try to dereference the pointer, possibly generating a general protection fault in the process. Instead, it has to put on the surgical gloves and treat everything about the child process as potentially dangerous.

The addition of DLLs makes the life of a Windows debugger even more difficult than that of a DOS debugger. A DOS debugger can assume that the symbol table for the child process is the only symbol table. A Windows debugger needs to juggle around the symbol tables of any DLLs it's debugging in addition to the symbol table of the main program. The correct symbol table to use often depends on the context in which the child process is executing.

In Windows 3.1, most of the operating-system support for debuggers and debugging utilities comes in the form of TOOLHELP.DLL. Although TOOLHELP was introduced with Windows 3.1, it's backward compatible with Windows 3.0. It exports upwards of 30 functions, but only a small subset is truly essential for debugging support. The two most important APIs in TOOLHELP are `InterruptRegister()` and `NotifyRegister()`. The former lets you see all CPU interrupts and exceptions of interest to a debugger, and the latter is how the debugger finds out about DLL loads, task termination, and so on.

The interrupts, exceptions, and notifications your TOOLHELP-installed handlers receive are from all tasks in the system, not just the task you're debugging. In addition, TOOLHELP multiplexes the interrupts and notifications among all programs that register handlers with it. Because of these two points, it's important that your handler routines inspect each interrupt, exception, and notification to see if it's of interest to the debugger, and chain it on if not.

Loading a New Process

Windows 3.1 offers no explicit support for loading a program for debugging. Instead, a debugger uses the standard Windows APIs `LoadModule()` or `WinExec()` to execute a child process. The difference in loading a child process for debugging is that the debugger needs to force the process to stop at the first instruction, rather than executing until it yields. The trick in stopping the child process at its first instruction is finding out where the new process will begin executing. By setting a temporary breakpoint at that location, a debugger can gain control before any child-process code is executed.

There are two approaches to finding the starting address of the child process. The first method is to read the NE (new executable) file of the program to be debugged and extract the starting CS:IP (code segment:instruction pointer) as a logical address. The debugger can then watch the segment-load notifications (i.e., the NFY_LOADSEG notification from `NotifyRegister()`). When it sees that the appropriate segment has been loaded into memory, the debugger inserts a temporary breakpoint into the segment. The second approach is a more elegant variation on the first method. It requires the debugger to look for the NFY_STARTTASK notification. The `dwData` argument for this notification is the starting CS:IP of the child task.

Execution Control

While being debugged, a Windows process is either executing its code normally or executing inside an interrupt handler in the debugger's code. A child process halts execution when it finishes stepping an instruction or when it encounters a breakpoint op code. Either of these events causes an interrupt, which transfers control to the debugger's interrupt-handler code. However, just because an exception has occurred does not mean that Windows switches tasks. As a result, you can have a strange state where the child process is still the active process but is running in code owned by the debugger process. The child process remains "suspended" in this interrupt handler until the user instructs the debugger to step through or run the program again. The figure above shows the situation graphically.

A Windows debugger controls whether the "debuggee" will step or run when it resumes by selectively modifying the trap flag in the copy of the child process's FLAGS register. This register is saved on the stack when the child process encounters INT 1 or INT 3. To make the child process single-step the next instruction, the debugger sets the trap flag in the image of the process's FLAGS register. The debugger then switches task

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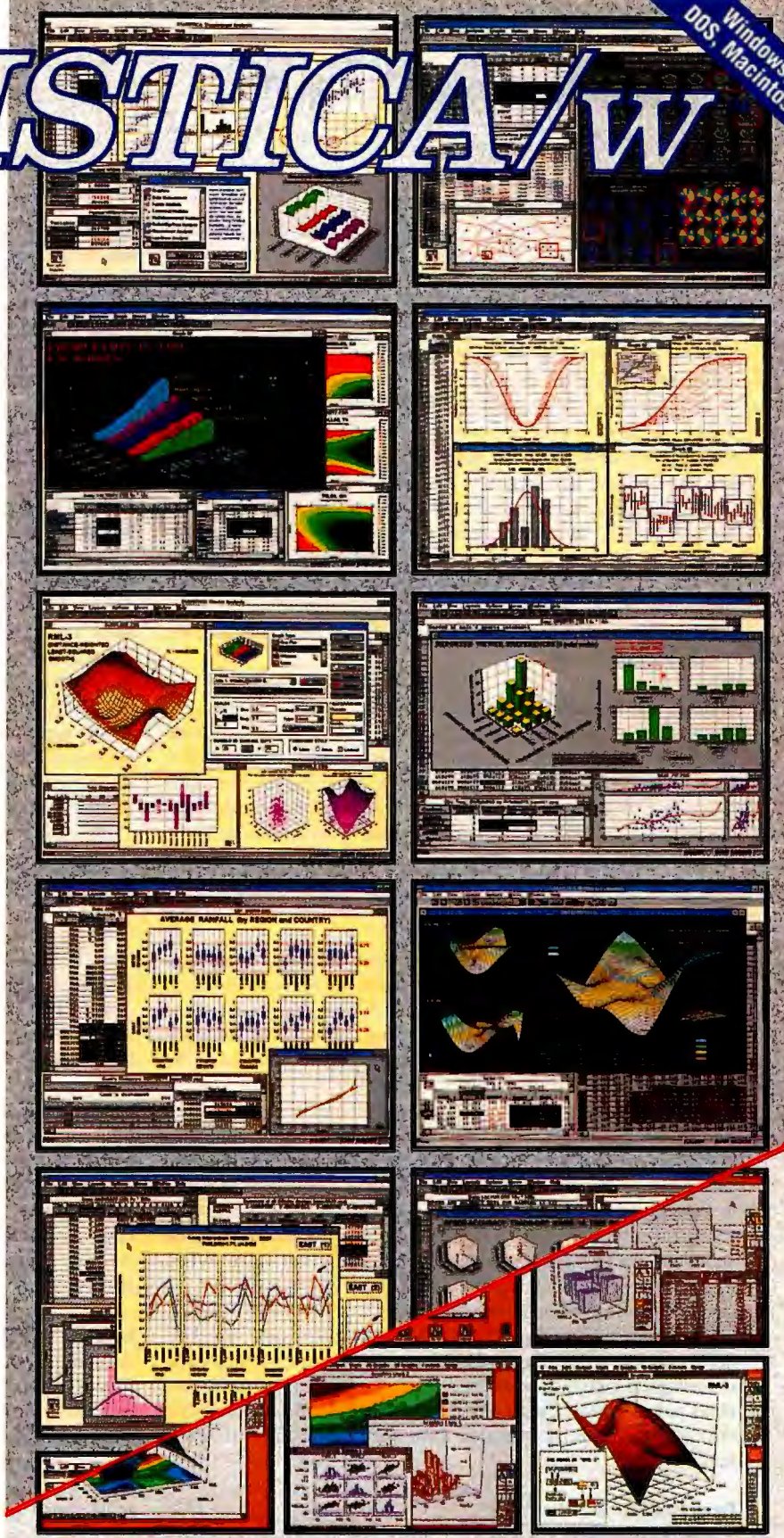

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contexts to the debuggee's context with `DirectedYield()` and drops out of the suspended-state loop. The child process eventually uses an IRET (return from interrupt service routine) to return to its own code, causing the modified copy of the FLAGS register to be restored to the FLAGS register. If the trap flag is set when the FLAGS register is reloaded from the IRET, the CPU executes one instruction before generating an INT 1, forcing execution to return to the debugger's interrupt handler.

To make the child process run (as opposed to stepping), the debugger simply does the opposite, clearing the bit in the trap-flag image. This ensures that the trap flag *won't* be set when the child process does the IRET back to its code.

Windows presents an interesting situation with regard to breakpoints. Since Windows can demand load and discard segments as necessary, a debugger needs to watch the segment-load notifications (NFY_LOADSEG, discussed below) to see if a segment with a breakpoint in it has been discarded and then reloaded. If so, the debugger needs to reinsert the breakpoint before letting the child process resume.

Memory and Register Access

Because Windows has a single address shared by all applications, it's possible for a debugger to directly read any memory belonging to the child process. However, a debugger that does this has to be extremely careful and perform segment limit and access checking for any address it attempts to read or write. Additionally, if the debugger wants to write to a code segment (e.g., to set a breakpoint), it needs to create an alias data selector. (An *alias selector* is a data selector that has the same address and limit as a code selector, or vice versa.)

Since doing access checking and creating aliases are "surgical glove" work, Microsoft mercifully provided the `MemoryRead()` and `MemoryWrite()` APIs in TOOLHELP. If you use these APIs, you can eliminate all the hassle of doing your own address validation. Instead, you call these APIs and just check the return value to see if they were successful.

A properly designed interrupt/exception handler in Windows will save the complete register set when the debuggee generates an exception and will restore all the registers before the child process does the IRET to resume execution. Typically the registers are saved by PUSHing them on the stack. If the user wants to change a register value while the child process is stopped, the debugger just changes the saved copy of the register value. When the child process resumes, the saved copy will be restored instead of the original register value.

The issue of 32-bit registers in Windows is interesting. The kernel scheduler in Windows saves only the 16-bit set of registers, ignoring the high halves of the extended registers. However, the child process may be using 32-bit registers, so it's important that the debugger interrupt handler save and restore the full 32-bit register set.

Event Notification

Event notifications such as DLL loads come through the handler routine installed by `NotifyRegister()`. Of particular interest to debuggers are the following notifications.

NFY_STARTTASK gives the debugger the ability to regain control before the child process executes the first instruction. NFY_EXITTASK tells the debugger that the child process has terminated. A debugger typically indicates this event to the user and cleans up internal tables as necessary.

NFY_STARTDLL tells the debugger about DLLs that are loaded while the child process is executing. A debugger might use this notification to update its internal tables. Note that this notification will not be generated for DLLs that are already in memory when the child task loads.

NFY_DELMODULE tells the debugger that a DLL has been unloaded from the system. The debugger might clean up tables at this time as well. Finally, NFY_LOADSEG tells the debugger that a particular segment has been brought into memory. If the debugger supports virtual breakpoints in code that's not yet loaded, it inserts breakpoint op codes at this time.

Address Mapping

Segments in a Windows .EXE or .DLL file are ordered, starting with segment 1, then segment 2, and so on. If you look at a .MAP file produced by a Windows linker, you can see this segment ordering. Like the addresses in .MAP files, the addresses of functions and variables in the debugging information are stored in terms of these logical segments. The actual selector values that will be used to access these segments when loaded into memory simply aren't known at link time. Therefore, a Windows debugger needs support from the operating system to map a logical segment number to the actual selector value that the loader allocated for the segment. It's also necessary to be able to work in the opposite direction—that is, to convert a selector value to an `hModule` and a logical segment number.

There are two ways to perform this address mapping. The supported method is to use the TOOLHELP `GlobalEntryHandle()` and `GlobalEntryModule()` APIs. `GlobalEntryHandle()` takes a selector as an input and, if possible, returns a GLOBALENTRY structure containing an `hModule` and a logical segment within the module. `GlobalEntryModule()` performs the inverse mapping, taking an `hModule` and a logical segment number and returning the corresponding selector as part of the GLOBALENTRY structure.

If you don't want to rely on the TOOLHELP functions (which can be somewhat slow), your other alternative for address-mapping services is to directly read the segment table in the module tables. A module table is simply the segment for which an `hModule` is the selector. If you know the format of the data in the module table, you can quickly look up just the information you need. My book *Windows Internals* (Addison-Wesley, 1993) and Andrew Schulman's *Undocumented Windows* (Addison-Wesley, 1992) contain the layout of a module table.

Isolating the Child Process

A fundamental tenet of debugger writing is that when the child process stops for some reason, no child-process code should be executed. However, when the process is stopped because it's suspended in the debugger's interrupt handler, it can't be processing messages. A Windows program that doesn't call `GetMessage()` or `PeekMessage()` regularly will freeze the input system. Buried inside the `GetMessage()` and `PeekMessage()` code is where Windows tasks yield to other tasks.

If you don't call these functions, other tasks will never get the opportunity to be switched to the foreground or to execute. This has serious ramifications. If you put a 20-second delay in the message handler of your Windows application, your keyboard and mouse are useless until the delay finishes. No other application can be switched to the foreground or run until the current task starts processing messages again.

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Now consider the case of a Windows-hosted debugger. Imagine that the child process is executing along and then hits a breakpoint. At this point, the process is suspended inside the debugger's interrupt handler and isn't processing messages. The mouse and the keyboard aren't responding; they're useless until the child process starts pumping messages again. The only way to make the child task process its messages again is to make it resume execution. But to do this, you need to communicate some sort of "go" command to the debugger. And alas, you can't communicate with the debugger because the mouse and keyboard aren't responding.

Initially, Windows debuggers dealt with this problem by ignoring it. However, a debugger that does this cannot use Windows to display its screens. Examples of this kind of debugger are Borland's Turbo Debugger for Windows, Microsoft CodeView for Windows, and the text-mode version of Symantec's MultiScope. Debuggers like these essentially freeze all of Windows while the child process is stopped. Instead of using Windows to show their screen, they switch the screen to text mode, use a secondary monochrome monitor, or communicate to a remote debugger over a serial line or network connection.

When using these debuggers, your system is always in one of two modes. The first mode is when Windows and your program are running normally. The other mode is when the debugger is active and you can't access any part of Windows. Although there is no official name for this debugging mode, I've dubbed it *super hard mode*, for reasons I'll explain shortly.

As more and more developers came into the Windows fold, a clamor began to arise for a true GUI debugger. In light of the rather gloomy prognosis described above, it might seem that a GUI debugger is simply not possible. However, the presence of the graphical version of MultiScope, Microsoft Visual C++, and Bounds-Checker for Windows shows that all is not lost. These are definitely GUI programs, yet they don't freeze up when the child process hits a breakpoint. Something else is going on here under the hood. As it turns out, there are two ways to deal with the problem.

The first way to prevent the Windows input system from freezing is termed *soft mode*. As part of the entry sequence of the debugger's interrupt handler, the code subclasses each of the child process's windows, directing the messages to go to a dummy window procedure in the debugger's code. The dummy procedure's job is to provide default message processing for the debuggee while it's not processing messages itself. After subclassing the child process's window, and while still in the interrupt handler, the code goes into a `GetMessage()`/`DispatchMessage()` loop. The child process spins in this loop until the debugger gives it the order to resume execution. Because all the child process's windows have been subclassed, there's no need to worry about code in the child process being called. Instead, messages destined for the process's windows are handled by the dummy window procedure in the debugger. *continued*

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To seal off the child process even more, a soft-mode debugger should also somehow prevent hook procedures in the child process from getting called. In Windows 3.1, the WH_DEBUG hook is supposed to help with this. A WH_DEBUG hook is supposed to be called before any other hooks are called. However, in stepping through the hook code in USER.DLL, it appears that there may be problems with this particular hook.

The default message processing that the dummy window procedure provides appears to be highly subjective. The messages that the MultiScope debugger handles are different from what the Visual C++ debuggers handle, which are different from what Bounds-Checker for Windows handles. For the most part, the dummy window procedure can simply pass the message on to `DefWindowProc()`. In all cases, however, there are some messages that the dummy window procedure should handle specially. For instance, it will not want to allow certain WM_SYSCOMMAND messages (e.g., SC_CLOSE) to go to the default handler.

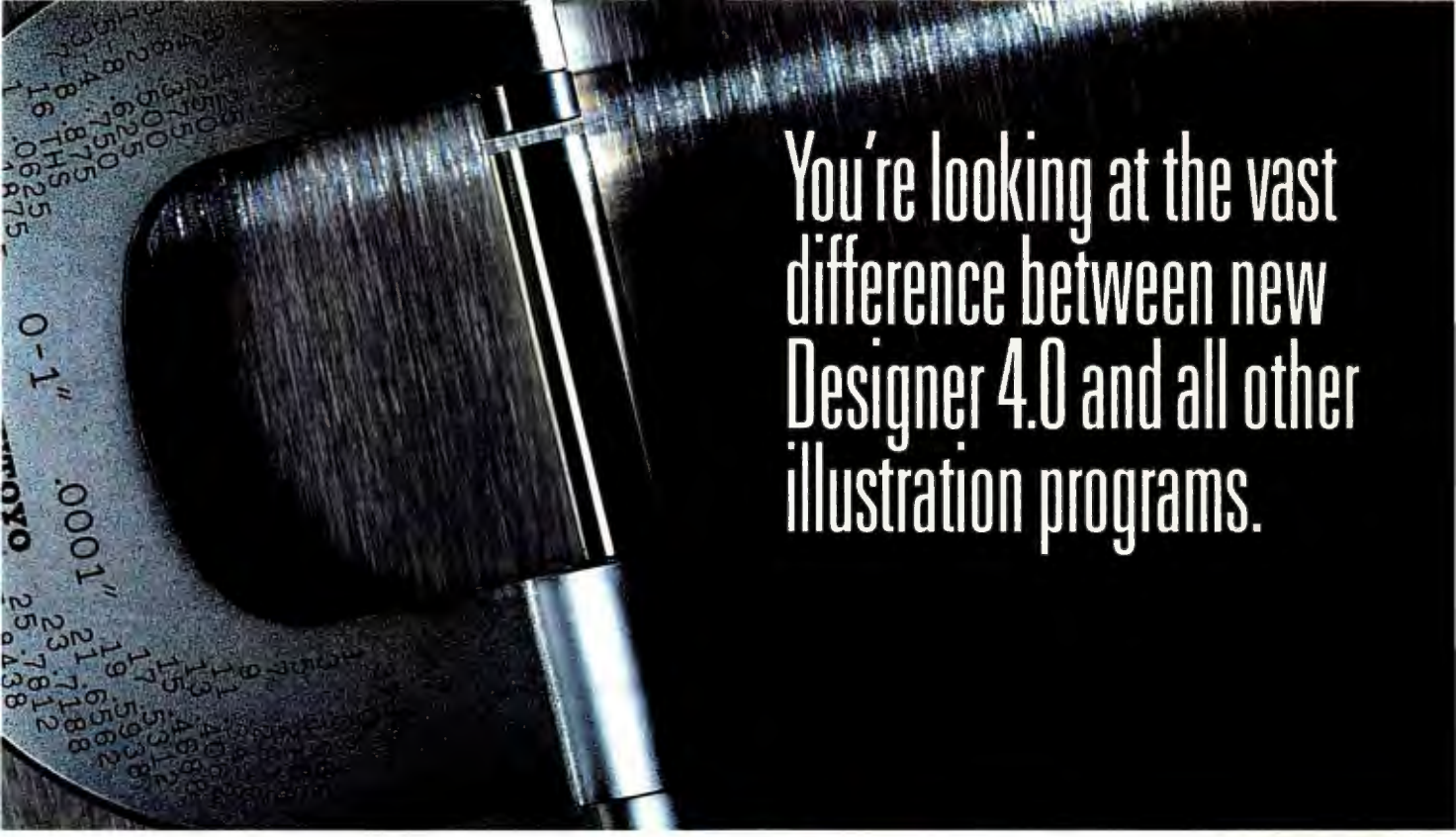
The advantage of soft mode is that all tasks in the system (except the child process) continue to operate normally. The windows of the child process remain on the screen but aren't responding to normal input commands. The disadvantage of soft mode is that important messages for the child process will be lost. For example, if the child process was in the middle of a DDE transaction when it stopped, the default processing provided by the debugger's dummy window procedure won't know what to do with the message. Put another way, while the child process is stopped, it won't see any of the messages it ordinarily would have received. Thus, soft-mode debugging isn't ideal for all situations.

Hard-Mode Debuggers

The second method of preventing the input system from locking up is to go into *hard mode*, a special mode of the windowing system that's new in Windows 3.1. In this mode, only one window (and its children) can receive messages; all other windows are frozen and receive no messages. To enter hard mode, a debugger calls `LockInput()`, specifying the window handle of its main window. Only the debugger responds to mouse and keyboard input, until the debugger calls `LockInput()` again. The child program, as well as all other programs, is frozen. If you've ever seen the old *Bewitched* TV series where Samantha temporarily suspends people, you probably have an idea of what hard mode is like.

The advantage of hard mode is that the debugger doesn't have to deal with messages intended for the child process. And since all other tasks are frozen, there's no chance that the child process will receive an important message until the debugger exits hard mode. This mode's disadvantage is that, while you're in it, you're confined to whatever facilities the debugger provides. There's no way to start up an external editor or browser, for instance.

Recently, some people have begun referring to text-mode debuggers as hard-mode debuggers. However, a true hard-mode



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Hands On Some Assembly Required

debugger uses Windows for its user interaction, while text-mode debuggers don't. For this reason, I refer to text-mode debuggers as *super hard-mode* debuggers.

If it's possible to have a GUI debugger, why would you want to use a text-mode debugger? By not using the windowing system to display information, these super hard-mode debuggers are the best way to minimize side effects caused by the debugger. Ideally, the system you're debugging shouldn't be influenced by the tool you're debugging with. Super hard-mode debuggers are as close as you can get to this ideal (at least without using a kernel debugger, which I'll describe next month). One of the few disadvantages of super hard-mode debuggers is that it is extremely difficult for a debugger to know about all the various Super VGA boards and how to switch between text and graphics modes with them.

Miscellaneous Support

In this category I lump such things as hardware breakpoints and access to system-level information (e.g., heap walking). In Windows, there is no direct support for hardware breakpoints, so an application must manipulate the debug registers itself. However, an application cannot read or write the registers directly, as only ring level 0 code is allowed to do this. Although the DPMI (DOS Protected Mode Interface) specification provides for setting the debug registers, bugs in the Win386 implementation of the DPMI specification rendered the provision useless. Therefore, the traditional route to manipulate the debug registers is to write a virtual device driver, since its code runs at ring 0.

For accessing system-level information such as the task list, the module list, and the local and global heaps, a Windows debugger can use the various TOOLHELP APIs. Although you can obtain this information from undocumented methods, TOOLHELP shields you from the differences found in different versions of Windows.

WINDEBUG

Before the TOOLHELP DLL, the only debugger support in Windows 3.0 came from WINDEBUG.DLL. Microsoft never publicly documented WINDEBUG.DLL, except to a few tool vendors such as Borland and Symantec.

WINDEBUG was an attempt to put a synchronous layer on top of the notification and interrupt streams that TOOLHELP lets you access. The WINDEBUG API consisted of one function to which you passed commands and from which you received notifications. Thus, it was similar to the `DosDebug()` API in OS/2, which I'll discuss next month.

The problem with WINDEBUG was that it assumed that it was the only code that needed to see interrupts and notifications. It didn't chain these events on, which led to problems when running with TOOLHELP under Windows 3.0. WINDEBUG has fallen into disfavor with the major compiler vendors, although you may occasionally sight some of its descendants, CVWIN.DLL and TDWIN.DLL.

Next month I'll conclude with a discussion of debugger support under OS/2 2.x and Windows NT. ■

Editor's note: *Some Assembly Required has no listings this month.*

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Virtual Device Drivers for DOS

Build virtual-device-driver support into your DOS applications and exploit the power of the Windows API

BILL HAWKINS AND ED PUCKETT

DOS programmers used to work in a relatively simple operating environment that offered near-total freedom. Now, writing a successful high-performance DOS application requires understanding the Windows VMM (virtual machine manager) and VxDs (virtual device drivers). Once you master the art of writing a VxD, however, Windows offers untold new freedom in DOS programming.

VxDs enable DOS applications to interact with almost any part of the Windows API. For example, you can use a VxD to communicate with the ODBC (Open Database Connectivity) interface, gaining access to data sources residing on both Windows and Mac platforms. You can use a VxD to access the mail-enabling functionality of MAPI (Messaging API). You can even use VxDs to fix or enhance features in your application that Windows has compromised.

The VMM Architecture

Enhanced-mode Windows is based on the VMM, which is a 32-bit, single-threaded, preemptive multitasking operating-system kernel that supersedes DOS. It creates a VM for Windows and for each DOS application. (Windows and Windows applications run in the system VM.) The VMM provides each VM with its own address space, interrupt vector tables, and I/O port space. The VMM shares CPU time among VMs to give each the illusion that it is in complete control of the computer.

VxDs virtualize hardware devices, enabling enhanced-mode Windows to multitask non-Windows applications alongside Windows applications. (Cooperative multitasking is performed only in the system VM. DOS applications, each in their own VM, enjoy superior scheduling performance when compared to their Windows counterparts.)

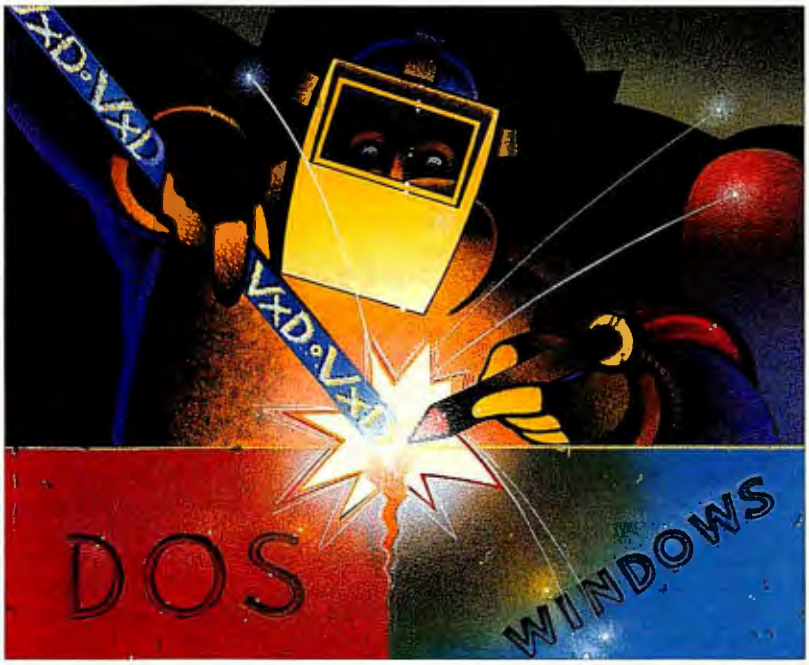
VxDs are 32-bit, protected-mode DLLs that run at ring 0 and span VMs. This special status lets VxDs control the behavior of almost any application running in the Windows environment. To write a VxD, you need the Windows Device Driver Kit.

Preparations

We were forced to learn about VxDs because we had to tightly integrate our 32-bit DOS-extended graphical application into the Windows 3.1 environment while waiting for a release of Windows NT that supported the NT file system (we needed this to port our application to Win32s). However, application-specific VxDs are essential for any DOS application that isn't going to be ported to the native Windows environment.

To begin integrating our application into the Windows 3.1 environment, we needed to fix two bugs. Our high-resolution video drivers were unable to coordinate with the Windows video drivers across hot-key events, and our print spooler and the Windows print spooler often collided.

We experienced three problems when running our DOS-extended graphical application in high-resolution video modes. Hot-keying from Windows back into our program often trashed the display, as did hot-keying back into Windows from our application. And if a user hot-keyed from our application back into Windows when our application was running in background mode, Windows would suspend our application.



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Solving the first two problems was not difficult. When our VxD detects that our application is about to gain screen focus, we simply restore a copy of our display state, which was saved the last time we detected that we were about to lose screen focus. However, restoring a stashed copy of the Windows screen just before returning

to Windows would miss any intervening screen events. Luckily, most VDDs (virtual display drivers) and screen grabber drivers correctly refresh their screen when they are regaining execution focus.

The third problem is trickier. Windows' VDDs typically suspend any high-resolution DOS application when that application loses the execution focus. The VDD does this as a conservative measure; responsibility for virtualizing the display lies with the VDD.

When a DOS application is running full-screen, the display is not virtualized and the application deals with the video hardware directly. When a DOS application is windowed or in the background, however, the VDD virtualizes that application's display and translates its display modifications to corresponding modifications in the application's window. The VDD also translates a background DOS application's display modifications to corresponding modifications in a special video state buffer maintained while the application is in background mode.

The VDD suspends a background DOS application that is running in a high-resolution mode because it must perform the aforementioned translations and cannot do so for the video modes it does not understand. We found this particularly frustrating because we had been careful to ensure that we were running in the same video mode as Windows, and our application was prepared to defer modification of the display until it was again the foreground application.

The Solution

We soon discovered that a VDD will not suspend a DOS application that is running in a standard VGA mode and changed our application accordingly. Our VxD would receive notification just prior to losing the display (i.e., Focus Out) and just after regaining the display (i.e., Focus In). We planned to get the information regarding the loss and gain of the display by monitoring the system controls, which are called in each VxD as the system state changes. Unfortunately, system controls corresponding to Focus Out and Focus In didn't exist.

We discovered that the Windows SHELL VxD maintains a service for hooking the underlying events of the Windows operating system, which is actually built on top of the preemptive operating system controlled by the VMM. By experimenting, we found a combination of system controls and SHELL events that would herald the display changes we sought for each of the possible ways of switching to and from Windows. It's unfortunate that these events are not officially documented.

We next focused on the print-spooler contention issues. Whenever device contention occurred, a frightening dialog box popped up. Because we already had a VxD, we used it to access the Windows print spooler.

This raises a crucial point: VxDs provide an *API-complete* pathway between Windows 3.1 and other VMs. By API-complete, we mean that anything that can be performed in the Windows VM using the Windows API can also be performed in another VM through the VxD pathway. This opens up a vast realm of possibilities for all those DOS boxes that enjoy the advantage of true preemptive multitasking.

API completeness depends on the ways in which data and control can be communicated across an interface. The most common one is a data interface, in which raw data is communicated. Shared memory buffers, message packets, and even function parameters are examples. Windows includes a data interface between itself and the other VMs: The INT 2Fh Clipboard interface transfers data between a Windows application and a program running in a different VM.

A control interface communicates process-execution information. An RPC (remote procedure call) is one example. Microsoft implements a simple control interface in the WX and WXServer programs it distributes with Microsoft C 7.0. With the help of a VxD, these programs implement a control interface consisting of a single command that executes a Windows application.

The Client/Server Approach

Because all computer interfaces are fundamentally data interfaces, control must be communicated in an encoded form and decoded so the receiver can act on it. In "Making Windows and DOS Programs Talk" (*Windows/DOS Developer's Journal*, May 1992), Thomas W. Olsen demonstrated how to pass data and control (encoded as data) between a DOS client and a Windows server process using an intermediary VxD. Olsen's code serves as a template for various client/server pairs you might want to implement.

We generalized this technique into a general-purpose client/server architecture between DOS clients and Windows servers. Each client/server pair is defined via C++ class derivation from standard base classes. Furthermore, a single VxD manages communication for all client/server pairs.

Using one VxD is attractive because each one reduces the amount of physical memory available to other applications. In fact, the current implementation of Windows locks all VxD memory, even memory that is flagged as not requiring such treatment. VxDs also require unique IDs, which Microsoft doles out on a case-by-case basis. Unfortunately, the ID is a 16-bit quantity, so there are only 65,536 approved VxD IDs.

Our single VxD maintains a list of service tags provided by the various servers on the Windows side. A client submits a request, and, if a service tag for the requested type exists, the VxD returns the tag and request to the server. The server is passed the linear address of the request and forms a memory selector for it. During the remainder of the request's processing, the request exists as a block of shared memory between the client and the server. The server decodes the request, acts upon it, and posts the results back into the request. You should note that, except for a small generic header indicating the server type, the request's structure is known only to the client and the server; it appears to the VxD as uninterpreted data.

This architecture makes providing Windows API services to DOS programs a straightforward affair. For the desired API subset, you simply define a suitable request structure and IDs for the various service requests. The server acts on each service request accordingly.

If you are still writing DOS applications and you feel encumbered by the Windows environment, take the time to learn how to write a VxD. You'll quickly find that you can do much more than you ever could in DOS. In fact, you might even end up requiring that your users run your application on top of the Windows 3.1 VMM. ■

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JERRY POURNELLE

IBM's Preemptive Strike

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OS/2 2.1 has the jump on Windows NT, but it won't get far without more extensive device-driver support

I always think of September as the beginning of the year. Many of us old academics still do, no matter how long we've been away from the college scene. That's actually a bit odd, since traditionally the fall academic term begins around Michaelmas on September 29. No matter, for me September is the first month of a new year. It's also time for my annual outfitting-for-college recommendations, which I'll get to in a moment.

Since my last column, I spent a week in Washington, D.C. I was there mostly to promote new ways to get access to space for all of us, not just NASA employees. I was also doing some research on a new novel. It was a good trip, capped off by a Saturday midnight expedition to the Capitol, where we visited George Washington's tomb—empty, of course, since he's buried at Mount Vernon, but the tomb's still there in case he ever needs it.

I also got to visit the floor of the House, look at the cloakrooms, walk in the Speaker's veranda, and even sit in the Speaker's chair. It's a rather awe-inspiring experience. So is coming out of the House entrance at the top of the Capitol steps; when we did, my member friend said, if this ever stops getting to you, it's time to quit. I wish they all thought that.

I went from Washington to Atlanta for Spring Comdex, which was hectic. A couple of years ago, BYTE's editors got a new duty: we, in conjunction with the Interface Group, give out awards for the best products shown for the first time at a Comdex. The Interface Group puts on Comdex, and there are two big ones, Spring and Fall, each year. For two days, between 15 and 20 BYTE editors race about the show floor, visiting every booth and looking for new products worth nominating. Then we all get together for a marathon editorial meeting—this year's lasted from 3 to 11 p.m. nonstop—at which we choose nominees and winners in each of about 10 categories. We also pick the Best of Show from among the winners.

I think I learn more at those meetings than I do the rest of the year. This shouldn't come as a surprise, since it would be hard to assemble a group with more collective knowledge about this industry than BYTE's editors, all of who have a passionate interest in this industry, as indicated by the heated discussions. The awards are given on the basis of both technical merit and potential impact on the industry; and we're well aware that winning—or even being a finalist for—one of the BYTE Best of Comdex Awards can itself give a product more impact than it would otherwise have.

Samuel Johnson said that when a man knows he is to be hanged in a fortnight, it concentrates his mind wonderfully. The Best of Comdex Awards do much the same: they make us concentrate on what's both new and important at Comdex. This year, three things stood out.

First, OS/2 had a large presence. Not as large as Windows, of course. Spring Comdex was officially divided into Comdex and Windows World. The split was about two-thirds to one-third, which is pretty astounding when you think

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how long Comdex has been around compared to how long Windows has existed as a practical product. Still, OS/2 had a real presence, and IBM announced that OS/2 2.1 is shipping; Microsoft Windows NT remained in beta testing.

Second, Windows NT had no small presence itself. There were perhaps 50 minibooths inhabited by NT users and applications developers. Considering that no one is quite sure just who NT is for, that's quite a showing.

Finally, the IBM/Motorola/Apple consortium's PowerPC chip was on display, and a few systems were running early copies of the chip. It was quite impressive, sufficiently so to win BYTE's Best Technology Award, which is notable since both Apple and IBM have bet a reasonable part of their future on the success of this chip.

There were other notable products, particularly a whole raft of PCMCIA products. Along with modems and network connections, these included full SCSI devices. Now your PCMCIA-equipped laptop can in theory be connected to any SCSI device you like, including disk drives, WORM and read/write optical drives, scanners, DAT (digital audiotape), and so forth. There were other exciting things, but for me, OS/2, Windows in general and Windows NT in particular, and the PowerPC chip were dominant. They also generated a story.

IBM's OS/2 operating system has some nifty features. There aren't many commercial OS/2 applications, but more are coming, and they work superbly. OS/2 runs DOS applications better than DOS, and version 2.1 runs Windows applications as well as Windows. The user interface is well thought out. It really does multitasking: I have had two separate communications programs running on two different modems going simultaneously on OS/2, with nary a dropped bit. I sure can't manage that with Windows. There's a lot going for OS/2.

Alas, OS/2 won't work with a lot of hardware. My pet peeve is that I can't use my Pioneer CD-ROM and read/write optical drives, nor my Network Archivist DAT backup system from Palindrome; indeed, about half the hardware in Chaos Manor doesn't work properly with OS/2. If you set out to construct an OS/2 system, and buy only hardware that's known to work with OS/2, you'll be fine, but most of us aren't willing to scrap much of our hardware for a new operating system.

OS/2 won't work with a lot of hardware because it doesn't have device drivers for them. Device drivers are programs that interface between the operating system and a particular peripheral. There are *many* different devices out there in the computer world. Writing device drivers can be tricky, and not all programmers do it well; some consider writing device drivers a black art. As a result, operating-system developers, including both IBM and Microsoft, must depend on outsiders to write device drivers.

There are far more Windows device drivers than OS/2 device drivers. Given that OS/2 2.1 is a better DOS than DOS, as good a Windows as Windows, and multitasks better than Windows, one suspects that the lack of device drivers is a major reason that Windows is more popular than OS/2. One also suspects that the presence or absence of device drivers will be a key factor in the coming war between OS/2 and Windows NT. In theory, both companies know this.

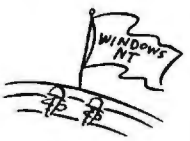
Billed as the clash of the titans, Spring Comdex/Windows World opened with Bill Gates "officially announcing"

NT in his Windows World keynote speech, while IBM's Jim Cannavino not only demonstrated OS/2 2.1, but announced that it was shipping. It was, too. I was handed a shrink-wrapped copy by IBM's John R. Patrick at the IBM OS/2 party, and quite a party that was, with several hundred IBM executives, evangelists, programmers, and engineers mingling with equal numbers of developers and hackers—and not a three-piece suit to be seen in the room.

Indeed, there were few suits to be seen on the show floor. When we presented IBM with BYTE's Best Technology Award for the show, Sheldon Adelson, founder of Comdex, remarked that when he first met me, I was wearing a bush jacket and had a screwdriver in my pocket; "Now Pournelle's wearing a suit, and the IBM vice president has a T-shirt."

Microsoft and IBM each had multiple booths. Microsoft dominated Windows World; IBM nearly saturated Comdex. Each had outposts in the others' territory. I felt a bit like a war correspondent as I went through the IBM and Microsoft booths. Both sides brought heavy-hitter programmer teams, sharp people indeed. Most of the troops on both sides are BYTE readers, so I had no trouble finding people to talk to about the strengths and weaknesses of the two operating systems. I could write a pretty good story about that, but the bottom line is that at the programmer level, the two companies are evenly matched.

They're not so evenly matched in organization. When another BYTE editor and I went looking for the PowerPC chip, no one at any of the main IBM booths had any notion of where to find it. Eventually we discovered it over in a far corner, where IBM had a very large and very impressive display of new technologies, easily one of the most interesting booths at the show.



There were other impressive IBM displays. An exhibit of free-form handwriting recognition that could read some of my scrawl. A voice-recognition system that you train by reading scripts so the system knows who you are. I may soon be able to walk up to my machine and say, "I'm Jerry Pournelle, and my voice is my password." Both those technologies were deservedly finalists for BYTE Best of Comdex Awards.

"Develop Your Device Drivers for OS/2!" proclaimed a sign at IBM's booth. "IBM Device Driver Source Kit for OS/2 Now Available on CD!" A flier announced "Free. WIN-OS/2 source code for seamless VGA Display Device Driver when you order the DDK!" Microsoft has long used CD-ROMs to distribute their development kits, and will even get developers a *discount* on a CD-ROM drive. Aha, I thought, now IBM has learned that trick. With any luck, we'll soon see a flood of new device drivers for both OS/2 and Windows under OS/2, and maybe it won't be long before I can hook up my Pioneer CD-ROM drive on an OS/2 system. By gum golly, it looks like IBM is doing something right.

Then I got closer, and to my horror, I saw the price. You can get the Device Driver Source Kit for only $499. It wasn't clear whether that was the regular price or a

show special. I went up to the young woman who was passing out the fliers.

"I thought the big problem with OS/2 was the lack of device drivers," I said. She gave me a smug look and handed me a flier. "Yeah," I said, "but isn't 500 bucks a bit steep? If I go over to Microsoft and whisper about writing device drivers for NT, they'll stuff kit disks into my briefcase." She drew herself up to her full height and said, "Thank you very much for the information." She was too polite to say, "We're IBM. We don't care. We don't have to," and maybe she didn't think it, but it sure looked like she did.

I went around to some of the sharp OS/2 programmer troops and told that story. They were disturbed. They hadn't known the price was that high. That kit, it seems, is sold by a different part of IBM. I spent an hour looking for any policy-level IBM official, or a PR officer, but I never found one to discuss this with. When I went back to the OS/2 station, the young woman, still smug, said, "Back again?" It was pretty clear she had no use for my observations, so I didn't offer any.

IBM is trying to play catch-up with OS/2 applications and drivers. They should want their development kits in the hands of every independent hacker and start-up company: not just the big companies.

I didn't know how much Microsoft charged for their kits, so I went over to find out. I'd no more than set foot on their carpet when one of the PR people recognized me and asked if she could help. "If I wanted to write NT device drivers, what should I do?" I asked. "You're in the wrong booth," she said. "Let's go over to the NT booth. I don't know anything about NT, but we'll find someone."

We walked over—no question that Microsoft's PR people knew where each and every Microsoft booth and display was—and in 7 minutes—I timed it—I was talking to one of the NT product managers. "Well, first you need the developer's kit, with the compilers and source code and stuff," he said. "That's on a CD-ROM for $69. Then you get the DDK. It's another CD-ROM, same price."

"Little steep, isn't it?" I said. "A little," he said, "but there's a lot there, all the sources we could find, not just ones we wrote but any we could talk people out of. Want a copy?" I think I just may have located the reason why there's a shortage of OS/2 device drivers, and why there probably won't be a shortage of NT drivers.

There's more to this story. When I got home, one of the first things to arrive on my doorstep was an Airborne Express package from Microsoft containing both kits on CD-ROM. I hadn't even asked for them.

I did ask for the IBM kits, which arrived four weeks later. I also sent by MCI Mail a copy of the above text to IBM's executives. The reaction was encouraging, in that they took it seriously; but so far the upshot has been a fax demonstrating that IBM isn't overcharging for their development tools, because Microsoft now charges more than $500 for their Windows development software. What that totally ignores is that Windows already *has* lots of applications and device drivers; they're not playing catch-up. Moreover, Microsoft's NT development tools don't cost anywhere near that much.

My wife's observation is that IBM's first reactions are like those of the federal government on job creation and the economy. They don't understand that if you put obstacles in people's way, creative people will go in another direction. IBM is trying to play catch-up with OS/2 applications and drivers. They should want their development kits in the hands of every independent hacker and start-up company, not just the big companies: anyone who can possibly write OS/2 software. They also ought to be busting their buns to make it easier for nonhackers to develop OS/2 applications.

I'm told that IBM is reviewing the situation. I hope so, because OS/2 2.1 is a good operating system, with great potential. [Editor's note: *As this column went to press, IBM gave advance notice of a 90-day special price of $59.95 for the Device Driver Source Kit, good through September 14.*]

Meanwhile, at Comdex, BYTE's Software Award went to Windows NT, which also took the Best of Show Award. OS/2 2.1 was a finalist in the software competition. All the winners in other categories are automatically finalists for Best of Show, so we don't usually mention what was second for that award; but this time the vote was so close that we thought we had no choice. Windows NT won over the PowerPC chip after three ballots in the closest vote I have ever seen. I don't have to say which way I voted.

This September is the first one in many years that won't be back-to-school-time at Chaos Manor. Richard, our youngest, has just graduated from UCLA

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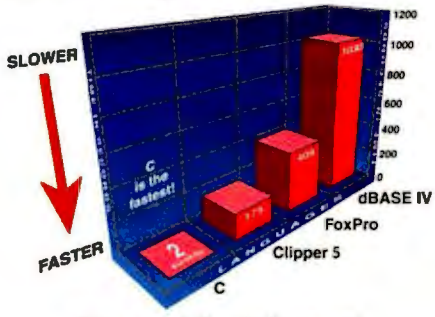

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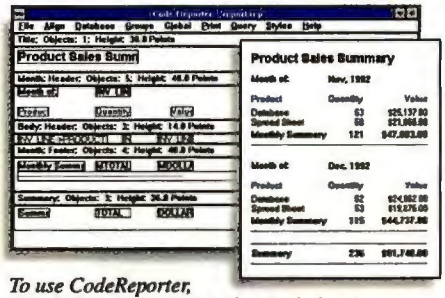

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and is angling for a post as a policy wonk, whatever that is, in Washington, D.C., for a year or so before going to graduate school. Richard began as a Mac user, and it's possible that if he hadn't had access to other machines he'd still be one; but in fact he has thoroughly changed over to Windows.

For the last year, he's carried an NCR 3170 portable (previously called the Safari NSX/20; see the April 1992 column), and he loves it. It's small and quiet enough to take to classes, the screen is bright enough that you can read it nearly anywhere, the batteries last long enough, and the machine is powerful enough to do the increasingly complicated work Richard is assigned.

Last month, Richard's 3170 got knocked off a table. The machine is rugged, but it's not indestructible. When he turned it on, the hard disk would read only. He could run all the software. He could even write and print papers and save them to a floppy disk or to the BSE external Flashdrive; he just couldn't save anything to the 3170's hard disk. Needless to say, this was a major inconvenience.

We'd had that machine longer than the usual warranty period, and while NCR would no doubt have fixed it for me, I asked our oldest son Alex to look into it. The result was instructive.

The 3170 has an 80-MB Micro IDE hard drive. It's made by JVC, but JVC won't sell drives to anyone but equipment manufacturers; at least Alex couldn't buy one through Workman & Associates, the consulting firm he works through. However, unlike the first wave of portable-computer drives, the 3170—and most other modern portables—uses the Micro IDE standard connector. Moreover, the 3170's BIOS understands a whole bunch of different drive types, so it was easy to replace the JVC drive with a Maxtor drive of the same size. For that matter, we could have put in a larger-capacity drive and it would have worked as well.

It's thus possible to upgrade 3170 portables. Alex cautions that you shouldn't try this at home: opening up that machine is no job for amateurs. It took Barry Workman about an hour to figure out how to disassemble the machine such that they could get it back together again, and Barry is good at this. Anyway, with the hard drive replacement, all is well, and the 3170 is running as good as new.

You can probably get whatever capacity you can afford for your portable, but get someone competent to install it. More to the point, the 3170 is a serious machine for academic use. I recommended it before, and still do.

There are many good machines

for experienced users, but for absolute beginners, I strongly recommend the Tandy Sensation. When my daughter Jenny got out of the Army, she became an instructor in a school for beginning computer users, which made her a natural for testing the Sensation. She's been able to compare it to a number of other entry-level Windows systems, and it's her hands-down favorite.

The Sensation is a full-featured machine. It's a 20-MHz 486SX, not the fastest machine in the world but no slowpoke either. The integration of the machine and the software is little short of splendid. The

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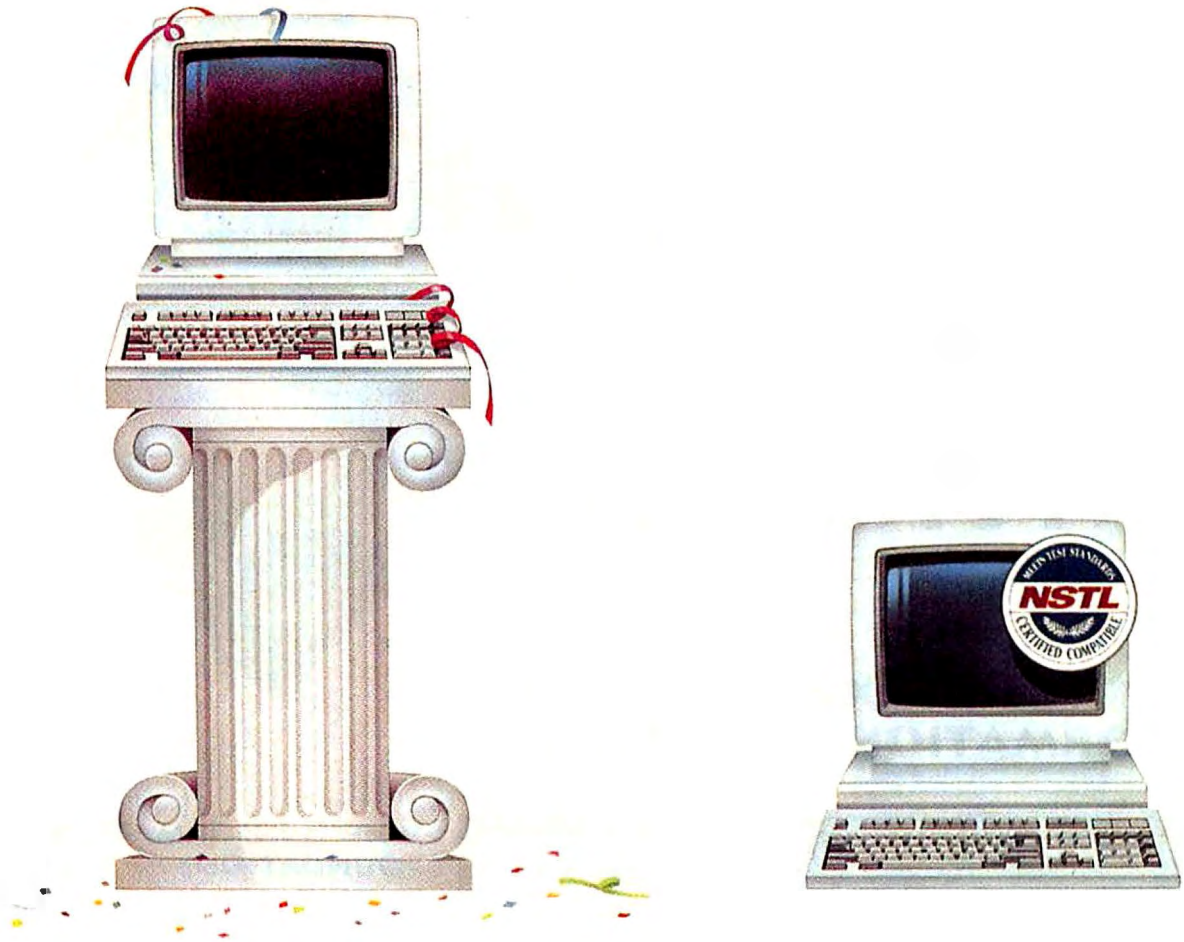

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Sensation comes with a well-done tutorial that begins with basics like how to use a mouse, what word processing is, and how spreadsheets work. From there, you can graduate to more sophisticated stuff, like how to use the fax modem, about which Jenny reports, "When I had to send out my résumé, it was all right there, and I had it sent to 20 places in an hour, starting with knowing nothing about fax modems."

She's since taken a position with a firm that deals in sales-automation software, and she still finds the Sensation useful. It's a good system for people who have never used a computer before, but it's also a general-purpose machine that can run any DOS or Windows software.

When I began this column, donkey's years ago, one of the first of Pournelle's laws was "silicon is cheaper than iron," by which I meant that a general-purpose computer was always to be preferred to a dedicated word processor or other specialized system. The Sensation illustrates that nicely: people who learn on it won't be surprised by the other things computers can do.

The Sensation comes with completely integrated multimedia capabilities: an internal CD-ROM drive, on-board sound, and an internal speaker. There's even a music-box program that lets you play an audio CD in the background as you work with the computer—something Jenny finds surprisingly convenient while working on documents. It also comes with enough software to get you going. Microsoft Works isn't the best word processor, spreadsheet, or database, but as I've said before, it's good enough at all three to take care of most beginners and many sophisticated users. The Sensation has good tutorials on using Works, and it comes with a number of templates that will let beginners sit down and right away do something useful with the computer.

There's also a ton of "infomercials": demonstration versions of software, everything from communications programs to sophisticated spreadsheet applications. BYTE readers won't be impressed by those, but they're a godsend to beginners who don't understand what computers are capable of.

The Sensation isn't perfect. While the WinMate Desktop—a Windows desktop shell—is great for beginners, after a while it gets in the way, and the documentation doesn't tell you how to just use Program Manager. WinMate also interferes with Norton Desktop, which is a pity because Norton Desktop for Windows is an excellent productivity enhancement once you've learned to use Windows. The only reliable way to get rid of WinMate is to go into WIN.INI, and that is something the people who get a Sensation won't do. There ought to be a "WinMate On/Off" button, which would take care of it.

There are other minor annoyances, but on balance I know no better introductory machine, and the Tandy Sensation is a candidate for the User's Choice Award as best beginner's system.

The most useful software for school will naturally depend on what you're studying. Richard isn't in hard science, but he still has to do a fair amount of number crunching, particularly statistical analyses of voting patterns, including correlations with socioeconomic factors. Despite all the specialized statistical software available at Chaos Manor, Richard finds that Microsoft Excel does just about everything. It computes primary statistics, does correlations, and draws graphs. The resulting papers have been very good for his grade point average.

Students write a lot of papers. Richard was captain of the UCLA debate team (they won the national championship that year, too), so he had to deal with more written material than most students. He got used to Microsoft Word when he was a Mac user, and now that he's converted to Windows, he still uses Word. He finds that a full-featured word processor lets him do fancy papers, with footnotes or endnotes as the professor prefers, font changes—the trick, he says, is to choose a font that makes the paper look longer without the professor realizing you did that—and inserted graphs and graphics. About 80 percent of all the work he has to do at school can be handled by Excel and Word.

For organization, he uses Ascend, a Windows program I've recommended before. It must be working, because he's better organized now. Come to think of it, I'm better organized than I was before I took up using Ascend.

The standard printer for students is Hewlett-Packard's DeskJet. Most will want the standard monochrome DeskJet 500, which works with DOS or Windows. The Mac has HP's DeskWriter series, greatly preferred to the standard Apple dot-matrix ImageWriter, because it's faster,

does startlingly prettier work, and doesn't actually cost much (if any) more than the ImageWriter. (Apple also has a fine series of non-dot-matrix printers, but we haven't tested them.)

Richard has been using the DeskJet 550C, which has a color capability, but in fact he seldom needs or uses color, in part because his primary computer is the NCR 3170 laptop. You can hook a color monitor to the 3170, and for some academic disciplines, the color capability would be important. Obviously, the DeskJet's color print quality at 300 dots per inch isn't up to dye-sublimation printer standards, but it's not bad—and a color cover, or a color illustration inserted into a term paper, can do wonders for getting a busy professor's attention.

You can have 700 MB of storage in a system you can hold in the palm of your hand. Amazing.

Richard reports that the DeskJet comes with printer drivers for both DOS and Windows. The Windows drivers install on top of the standard printer drivers that come with Windows, and they slow Windows printing even more than usual. On the other hand, Windows gives a great deal more flexibility in fonts and formatting, and particularly for final drafts is usually the way to go. There's a software-selectable lower-quality output you can use for faster printing of intermediate drafts.

The DeskJet's sheet feeder tends to be a bit fussy depending on what you're putting into it. There's also a problem with envelopes: some software doesn't recognize where the DeskJet thinks the envelope is. Getting things set properly to print the Ascend daily appointment and record sheets is a bit of a task as well; but all in all, the DeskJet, either the black-and-white model or the fancier color model, is in my judgment the right printer to send off to college with your student. Recommended.

BSE's Flashdrive, a portable hard drive, was the other accessory we sent with Richard. That serves both as a backup system—when the 3170's drive became read-only, he was able to save everything off to the Flashdrive—and a storage place. The Flashdrive is about the size of a cigar box and comes in a variety of capacities. Installation is simple, and I've used these drives for years without problems. They now have a new model featuring Toshiba's 340-MB 2½-inch hard drive. All the Flashdrives work fine compressed with Stacker—I don't recommend MS-DOS 6 compression—meaning that you can have 700 MB of storage in a system you can hold in the palm of your hand. Amazing.

I consider a CD-ROM drive essential to any college—or high school for that matter—student's computing equipment. Years ago, I said for the record that "CD-ROM will change the world," a sentiment that Microsoft Press used to quote on every CD-ROM they published; and that prediction is coming true. There was a recent *Wall Street Journal* article about how the CD-ROM has revolutionized educational publishing. That revolution will continue: you can now tailor-make CD-ROMs for particular schools, courses, and classes, and produce them economically. CD-ROMs offer a vast amount of information on nearly any subject you like, all organized and indexed for rapid searches. Incidentally, this is going to be of increasing importance to local school boards, because textbooks tend to drive curricula.

A good CD-ROM drive for school use is the SyDOS Personal CD-ROM Drive. This is a small, self-contained unit that interfaces through your computer's parallel port. Hook it to a portable computer, and you can use your system in places where they won't let you check out the CD-ROM. You can transfer selected data onto your hard disk for incorporating into papers and reports. The SyDOS Personal CD-ROM Drive is bundled with a number of CD-ROM packages, and it's a good deal. Unfortunately, parallel-port access is slow compared to an internal drive.

The interesting thing about the SyDOS drive is that there's also an interface bus card for desktop systems that will let you use that same CD-ROM drive for multimedia as if it were an internal unit. Of course, the Tandy Sensation comes with a CD-ROM drive; and for upgrading desktop systems without a CD-ROM, I recommend Creative Labs' Multimedia Upgrade Kit, which gives you both internal CD-ROM and sound capability.

Incidentally, the SyDOS parallel interface software was written by BSE, so I have great confidence in it. I've never had a problem with anything BSE does.

Once you have a CD-ROM drive, you'll find many almost indispensable CD-ROM titles. One is the updated Microsoft Bookshelf, which incorporates a reasonable encyclopedia, *Bartlett's Familiar Quotations*, *The American Heritage Dictionary*, and more. (Bookshelf is included

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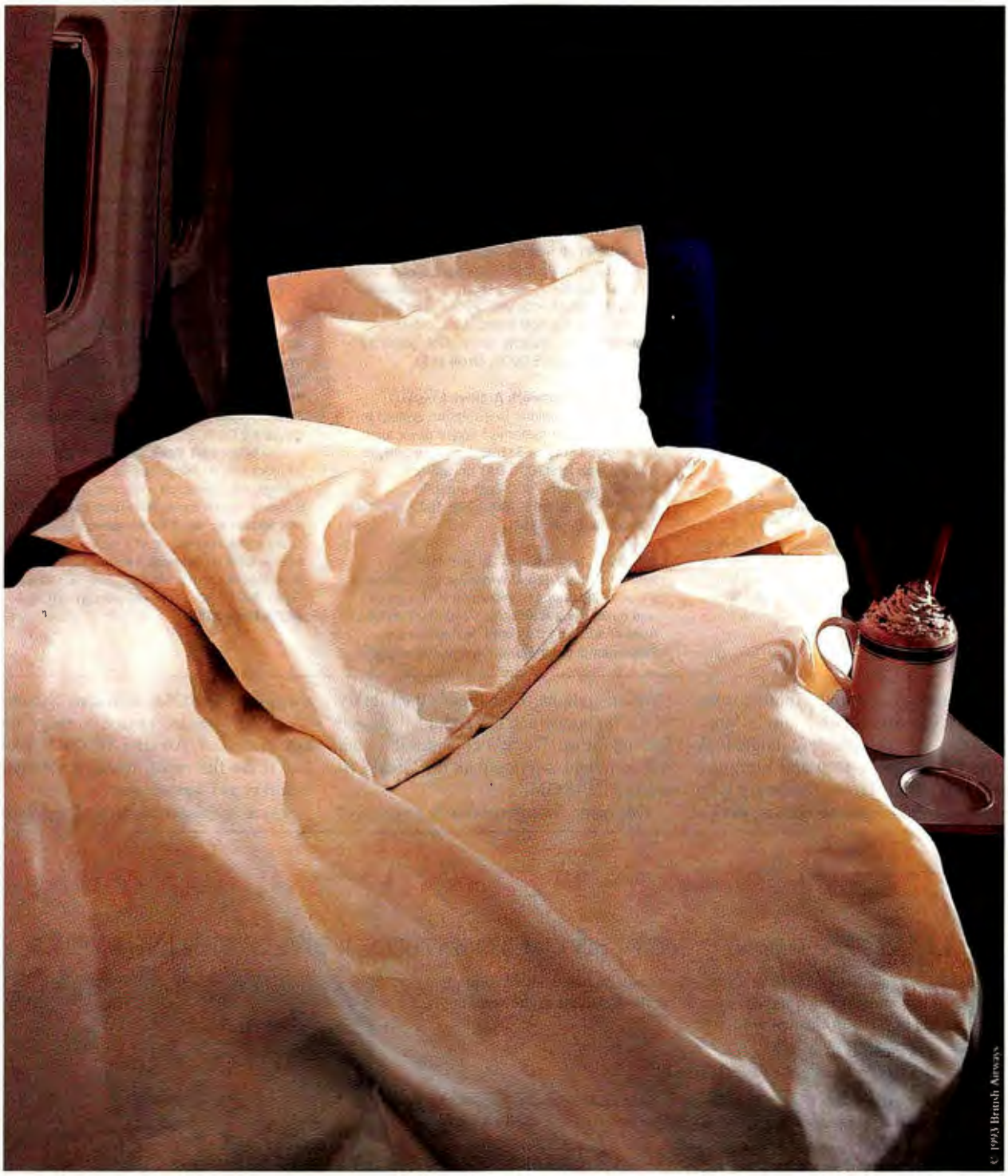

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Ascend is the best Windows-based calendar and time management program I've seen. It's $249 from **Franklin Quest Co.**, 2550 South Decker Lake Blvd., Suite 26, Salt Lake City, UT 84119, (800) 877-1814 or (801) 975-9992. **Circle 1146 on Inquiry Card.**

Buzz Aldrin's Race Into Space ($69.95) re-creates the space race of the 1960s. Build up your systems. Allocate funds to R&D. Watch a *Mercury* ship rise from the Cape and zoom off to orbit. **Interplay Productions**, 17922 Fitch Ave., Irvine, CA 92714, (800) 969-7529 or (714) 553-6678. **Circle 1147.**

HP's **DeskJet** ink-jet printers are both reliable and affordable. The **DeskJet Portable** sells for $479 from **Hewlett-Packard Co.**, Direct Marketing Organization, P.O. Box 58059, MS511L-SJ, Santa Clara, CA 95051, (800) 752-0900. **Circle 1148.**

Flashdrive portable hard drives connect to your printer port or use an add-in card. Drive sizes range from 25 MB to 340 MB, and prices are from $299 to $1049. **The BSE Co., Inc.**, 2114 North Fourth St., Flagstaff, AZ 86004, (602) 527-8843. **Circle 1149.**

DeLorme Mapping's **Global Explorer** is the most detailed CD-ROM world atlas I've ever seen. The **Street Atlas USA** CD-ROM offers street maps for every major city in the U.S. Both are available for DOS systems and sell for $169. Contact **DeLorme Mapping**, Lower Main St., P.O. Box 298, Freeport, ME 04032, (207) 865-1234. **Circle 1150.**

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Monarch Notes on CD-ROM ($69.95) summarizes the great works of literature for harried college students. **Great Literature** ($54.95) contains the text of 1896 classics. Both are DOS programs only. They're available from the **Bureau of Electronic Publishing**, 141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700. **Circle 1152.**

The **NCR 3170** notebook computer has wonderful provisions for communications, does Windows extremely well, and is an all-around handsome and handy unit. Prices start at $2533. Contact **NCR Corp.**, 1700 South Patterson Blvd., Dayton, OH 45479, (800) 225-5627 or (513) 445-5000. **Circle 1153.**

Palindrome's **Network Archivist** backup system uses a unique DAT rotation system to ensure that your system or server never loses data. Prices start at $1695 (software only) or $4695 (with Fast2000 DAT drive) from **Palindrome Corp.**, 600 East Diehl Rd., Naperville, IL 60563, (800) 288-4912 or (708) 505-3300. **Circle 1154.**

OS/2 2.1, IBM's robust 32-bit operating system, runs DOS and Windows applications in a true multitasking environment that's pretty well bulletproof. It sells for $249 ($99 on CD-ROM or $119 on disk until September 14). Professional programmers will also want the **Device Driver Source Kit for OS/2**, available on CD-ROM for $499 ($59.95 through September 14) from **IBM Corp.**, 1 Old Orchard Dr., Armonk, NY 10504, (800) 633-8266. **Circle 1155.**

The **SyDOS Personal CD-ROM Drive** ($499) is a small, self-contained unit that hooks directly to your desktop or laptop computer's printer port. Contact **SyDOS** at 16501 Park of Commerce Blvd., Suite 110, Boca Raton, FL 33487, (800) 437-9367 or (407) 998-5400. **Circle 1156.**

The Tandy Sensation is a complete multimedia computer system and software bundle that's well suited for first-time users. It sells for $1999 (excluding monitor) from **Tandy Corp.**, 1500 One Tandy Center, Fort Worth, TX 76102, (817) 878-4969. **Circle 1157.**

Windows NT ($495) and **Windows NT Advanced Server** ($1495) are 32-bit multitasking operating systems for networks and client/server applications that use the Windows GUI. Programmers will want the **Win32 SDK** CD-ROM ($69) and the **Win32 Device Driver Kit** CD-ROM ($69).

The **Microsoft Bookshelf** CD-ROM ($195) incorporates an encyclopedia, book of quotations, thesaurus, dictionary, and other handy research tools. **Microsoft Excel** ($495) and **Microsoft Word for Windows** ($495) will cover about 80 percent of a college student's needs. Contact **Microsoft Corp.**, 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080. For developers: (800) 227-4679. **Circle 1158.**

with the Tandy Sensation.) Another is the Bureau of Electronic Publishing's Monarch Notes, and you definitely should look into their various history and literature CD-ROMs. Their Great Literature CD-ROM has 1896 complete classic works, plus illustrations. Then there's the Library of the Future, which has about a thousand literary titles. There's considerable, but not complete, overlap with the Great Literature CD-ROM.

DeLorme Mapping makes a series of maps on CD-ROM, including Street Atlas USA, with street maps of every major city in the U.S. Another, Global Explorer, has to be the most detailed CD-ROM world atlas I've ever seen.

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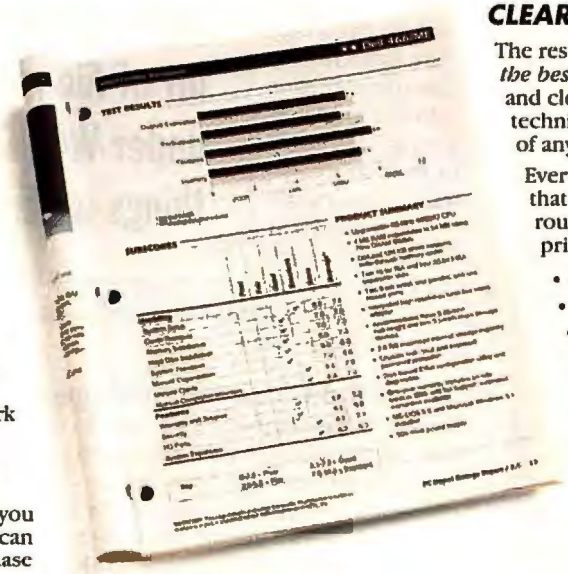

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Exeter Software publishes an interesting catalog called *Scientific Software for Teaching and Research*. (You can contact them at 100 North Country Rd., Building B, Setauket, NY 11733.) It's intended more for teachers than students, but it does show the kinds of scientific-education software available. I haven't been able to look at everything in their catalog, but many of the programs they feature have been recommended in this column, and I see none I dislike in there.

I recommend that if you're going to do a lot of file moves under W4WG, back things up first.

My disk directory got munged the other day. I knew when I tried to do disk defragmentation and was told that I had lost chains. Norton Disk Doctor—an indispensable program—found the lost chains and reported that my directory structure was invalid; in particular, the \ASKSA directory wasn't really a directory, and did I want it turned into a file? I didn't have much choice, so I let NDD do that.

Fortunately, I had backed up the system since the last time I used askSam, so it would be no trick restoring everything from Network Archivist—except it was. Network Archivist gave a cryptic message and asked for tapes; eventually it asked for every tape I'd ever made, after which it said it couldn't restore that directory.

Inspection showed why: there was a file called ASKSAM (made by NDD, of course), and since that file existed, Network Archivist couldn't create a directory with that name. Once the file was erased, it did the restoration in seconds using only one tape. Annoying, but if that's the worst thing Network Archivist ever does to me, I can't complain.

I can't prove it, but I think what munged my directory in the first place was *moving* files across the Windows for Workgroups network. I had a similar problem the last time I used W4WG's File Manager to move a couple of directories. When I get this column out, I'm going to back things up good and do some tests; meanwhile, I recommend that if you're going to do a lot of file moves under W4WG, back things up first.

The game of the month is Buzz Aldrin's Race Into Space. This is an exciting and well-done representation of the original space race. Build up your systems. Allocate funds to R&D. Watch a *Mercury* ship rise from the Cape and zoom off to orbit—or blow up, as many of them did. Digitized animation, photos, music, and sound effects—it's all there, and all told by people who were there when it happened.

My only objection to this game is that you're stuck with the historical alternatives: back in those heady days, some of us advocated systems and approaches that I still think would have worked better. That's a minor quibble, though. This game captures a lot of the look and feel of NASA's glory days. Get one for your son or daughter.

The book of the month is the revised edition of James Dale Davidson and Lord William Rees-Mogg's *The Great Reckoning* (Simon & Schuster, 1993). It's subtitled *Protect Yourself in the Coming Depression*, and I hope I'm being an alarmist in recommending it.

The computer books of the month are the Waite Group series on Visual Basic. Microsoft's Visual Basic 3.0 is a wonderful program, and those who learn it will not regret that. The Waite Group has done a splendid job with books for everyone from beginners to advanced programmers.

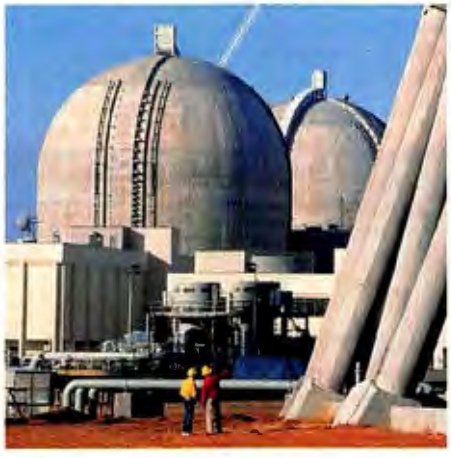
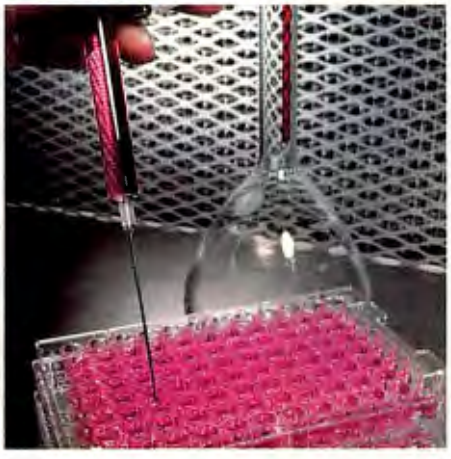
I know I promised more on networking, and I'll get to that Real Soon Now. Meanwhile, the computer industry continues to be a bright spot in the general economic gloom, and I can't emphasize enough that it's worth whatever you have to do to get your kids a good start as computer users—and to keep up with it yourself. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."







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What's New Hardware

ACTIVE-COLOR NOTEBOOK ▼

The CompuAdd 425TXT notebook computer ($3695) from CompuAdd Computer (Austin, TX) has a 9½-inch active-matrix display with 640- by 480-pixel resolution and 256 colors. Based on a 25-MHz 486SX, the 6.1-

pound notebook includes a 200-MB hard drive, an internal fax modem, 4 MB of RAM, 512 KB of video memory, a PCMCIA slot, and a built-in trackball.

Phone: (512) 250-2000.

Circle 1139 on Inquiry Card.

NETWORK TIFF-IMAGE PRINTING

From Talaris Systems (San Diego, CA), the 17-ppm 1794FT Imagestation ($7490) network laser printer can accept simultaneous TIFF files from a variety of inputs without host software or setup commands. The 1794FT automatically skips ASCII banner pages and recognizes and switches among eight optional printer languages.

Phone: (619) 587-0787.

Circle 1067 on Inquiry Card.

VOICE-PROCESSING PACKAGE

Talking Technology's (Alameda, CA) multiline Voice Ranger ($599) card records and plays messages in compressed and uncompressed modes under DOS. The two-port Voice Ranger is expandable to 16 ports. The card can record speech simultaneously from multiple lines.

Phone: (510) 522-3800.

Circle 1271 on Inquiry Card.

PCMCIA SERIAL CARD ▶

The Serial I/O Card ($215) from Socket Communications (Hayward, CA) fits into a PCMCIA Type II slot to provide serial data transfer rates of up to 115,200 bps. You configure the communications parameters port via software. The 5-ounce unit has an attached cable that is 8 inches long, terminating in a male DB-9 connector. Power consumption from the host system is 150 mW when active and 50 mW when inactive.

Phone: (800) 552-3300 or (510) 670-0300.

Circle 1144 on Inquiry Card.

MULTIMEDIA CARD AND DRIVE

A Multimedia Upgrade Kit ($499) from ATI Technologies (Thornhill, Ontario, Canada) includes an ATI Stereo F/X-CD sound card, a Mitsumi LU005 internal CD-ROM drive, and Windows Master and Game Master CD-ROM disks. The

sound card has 8-bit, 44-kHz stereo playback and 22-kHz stereo recording capabilities, and the CD-ROM drive exceeds MPC specifications.

Phone: (416) 882-2600.

Circle 1276 on Inquiry Card.

FAST FOUR-PORT PRINT SERVER

NetAdvantage PSC ($795) is an internal, four-port printer-server card for workstations. From Protec Microsystems (Pointe-Claire, Quebec, Canada), the card operates at up to 120 Mbps per port, and you can install up to four cards per workstation. Each card can log and serve eight file servers and up to 64 print queues. Printers can be up to 200 feet from the card and use unshielded twisted-pair cables and RJ-45 connectors. NetAdvantage, compatible with Ethernet, ARCnet, and token ring, runs independently of DOS or Windows applications.

Phone: (800) 363-8156 or (514) 630-5832.

Circle 1134 on Inquiry Card.

PCMCIA FAX MODEMS

Designed to fit into a PCMCIA Type II slot, GVC Technologies' (Sparta, NJ) FM144/144V(P) fax modem ($499) operates as a V.32bis modem with 14,400-bps send/receive Group 3 fax capabilities. The unit also includes V.42bis/MNP 5, V.42 error control, and automatic speed selection. Modifiable nonvolatile RAM can hold up to four telephone numbers.

Phone: (201) 579-3630.

Circle 1132 on Inquiry Card.

Multi-Tech Systems' (Mounds View, MN) MT1432LT data/fax modem ($599) fits into a Type II PCMCIA expansion slot. The MT1432LT incorporates V.32bis/V.42bis data and V.17 fax standards and includes MultiExpress data-communications and MultiExpressFax software. You can remotely configure the unit and use its flash PROM for upgrades from the company's BBS.

Phone: (800) 328-9717 or (612) 785-3500.

Circle 1133 on Inquiry Card.

WORKSTATIONS WITH FASTER GRAPHICS

Two graphics accelerator boards based on the S3-928 chip set provide improved graphics performance for Mobius's Protege workstations (from $3883). The workstations include 16 MB of RAM, a 240-MB hard drive, a monitor, Unix software, and a CX+ or CX+ TrueColor VESA Local Bus interface board. The boards have a standard resolution of 1280 by 1024 pixels with 256 colors. The CX+ TrueColor board can also run at 1600 by 1200 pixels in 256 colors.

Contact: Mobius Computer Corp., Pleasanton, CA, (800) 662-4871 or (510) 460-5252.

Circle 1061 on Inquiry Card.

Hardware

HEAVY-DUTY CURSOR CONTROLLER

Designed for unfriendly environments, the DuraPoint cursor controller ($279) from Interlink Electronics (Camarillo, CA) contains no moving parts and is

sealed against liquids, dirt, and dust. Compatible with DOS, Windows, and OS/2, the unit includes serial and PS/2 mouse-port interfaces.

Phone: (805) 484-1331.

Circle 1275 on Inquiry Card.

PCMCIA SCSI ADAPTER

New Media's (Irvine, CA) Visual Media PCMCIA SCSI adapter card ($229) lets you connect your Type I PCMCIA slot–equipped laptop or notebook computer to as many as seven logical SCSI-based peripherals via a 22-inch cable with Centronics, DB-25, or SCSI-2 connector options. The card includes 512 KB of memory, an ASPI Manager driver, diagnostics, and test software.

Phone: (714) 453-0100.

Circle 1069 on Inquiry Card.

AUTOMATIC COLOR MONITORS

An 8-bit microprocessor automatically controls the picture size, position, brightness, contrast, and color balance of Idek/Iiyama North America's (Warminster, PA) 21-inch, 1600-by 1200-pixel VisionMaster color monitors (from $2895). You can manually adjust color temperatures for color matching for color printers and other monitors. The Idek monitors meet EPA and European energy-saving requirements and MPR II low-radiation safety standards.

Phone: (215) 957-6543.

Circle 1070 on Inquiry Card.

400-DPI PLOTTERS

Xerox Engineering Systems' (Stamford, CT) 8770 Series plotters (from $25,900) incorporate the company's patented Advanced Silicon Imaging to print documents with laser-like quality (400 dpi). The plotters have high-voltage integrated circuitry that's etched onto an amorphous silicon wide-format print head and feeds a rectangular nib. The plotters operate with 24- or 36-inch media, including opaque, vellum, and translucent paper and clear and matte-back film.

Phone: (800) 937-8255 or (203) 968-3000.

Circle 1071 on Inquiry Card.

PORTABLE MULTIMEDIA PC ▼

The lunch box–style Regal/Multimedia Portable PC ($4995) from Micro Express (Santa Ana, CA) is based on a 33-MHz 486DX and includes a 10-inch active-color VGA LCD display, a CD-ROM drive, a 200-MB hard drive, a Sound Blaster Pro card, external stereo speakers, and a microphone. Simultaneous LCD and external Super VGA displays are possible.

Phone: (800) 989-9900 or (714) 852-1400.

Circle 1068 on Inquiry Card.

MULTIMEDIA PC/TV ADAPTER

The Presenter Plus Sound ($595) adapter has input and output audio capabilities designed to let you add sound to video presentations without using a sound board. You plug the adapter into your computer system's parallel port. The unit has a jack for a microphone or a standard telephone headset and can play back 16-bit WAV-format sound. Included are Asymetrix Compel multimedia presentation software, a PC-to-TV interface, TV font software, video and audio cables, a VGA extension cable, and a power supply.

Contact: Consumer Technology Northwest, Inc., Beaverton, OR, (800) 356-3983 or (503) 643-1662.

Circle 1060 on Inquiry Card.

ONE-FINGER TYPING AID

Intended principally for one-finger typing, the Keypen ($98) from AIZ (Idaho Falls, ID) is a stylus for pressing keys on a keyboard. The pen-like wand has Ctrl, Alt, and right- and left-hand Shift buttons and a small rubber tip. For a Ctrl, Alt, or Shift function, you use the keys on the Keypen, eliminating the need to simultaneously hold down two keyboard keys.

Phone: (800) 353-9736 or (208) 525-1814.

Circle 1072 on Inquiry Card.

A TRIO OF COLOR MONITORS

The Diamond Scan 15-, 17-, and 21-inch color monitors (from $645) from Mitsubishi Electronics America (Cypress, CA) incorporate 0.28-mm dot-pitch and flat-square CRTs with Invar masks. Resolutions range from 1024 by 768 pixels (15-inch) to 1600 by 1280 pixels (21-inch) noninterlaced. You can store a series of programmable setup parameters and factory presets in the Diamond Scan monitors' scan-mode memory.

Phone: (800) 828-6372 or (714) 220-2500.

Circle 1274 on Inquiry Card.

What's New Hardware

DIAL-IN LAN SERVER

From Gateway Communications (Irvine, CA), the 20-MHz 386SX LAN Access Server (from $1795) includes 4 or 8 MB of RAM, VGA capability, and data-compression software. The compact system connects directly to any NetWare-based Ethernet LAN as an independent node, eliminating the need for a dedicated PC. Supplied with DOS 5.0, the unit is compatible with several versions of NetWare. Access method is via direct dial over switched analog lines and RS-232 at up to 57,600 bps.

Phone: (800) 367-6555 or (714) 553-1555.

Circle 1073 on Inquiry Card.

CARD ADDS PS/2 HARD DRIVES

You can mount two 2½-inch IDE drives on a CardDrive ($179) and control two additional 3½- or 5¼-inch drives mounted elsewhere in a system, for a total of four IDE hard drives. CardDrive plugs into a PS/2 Micro Channel–bus slot and is available with or without hard drives from Productivity Enhancement Products (Laguna Hills, CA). The CardDrive is compatible with OS/2, DOS 3.0 through 6.0, Windows 3.x, and Novell NetWare. The 16-bit card is compatible with 32-bit systems.

Phone: (800) 451-3475 or (714) 348-1011.

Circle 1074 on Inquiry Card.

UPS FOR FAXES, MODEMS, AND MORE ▼

From Upsonic (Tustin, CA), The Magician ($99) is a UPS that is designed for use with fax machines, modems, and other small business equipment. The UPS provides power- and data-line surge protection as well as battery-backup power. During a power outage, The Magician provides a fax machine with up to 45 minutes of standby battery time, or up to 15 pages of transmission and up to 20 pages of reception. An audible alarm signals when power is lost. Measuring 3 by 3¼ by 10¾ inches, The Magician UPS unit weighs 6 pounds.

Phone: (800) 877-6642 or (714) 258-0808.

Circle 1137 on Inquiry Card.

DESKTOP PC WITH FLAT-PANEL DISPLAY

A 64,000-color active-matrix thin-film-transistor flat-panel display is standard with the APF4000 Series (from $5995) of 66-MHz 486DX2 desktop computer systems. Included are VESA Local Bus video, a 170-MB hard drive, a 1.44-MB floppy drive, and a PCMCIA Type II slot. Consuming less than 50 W, the APF4000 has no cooling fan, which means quiet operation. The diminutive system measures 9 by 10 inches and weighs 14 pounds. Ethernet and Token Ring interfaces are available.

Contact: APF, Greenville, SC, (803) 244-4416.

Circle 1062 on Inquiry Card.

A LOW-COST ETHERNET ADAPTER

Implementing the ISA bus-master DMA mode for low CPU utilization and high throughput, the HP PC LAN Adapter NC/16 TP ($119) from Hewlett-Packard (Palo Alto, CA) supports 14 major network operating systems. The HPNCSet utility software auto-configures the DMA channel and other parameters and can run in a batch mode to set up multiple adapter installation.

Phone: (800) 752-0900.

Circle 1273 on Inquiry Card.

FAX PROTOCOL ANALYZER

Used to monitor, capture, and analyze communications sequences between fax machines and/or PC fax cards, the GD-Fax protocol analyzer ($4200) includes card-resident data-capture and user-interface software. From Gray Associates (Truckee, CA), the GD-Fax plugs into an AT slot and records T.30 and T.4 transaction and timing data to disk for analysis against CCITT standards.

Phone: (916) 582-8623.

Circle 1135 on Inquiry Card.

ETHERNET PRINT SERVER

The NPS 550 Ethernet Print Server ($695) from Axis Communications (Danvers, MA) provides simultaneous printing capabilities for NetWare, TCP/IP, and EtherTalk environments. Included is support for two high-speed Centronics parallel and one RS-232 serial printer with up to eight programmable logical printer entries and throughputs of up to 120,000 bps. The NPS 550 also has status-logging, security, accounting, and multiple-router-support features.

Phone: (508) 777-7957.

Circle 1131 on Inquiry Card.

PORTABLE PEER-TO-PEER ADAPTER

An external LAN adapter that operates at 500,000 bps, Pocket WinLAN ($169) from Apexx Technology (Boise, ID) uses a parallel port and telephone wiring to configure peer-to-peer networking via any networking software that supports Microsoft's NDIS driver specification. You can daisy-chain as many as 250 PCs up to 600 feet away via the adapter's two RJ-11 jacks. Included are a 25-foot phone cable and a driver disk.

Phone: (208) 336-9400.

Circle 1065 on Inquiry Card.

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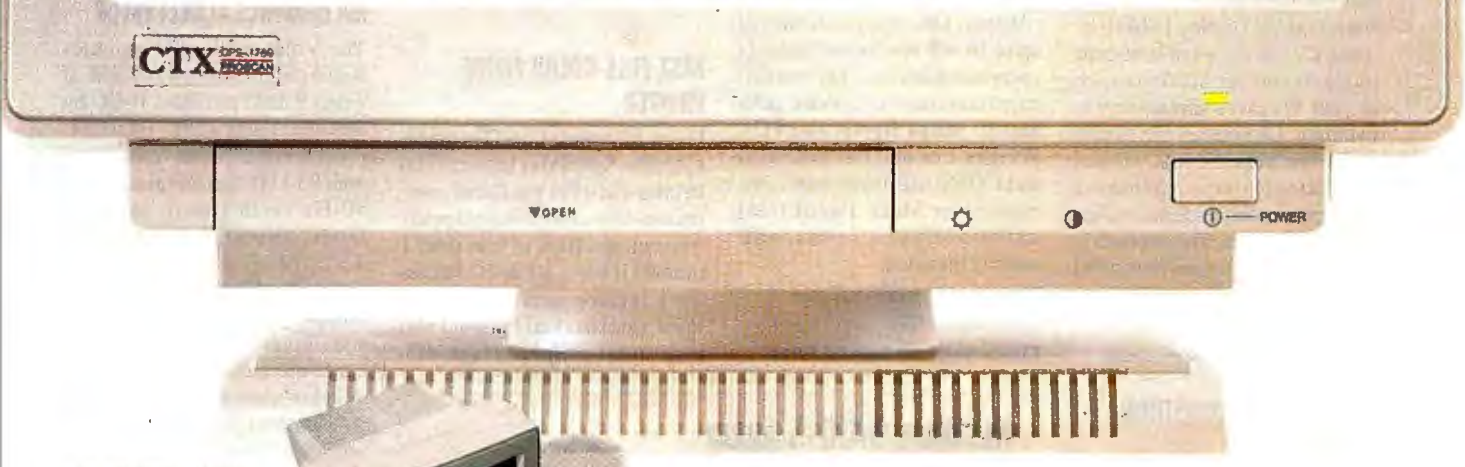

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CTX proudly presents to its world-wide users crisp, steady and brilliant images with advanced features, while maintaining its reliability and affordability. To get a closer look at the world-standard monitor, contact your nearest **CTX** dealer today.

MODEL	5468A	5468NI	1451	1461	1560/1561	1760DF
CRT	14"	14"	14"	14"	15"	17"
Dot Pitch	0.28 mm	0.28 mm	0.28 mm	0.28 mm	0.28 mm	0.28 mm
Scan Frequency	H: 30-38 KHz V: 50-90 Hz	H: 30-38 KHz 47-50 KHz V: 50-90 Hz	H: 30-50 KHz V: 50-90 Hz	H: 30-60 KHz V: 50-90 Hz	H: 30-60 KHz V: 50-90 Hz	H: 30-65 KHz V: 50-90 Hz
Resolution	640x480/72Hz 1024x768/87Hz	800x600/72Hz 1024x768/60Hz	800x600/72Hz 1024x768/60Hz	800x600/72Hz 1024x768/72Hz	800x600/72Hz 1024x768/72Hz	1024x768/72Hz 1280x1024/60Hz
Non-interlaced	800x600/60Hz	Yes	Yes	Yes	Yes	Yes
Full Screen	--	--	Yes	Yes	Yes	Yes
Low Radiation	5468LR	5468NR	1451LR	1461LR	1560LR/1561LR	1760LR
Digital	--	--	--	--	Yes/--	Yes

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Circle 77 on Inquiry Card (RESELLERS: 78).

What's New Hardware

▲ A MONITOR WITH A TWIST

A 15-inch color monitor for PCs running Windows provides portrait and landscape views. You can use Portrait/15 Plus ($799) from Portrait Display Labs (Fremont, CA) in the usual landscape mode to run applications such as your Windows spreadsheet or database. Or you can physically rotate the monitor to a vertical orientation to run your Windows word processing or desktop publishing program. The monitor's vertical mode lets you view a full 8½- by 11-inch document.

Phone: (510) 249-0444.

Circle 1064 on Inquiry Card.

POCKET DATA-ACQUISITION SYSTEM

Modular Computer Concepts' (Huntington Beach, CA) MCC-24 pocket A/D data-acquisition system (from $299) measures 2.5 by .65 by 2 inches and plugs into a PC parallel port. Input specifications are eight 12-bit channels and 0- to 5-V input with ±30-V overvoltage protection. The MCC-24 requires no batteries and no jumpers, and you control all functions via software. The converter includes programming libraries; applications software is available.

Phone: (714) 965-0620.

Circle 1136 on Inquiry Card.

PC/VCR GRAPHICS CONVERTER

With the Mediator LC ($599) graphics-to-video converter from VideoLogic (Cambridge, MA), you can record PC graphics on a VCR or output images in S-Video, composite, or RGB video formats. The unit supports conversion of 640- by 480-pixel VGA, Super VGA, or XGA graphics to NTSC video output and includes controls for image positioning, brightness, color, and picture quality. You can view images simultaneously on a PC and a video output device.

Phone: (617) 494-0530.

Circle 1138 on Inquiry Card.

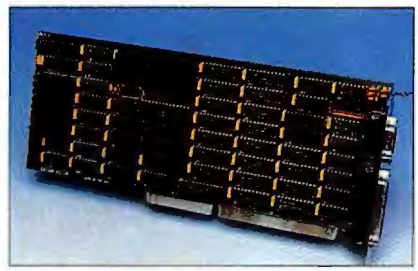
PC AND MAC FAX MODEMS

Available in models for PCs ($229) and Macs ($269), the SupraFaxModem 144LC external fax modems from Supra (Albany, OR) operate at rates of up to 14,400 bps for fax and data communications. The metal-cased units have two phone jacks and 13 status lights. For PCs, WinFax Lite and FaxTalk (fax) and COMit (data) software is included; for Macs, Faxstf (fax) and MicroPhone LT (data) software is included.

Phone: (800) 727-8772 or (503) 967-2400.

Circle 1140 on Inquiry Card.

HIGH-SPEED PORT/ PRINT BUFFER ▶



Configurable with up to 4 MB of RAM, the DataBlaster buffer card (from $349.99) plugs into an AT-bus computer and has a serial input/output rate of 250,000 bps/19,200 bps and a parallel input/output rate of 25,000 cps/12,500 cps. From Blastronix (Murphys, CA), the card has serial/parallel and parallel/serial conversion built in; the included software controls configuration and diagnostics.

Phone: (209) 795-0738.

Circle 1272 on Inquiry Card.

FAST, FULL-COLOR PROOF PRINTER

From Microtek Lab (Torrance, CA), the SnapPrint Instant Film Printer ($1499) produces continuous-tone color Polaroid prints from image files in less than 1 minute; it takes 30 to 40 minutes for full color saturation. SnapPrint uses standard Polaroid 990 high-speed or Spectra high-definition film and works with Mac IIs (with 5 MB of RAM and System 6.0.5 or higher) and PCs (with 8 MB of RAM and Windows 3.0 or higher).

Phone: (213) 321-2121.

Circle 1141 on Inquiry Card.

ISA GRAPHICS ACCELERATOR

The Volante Warp24 graphics board (from $499 with 1 MB of video RAM) provides 1024- by 768-pixel and 1280- by 1024-pixel noninterlaced resolutions with 93-kHz horizontal scan and 80-Hz vertical-refresh rates. From National Design (Austin, TX), the card includes color dithering, object shading, surface mapping, polygon pattern fills, and clipping, as well as BitBlt, hardware cursor, and line-draw Windows accelerator functions. A Windows screen utility lets you change resolution, font size, and vertical-refresh rate and restart Windows automatically.

Phone: (512) 329-5055.

Circle 1142 on Inquiry Card.

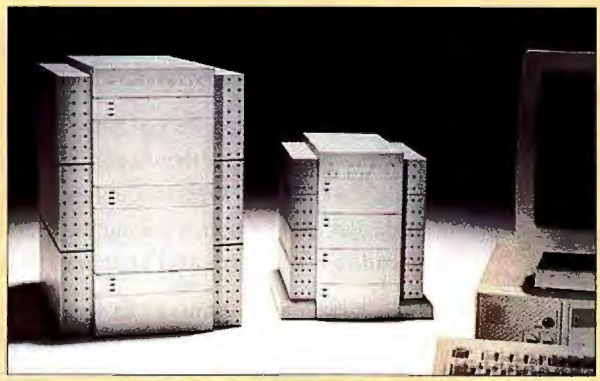
FULL-MOTION CAPTURE/ PLAYBACK BOARD

Sigma Designs' (Fremont, CA) WinMovie full-motion video-capture and playback board ($299) includes Video for Windows, Xing Technology's Picture Prowler, and utility software. WinMovie captures video at 30 fps from NTSC or PAL S-Video or composite sources, and it is compatible with all Super VGA adapters. The board supports resolutions of from 80 by 60 pixels to 640 by 480 pixels in 8-, 16-, or 24-bit colors and requires at least a 33-MHz 386.

Phone: (510) 770-0100.

Circle 1143 on Inquiry Card.

NETWARE RAID-5 ARRAY

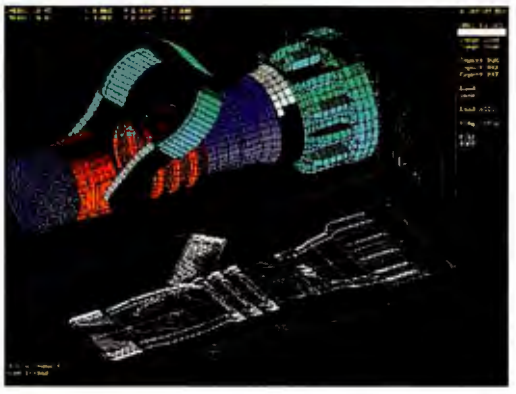


RAIDion LT 1120 for NetWare 3.11 and 4.0 ($6300) from Micropolis is a 1-GB, three-drive, fault-tolerant storage subsystem that includes Novell-certified RAIDware optimized for NetWare drivers. Each self-contained module has a separate power supply, a cooling fan, and a disk drive; this facilitates hot-swapping and fast repairs. You can expand the subsystem in 500-MB modules up to a total of 28 GB.

Contact: Micropolis Corp., Chatsworth, CA, (818) 709-3300.

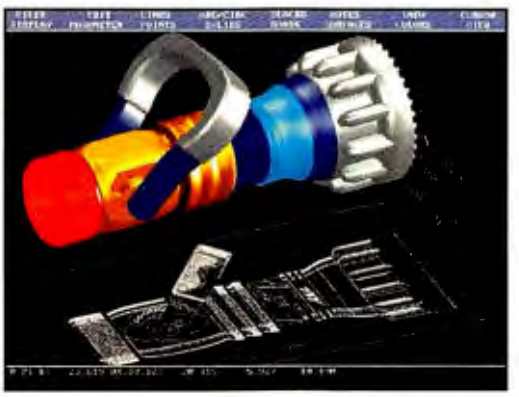
Circle 1063 on Inquiry Card.

Now You Can Draw A Nozzle Without Getting Hosed.



GenericCAD
(under $500)

AutoCAD
(over $3,500)



DesignCAD
(under $500)

There is a serious misconception in the software industry that the more a program costs, the better it is... if you purchase a less expensive program, your results will suffer.

It is time this rumor was laid to rest.

To create this ad, our artists were asked to create the same drawing using three different programs with everything else being the same. Same computer, same graphics board, same monitor, etc.

Each rendering was created with the program's base package. No add-ons.

As you can see, DesignCAD produced the highest quality rendering while priced considerably less.

In the interest of fairness, you could get a better rendering with AutoCAD providing you pay an additional $3,000 for their materials shading package (making your total cost almost $7,000.) But keep in mind DesignCAD comes complete with its own built-in materials rendering package at *no extra charge*. Plus, you can render directly on the drawing screen without having to export to a separate rendering package.

We would also like to note that the AutoCAD drawing took the longest, was the most difficult to produce and continually caused our machine to crash. Of course we're not the PC Magazine labs.

Although it's not generally true, there are times when you can get more for less. DesignCAD proves it. Your eyes see it.

To get your own DesignCAD information pack with a free demo disk, just call, fax or write.

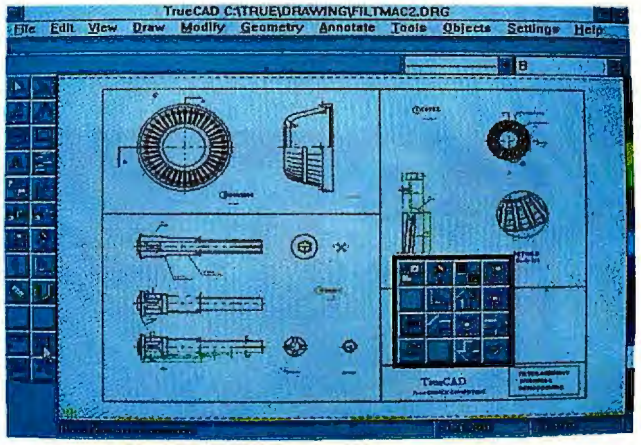
American Small Business Computers
One American Way, Pryor, OK 74361

Phone (918)825-7555
Fax (918)825-6359

PC MAGAZINE EDITORS' CHOICE

Circle 65 on Inquiry Card.

What's New Software



EXTRA MUSCLE FOR CAD ▲

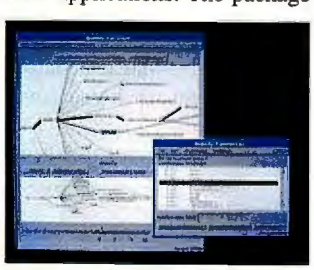
TrueCAD for Windows ($395), a full-featured CAD package from Choice Computing (Los Altos, CA), lets you take advantage of the graphical environment and offers an intuitive interface that makes the program easy to use. Its construction geometry lets you quickly design and create complex entities. With DXF and HPGL import and export capabilities, the software lets you share drawings with such applications as Word for Windows and CorelDraw.

Phone: (800) 828-2770 or (415) 949-2615.

Circle 1300 on Inquiry Card.

BREATHING NEW LIFE INTO APPLICATIONS

The Quantify software development package (from $1198) measures the performance of a program and its components and graphically displays its evaluation. Pure Software (Sunnyvale, CA) says this will help C and C++ developers to pinpoint and eliminate performance bottlenecks and improve the speed of their applications. The package uses Object Code Insertion technology to analyze entire programs, including shared and third-party libraries.



Phone: (408) 720-1600.

Circle 1292 on Inquiry Card.

PUTTING A NEW FACE ON AUTOCAD

PanaIcon ($99) provides an icon-based interface for AutoCAD release 12. From Panacea (Londonderry, NH), the software can take AutoCAD drawing files and convert them to iconic menus. PanaIcon supports multiple nested icon menus that can be dynamically resized. By selecting an icon, you can call or execute any AutoCAD function, ADS, or AutoLisp routine.

Phone: (800) 729-7420 or (603) 437-5022.

Circle 1282 on Inquiry Card.

TUNE UP YOUR HARD DISK

SoftLogic Solutions' (Manchester, NH) Disk Optimizer for Windows ($49.95) defragments the files on your hard disk while the system is idle. The application enables you to consolidate the free space on your hard disk. A layout display shows you all the available space and its location. Disk Optimizer for Windows can handle large-capacity drives using expanded or extended memory.

Phone: (603) 627-9900.

Circle 1284 on Inquiry Card.

MORE ANIMATION FOR WINDOWS

Animation Paint Box ($299.95) from Azeena Technologies (Long Beach, CA) integrates painting and animation tools for the Windows environment. The package's onion-skin tool lets you simultaneously see the previous, current, and following frame of an animation for precise alignment of objects between frames. The rub-through tool brings underlying objects to the top screen. Animation Paint Box supports various file formats, including AVI (Audio Video Interleave).

Phone: (310) 988-1889.

Circle 1283 on Inquiry Card.

NATIVE C++ FOR THE MAC

Symantec C++ 6.0 for Macintosh ($499) provides a development environment with a native C++ compiler and an incremental linker, which the company says reduces development time by linking only new or modified code to a program. The open environment from Symantec (Cupertino, CA) lets you integrate preferred code editors and resource tools.

Phone: (800) 441-7234 or (408) 253-9600.

Circle 1286 on Inquiry Card.

SPEED UP COMMERCIAL FORECASTING

SmartForecasts 32-bit Batch Edition ($5995) helps you take on massive forecasting problems, such as estimating customer demand for large inventories or projecting cash flow for financial institutions. The Smart Software (Belmont, MA) program uses 386|DOS-Extender technology, providing greater internal data capacity and faster calculations.

Phone: (800) 762-7899 or (617) 489-2743.

Circle 1285 on Inquiry Card.

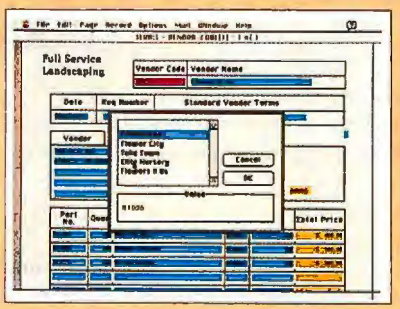
OCR SOFTWARE FOR WINDOWS

TextBridge ($99) from Xerox Imaging Systems (Peabody, MA) lets you convert hard copies of documents into leading word processing, spreadsheet, and database formats while working in Windows. The OCR software accepts TIFF files from most fax-modem software, and the Lexifier enhanced technology improves the software's handling of degraded and non-word-based documents.

Phone: (800) 248-6550 or (508) 977-2000.

Circle 1293 on Inquiry Card.

AUTOMATE CROSS-PLATFORM WORK FLOW



JetForm for E-Mail's Mac version (five users, $495; 20 users, $1495) joins DOS and Windows packages to provide cross-platform, enterprise-wide forms automation with a mail-enabled system. The intelligent forms product includes work-flow tools that let you route and track forms using standard E-mail systems and your existing equipment and networks.

Contact: JetForm Corp., Waltham, MA, (800) 538-3676 or (617) 647-7700.

Circle 1278 on Inquiry Card.

Attitude TrueType Fonts

MasterPiece TrueType Font Library

Agnes ASPEN BAMBAM benediction
Cambria CARTOON Casual Catacomb
Chancellor Chill Cursive Country Club
COYOTE DALMATION DECORAGE
DELHI Doily DOORJAM DUNCAN
EMPIRE FIRE FLAMINGO Flores
Frankenfooter FRISCO Gaslight HORROR
Invitation Knarly Lakeside Lizard
LOOPY MOO-GOO MORBIUS Moulon Rouge
MOZAMBIQUE Nervous Nottingham Ornate
PENCILPOINT PICANTE RAHRAH RANSOM
Renaissance Rhino Ripper Roady Rooster
Ruhr SAHARA SALOON SCRAWL SEASCAPE
Sesar SLANG SLAVIC SPANKY STENCIL
STIKK UGANDA UNDERGROUND Uppercrust
Waterfall Whitewash Willroge ZAP Zephyr

This is only a partial listing of the over one hundred and fifty fonts in this package

Special Offer Only $49.95 Call (800) 568-4607

The MasterPiece TrueType Font Library from Attitude, Inc. now contains over 150 one-of-a-kind, designer TrueType soft fonts. These totally unique display and headline fonts are what you need in order to get the attention your memos, brochures, flyers and correspondence deserve. And with the MasterPiece TrueType Font Library you'll have the headline fonts to complement your collection of text faces. So don't settle for the basic vanilla text fonts. Get an Attitude!

Also included is the new Attitude TrueType Installer. This utility will allow you to view any TrueType format font, either on screen or in a printout, as well as install, remove or check if any font is already installed.

Attitude, Inc.
14742 Beach Blvd., Dept. 440
La Mirada, CA. 90638
TEL: (714) 680-8112 FAX: (714) 680-6640

VISA, MASTERCARD, AMEX & DISCOVER

Circle 290 on Inquiry Card.

What's New Software

PLAN YOUR PROJECTS IN WINDOWS

Prisma Software (Cedar Falls, IA) has introduced GanttChart ($89), a business graphics program that you run under Windows. The program organizes projects on worksheets and schedules them on time-line charts. You can tailor your screen display to focus on important aspects of a project. GanttChart allows you to create and print presentation-quality charts and switch their time frame among daily, weekly, or monthly increments with the click of a mouse.

Phone: (800) 437-2685 or (319) 266-7141.

Circle 1287 on Inquiry Card.

CRYSTAL BALLS FOR INVESTORS

Money Maker for Windows ($99) from Q-West Associates (San Diego, CA) graphically builds securities and portfolio analyses. After you define the type of investment that you're working on, a storyboard is assembled, showing the potential gains and losses and the projected rate of return under various market conditions. A financial toolbox assembles and tracks investments, profits, and costs.

Phone: (619) 484-6648.

Circle 1288 on Inquiry Card.

With The Yellow Pad ($49.95), you can experiment with a variety of investment scenarios, examining the effects of different assumptions on your assets and income. The financial calculator from Orinda Software (Orinda, CA) can enter data on your total assets and perform one computation, or it can work with data for individual assets and income groups, computing a report for each one.

Phone: (510) 254-3503.

Circle 1289 on Inquiry Card.

BRIDGING COMMUNICATIONS PROTOCOLS

Zoomit's (Toronto, Ontario, Canada) X.400 & SMTP Dual Stack (from US$8000) enables those using the SMTP and X.400 protocols on a Banyan Vines network to exchange mail. The software automatically configures message-transfer agents and routing tables to simplify direct connectivity. It also features audit trails and message logging and tracking.

Phone: (416) 866-7442.

Circle 1290 on Inquiry Card.

ONE SMART X SERVER

XVision 5 ($495; upgrade, $95), a PC server from VisionWare (Menlo Park, CA), lets you connect via the X Window System standard to Unix and VMS host-based applications while working in Windows or NT. The software detects network transports, optimizes graphics speed, and substitutes fonts. XVision 5 offers a drag-and-drop object-oriented desktop, a built-in VT320 terminal emulator, and file transfer and local printing.

Phone: (415) 325-2113.

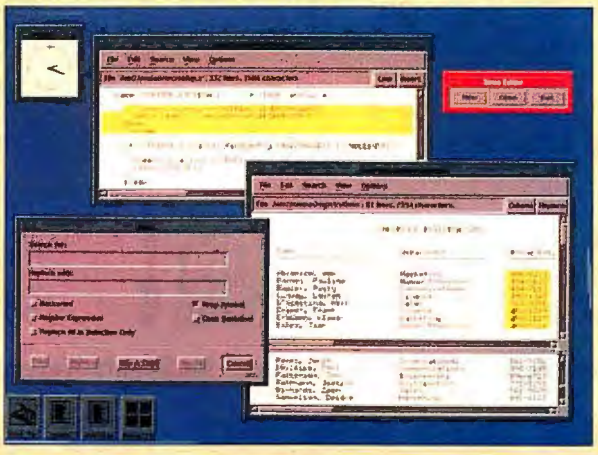
Circle 1291 on Inquiry Card.

POWERFUL POINT-AND-CLICK EDITING FOR MOTIF USERS

A Motif-based text editor, Siren Editor runs on several Unix platforms, including Sun SparcStation, HP 9000, IBM RS/6000, Silicon Graphics, and SCO workstations. Siren Editor offers column editing and traditional line-editing capabilities, and its window management facilities let you view and edit multiple files in an integrated environment. A shell extends the software's capabilities to include all Unix commands, programs, and scripting facilities. Administrators can customize Siren Editor to meet their organization's needs. Prices: single user, $249; network, from $995.

Contact: Siren Software Corp., Menlo Park, CA, (800) 457-4736 or (415) 322-0600.

Circle 1279 on Inquiry Card.



Software Update

Generic CADD 6.1 ($495), Autodesk (Bothell, WA), adds an AutoCAD-style menu option, an on-line function

that cross-references Generic CADD and AutoCAD commands, and the ability to write files in AutoCAD's DWG format.

Phone: (800) 228-3601 or (206) 487-2233.

Circle 1301 on Inquiry Card.

Morph 2.0 ($239), Gryphon Software (San Diego, CA), adds dynamic morphing, caricaturing, and customized warping.

Phone: (619) 536-8815.

Circle 1302 on Inquiry Card.

MKS RCS 6.1 ($349), Mortice Kern Systems (Waterloo, Ontario, Canada), adds support for Windows 3.1.

Phone: (519) 884-2251.

Circle 1303 on Inquiry Card.

Lazarus for Novell 1.5 (PC license, $74.99; server license, $299; site license, $1495), Software Marketing Group (Des Moines, IA), reduces the TSR size to under 4 KB, supports Open Data-Link Interface drivers, and adds automatic reattachment to servers.

Phone: (515) 284-0209.

Circle 1304 on Inquiry Card.

CorelDraw 4 ($595 U.S.; $695 Canada), Corel (Ottawa, Ontario, Canada), adds an animation module, OCR software, and more. See our review on page 169.

Phone: (613) 728-8200.

Circle 1305 on Inquiry Card.

NetWare for Macintosh 4.0 ($1195), Novell (Provo, UT), adds access to NetWare directory services, DOS file-extension mapping, HFS CD-ROM access, and more.

Phone: (801) 429-7000.

Circle 1317 on Inquiry Card.

PICTURE WINDOWS.

Picture This ... a real-time television monitor built right into your PC ... Now, picture using this monitor while running Windows™ applications at the same time ... And, picture taking that crystal clear video image and resizing (right down to icon size!) or clicking and dragging it to any position on the screen as easily as moving any other Window ... This is *Win/TV™*, the video overlay, frame and clip capture board from Hauppauge Computer.

Picture Perfect ... Using *Win/TV* and Microsoft's Video for Windows™, you can capture full motion video, saving synchronized audio and video clips to disk. With *Win/TV*'s "frame grabber" you can capture any video frame and save it to disk in the most popular formats like TIFF, TGA, PCX and BMP. Seemlessly integrate still and full motion video clips into multimedia applications such as databases, marketing and training presentations. Great for Microsoft PowerPoint, Asymetrix Compel, Corel Draw, Tempra and lots more!

Picture Yourself ... owning your own "Windows on the World"! Access 122 channel television with *Win/TV*'s built-in cable ready tuner, plus two optional video sources (video cameras, VCR's, laser disks, etc.) Maybe you want to work on you spreadsheets but don't want to miss an important news flash or a current stock market report. Keep an eye on current events while keeping control of your inventory!

Whether you're enjoying live TV, grabbing a frame and exporting it to a desktop publishing document, or creating your own video clips with Microsofts' Video for Windows, you'll be wowed by the clarity of Win/TV images.

Get Win/TV and open a window on some fresh, new and exciting possibilities.

Suggested retail: $495.00 ($549.00 with Video for Windows)

Available from PC Connection, Microwarehouse, PC Zone, plus many other computer stores throughout the U.S., Canada, Europe and Japan.

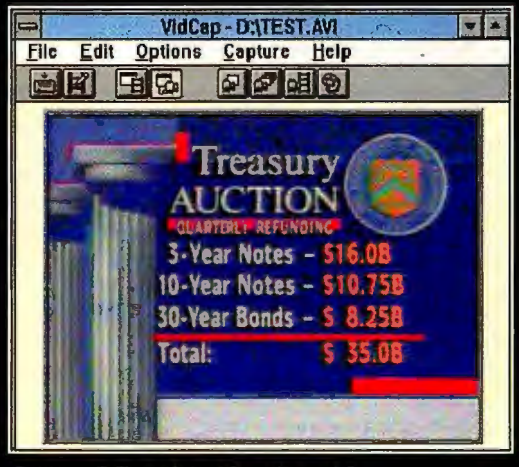
GSA# GS00K92AGS6156 PS01

Trademarks: Win/TV: Hauppauge Computer Works; Windows, Video for Windows: Microsoft Corp.; Photoshop: Adobe Corp.; XPress: Quark.

Circle 88 on Inquiry Card (RESELLERS: 89).

New: MaxResSave for the highest quality images

Capture the perfect video image with Win/TV's "frame grabber" - great for desktop publishing and presentations with impact!



Capture full motion video clips with Video for Windows (optional.)

Resize or reposition your Win/TV window anywhere on the screen. The "always-in-front" mode allows the video image to always be viewable.

Hauppauge!

Hauppauge Computer Works, Inc.
91 Cabot Court Hauppauge, NY 11788
In N.Y. tel: (516)434-1600 fax: (516)434-3198

800-443-6284

In Europe: (49)2161-17063 In the U.K.: 071-378-7309

Prepared using Win/TV, Adobe Photoshop, and Quark XPress

What's New Software

AUTOMATED GUI TESTING

In what Software Quality Automation claims is the first automated GUI-testing solution to be implemented on a team/workgroup model, SQA TeamTest ($1495 per license) integrates automated GUI testing with team work-flow tracking and reporting. Based on a network Test Repository that coordinates the work of any number of testers on a network, the software is built on the company's Team Testing Architecture. During testing on individual PCs, the Test Repository is automatically updated during all stages of the process.

Contact: Software Quality Automation, Woburn, MA, (800) 228-9922 or (617) 932-0110.

Circle 1280 on Inquiry Card.

MACS AND PCS SHARING DATA

Conversions Plus ($149), a file transfer and translation utility from DataViz (Trumbull, CT), lets you exchange documents between popular Mac and PC applications and retain original document formatting. The package has a translator library with more than 350 translation combinations for word processing and graphics programs and a Mac disk-mounting utility that moves files to and from high-density Mac disks inserted in PC drives.

Phone: (203) 268-0030.

Circle 1294 on Inquiry Card.

UNIX-BASED COLLABORATION

X/TeleScreen (initiator license, $995), an X Window System application-collaboration tool based on Motif, lets X displays on Unix networks share unmodified, off-the-shelf X applications. National Information Systems' (San Jose, CA) software lets network users confer with each other; interact with applications; and update documents, graphics, and spreadsheets in real time. X/TeleScreen is available on certain Sun Microsystems, Silicon Graphics, and DEC workstations.

Phone: (800) 441-5758 or (408) 985-7100.

Circle 1295 on Inquiry Card.

BUILDING VISUAL GUIS

With CenterLine Software's (Cambridge, MA) ViewCenter for Motif ($2995), software developers can interactively create, modify, test, and generate C++ code and object components for GUIs. The development tool is based on Visual Edge's UIM/X 2.5 GUI builder and is tightly integrated with CenterLine's CodeCenter and ObjectCenter Unix programming environments. ViewCenter for Motif supports certain Sun Microsystems and Hewlett-Packard workstations.

Phone: (617) 498-3000.

Circle 1296 on Inquiry Card.

MANAGING YOUR INVENTORY

Inventory Analyst Professional ($495), a menu-driven, spreadsheet-based inventory-control system for DOS and Windows users, does batch forecasting and scheduling for thousands of items simultaneously, automatically chooses appropriate forecasting methods, and ranks and groups items by dollar volume. Intex Solutions' (Needham, MA) planning and analysis application works with all DOS versions of Lotus 1-2-3, with Excel, and with Quattro Pro.

Phone: (617) 449-6222.

Circle 1297 on Inquiry Card.

CUSTOMIZING INSTALLERS

For developers and product managers who want the ability to create custom installers for their products, Aladdin Systems' (Watsonville, CA) StuffIt InstallerMaker (prices vary) provides a selection of predefined destinations for files being installed and determines what files to load based on the configuration of the end user's computer. The program compresses the files, reducing the number of distribution disks and providing one-button installation.

Phone: (408) 761-6200.

Circle 1298 on Inquiry Card.

FINDING OUT ABOUT YOURSELF

Brain Works ($49.99), a self-assessment test that helps you determine your own learning style, measures the extent to which you favor your right or left brain. The 20 multiple-choice questions in the test, from Synergistic Learning (East Grand Rapids, MI), involve subjects ranging from personal opinions to word associations.

Phone: (616) 956-7557.

Circle 1299 on Inquiry Card.

Software Update

Crystal Ball 3.0 for Windows ($295), Decisioneering (Denver, CO), adds a chart that indicates the weight of each factor in its analysis, four probability distribution types, dynamic cell references, and an improved interface with Excel.

Phone: (303) 292-2291.

Circle 1306 on Inquiry Card.

BusinessWorks 8.0 (from $395), Manzanita Software Systems (Roseville, CA), adds general ledger, accounts payable, accounts receivable, and system features.

Phone: (916) 781-3880.

Circle 1307 on Inquiry Card.

BasePak 2.0 ($3800), ProtoComm (Trevose, PA), adds the ability to store video files on a Novell partition, support for additional video software platforms and compression technologies, utilities that maximize system performance, and a customized network protocol.

Phone: (215) 245-2040.

Circle 1308 on Inquiry Card.

VBAssist 3.0 ($179), Sheridan Software Systems (Melville, NY), adds a drag-and-drop feature that links table columns to bound controls, the ability to update in one window all fields in a database associated with the bound data control, and automatic forms generation.

Phone: (516) 753-0985.

Circle 1309 on Inquiry Card.

CadDesign 3.0 (from $395), Tailor Made Software (Kent, WA), adds additional image-manipulation techniques for contrast, brightness, and color; support for Super VGA and the HP LaserJet 4; and 600-dpi printing.

Phone: (206) 631-1513.

Circle 1310 on Inquiry Card.

Your Direct Link to Products

BYTE introducesYour Direct Link – An enhanced service for BYTE readers that gives you free information on products – faster and easier!

In the NEW Direct Link section, here's what you'll find:

Alphabetical Index to Advertisers Including Phone Numbers

Now dial companies directly.

Product Category Index to Advertisers

Order information on individual products or complete product categories.

Redesigned Editorial Index

Free information from companies covered in articles, columns, or news stories.

New Enhanced Direct Link Card

Receive free information quickly by filling out and mailing or faxing *Your Direct Link Card* today!

Send for FREE product information by filling out *Your Direct Link Card* found in the back of every issue.

Buy It Through BYTE!

BYTE

What's New Software

PAINTER/X2 ADDS MULTIPLE LAYERING

Fractal Design's (Aptos, CA) Painter/X2 ($149) is an extension to Painter 2.0 ($399) that adds the capability to layer multiple objects within paintings. Painter/X2 speeds up drawing tasks by incorporating multiple graphics elements through the use of floating selections. A new feature called the Portfolio allows you to save an image for future use by simply dragging it into the Portfolio, where it appears as a thumbnail view for easy identification. The package is available for Windows and the Macintosh.

Phone: (408) 688-5300.

Circle 1329 on Inquiry Card.

Q+E EXTENDS IMPROV FOR WINDOWS

Q+E Extend for Improv ($199) client/server edition from Q+E Software (Raleigh, NC) is a database access tool for bringing data from PC and SQL databases into Lotus's Improv for Windows spreadsheet. It adds database access commands directly to Improv's tools menu. Extend for Improv provides you with direct access to more than 20 PC and SQL database formats, automatically creating the structures needed to present and analyze data in Improv's multidimensional views. Queries that are built with Q+E Software's Q+E Database Editor can be opened in Improv without translation.

Phone: (919) 859-2220.

Circle 1331 on Inquiry Card.

EISTOOLKIT UPDATED FOR UNIX

MicroStrategy's (Wilmington, DE) EISToolKit (Designer version, $1995; 10-pack User version, $7995) application development system is available for Unix systems running the Sun OpenLook and Motif environments. EISToolKit offers a GUI, presentation graphics, database connectivity, and spreadsheet modeling tools in addition to a full-featured spreadsheet for data analysis, and HyperScript, a 4GL (fourth-generation language) for detailed project customization. Unix clients will initially have access to Informix databases and later to Oracle and Sybase. EISToolKit for Unix ships with the Informix DataLink API.

Phone: (800) 927-1868 or (302) 427-8800.

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STOP WAITING FOR YOUR PC

Quick Restart ($39.95) from PowerPro Software (Foster City, CA) is an auto-resume utility for Windows and DOS PCs. The program lets you restart your computer and instantly return to your application where you left off, without waiting for lengthy morning boot-ups and with no loss of data or system state, PowerPro says.

Phone: (415) 345-9278.

Circle 1315 on Inquiry Card.

WALL DATA'S MIGRATION TO WINDOWS

Wall Data's (Redmond, WA) Rumba APPC (Advanced Peer-to-Peer Communications) suite of tools ($495) integrates Windows with SAA (Systems Application Architecture) networks and enables you to access and run AS/400, mainframe, and APPC applications on the same SNA (Systems Network Architecture) networks. The Rumba APPC engine is implemented as a native Windows application. With Rumba for the Mainframe and Rumba for the AS/400 APPC editions, you can simultaneously run 3270, 5250, and APPC applications.

Phone: (800) 487-8622 or (206) 883-4777.

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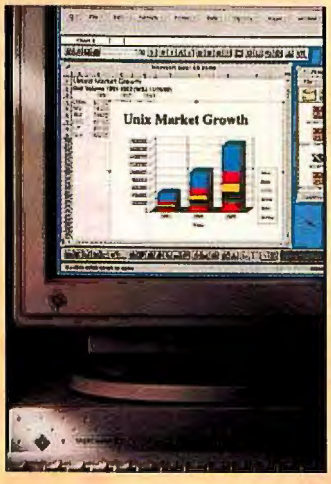

Quorum's Equal 1.0 ($1295) lets you run Mac versions of Microsoft Word and Excel on Sun SparcStations and Silicon Graphics Indigo workstations. Equal 1.0 is an Application Adapter, which Quorum defines as a layer of software that allows personal computing applications to seamlessly run unmodified on workstations. The Equal 1.0 package includes the Mac versions of Word and Excel, plus software from Quorum that lets you run these applications on Unix workstations. Once adapted, the Mac programs act and look like native Motif or Open Look applications. You can cut and paste text and graphics between Word and Excel and native applications such as the Unix version of the FrameMaker page-layout program.

Contact: Quorum Software Systems, Menlo Park, CA, (415) 323-3111.

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Software Update

TeleFinder 3.1 ($425), Spider Island Software (Irvine, CA), adds internode messaging, chat rooms for live conferences, file preview, and full-text formatting.

Phone: (714) 669-9260.

Circle 1311 on Inquiry Card.

Alpha Four 3.0 (single user, $495; network, $595), Alpha Software (Burlington, MA), adds full mouse support on all screens; multifile data entry; the ability to design screens with scrolling windows that display data from linked databases; real-time modification of fields in linked databases; and cascading and conditional lookup tables.

Phone: (617) 229-2924.

Circle 1312 on Inquiry Card.

Gpf 2.1 ($1295), Gpf Systems (Moodus, CT), adds the ability to generate native OS/2 2.1 Presentation Manager Workplace Shell and Windows 3.1 interface code from one design; support for C and C++ compilers; and the ability to automatically generate DLLs.

Phone: (800) 831-0017 or (203) 873-3300.

Circle 1313 on Inquiry Card.

SQL/Workbench 2.1 ($8400 per server), Intelligent Environments (Tewksbury, MA), adds support for OS/2 and Windows client/server development tools and an import/export feature that lets you pull SQL statements across multiple workbenches.

Phone: (508) 640-1080.

Circle 1314 on Inquiry Card.

Abacus II (single user, $995), Abacus Systems (Minot, ND), adds a simplified start-up procedure; inventory tracking; and a Quick Pay feature for real-life, one-time events.

Phone: (701) 838-4686.

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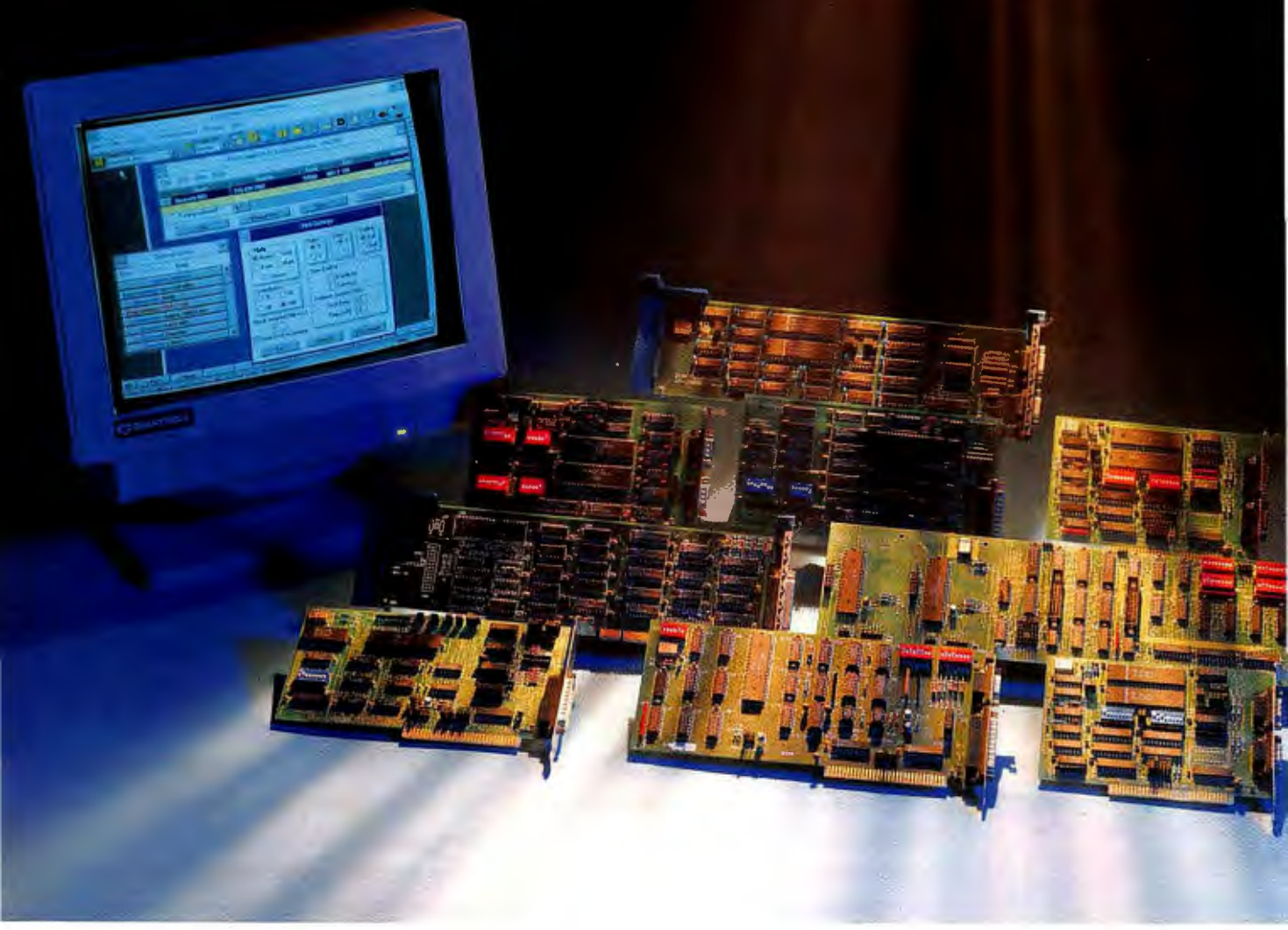

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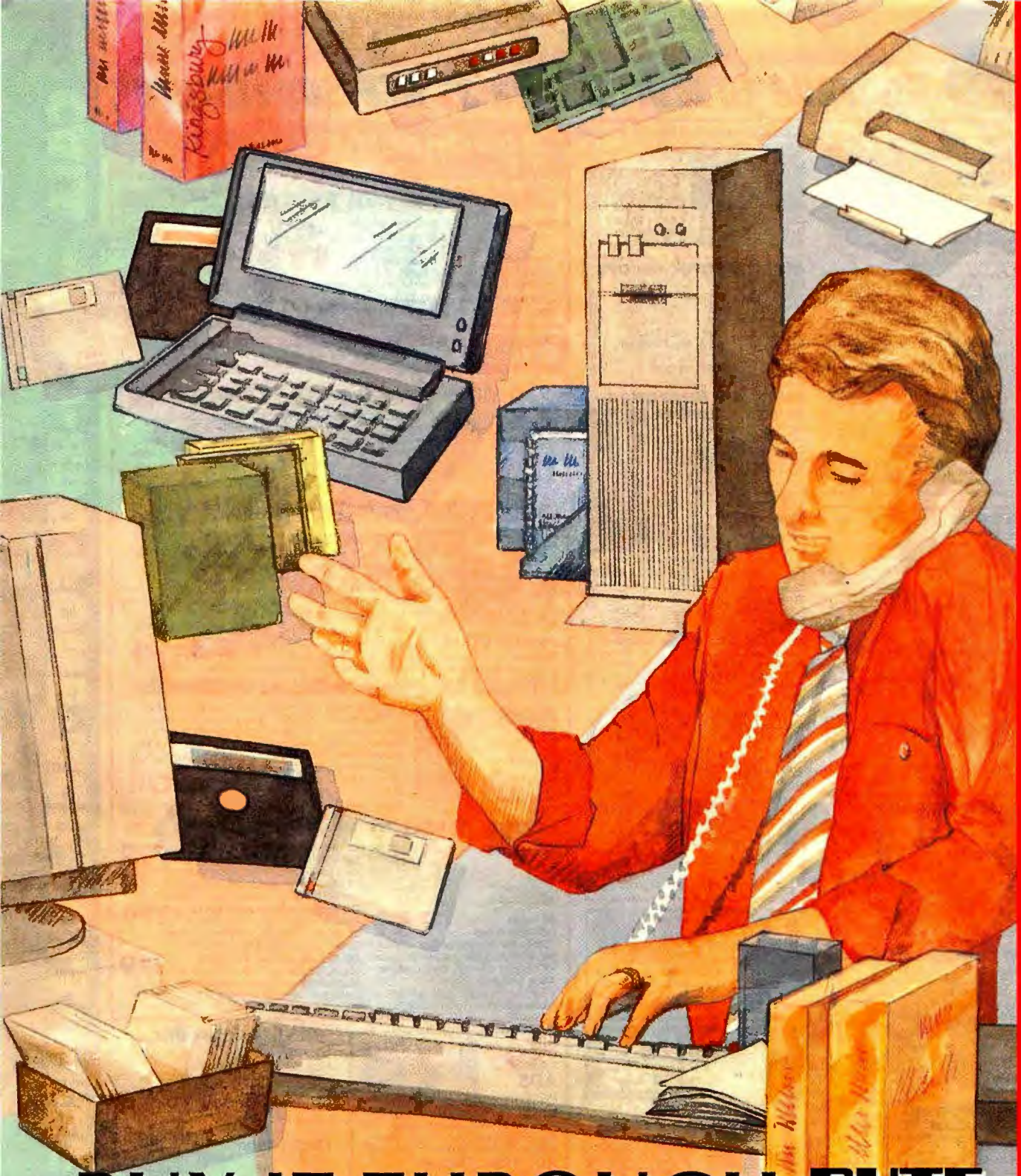

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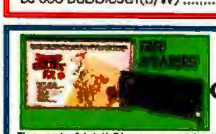

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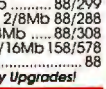

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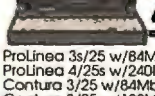

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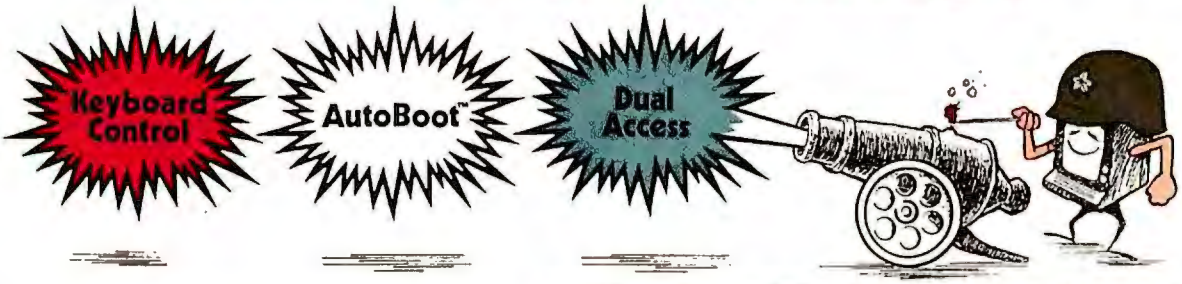

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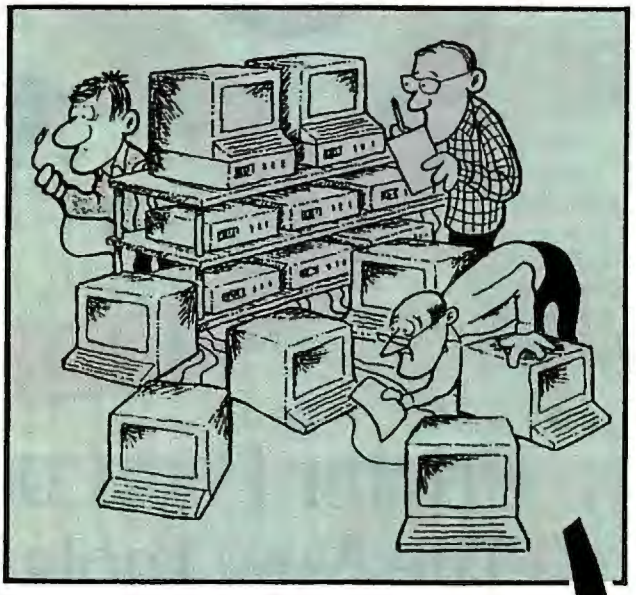

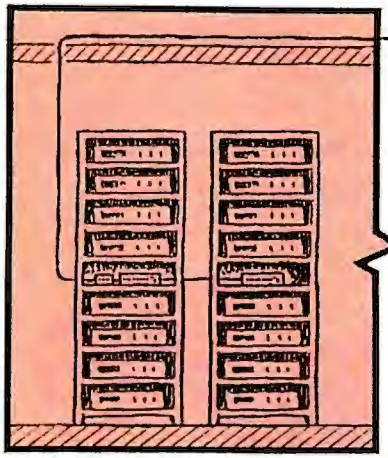

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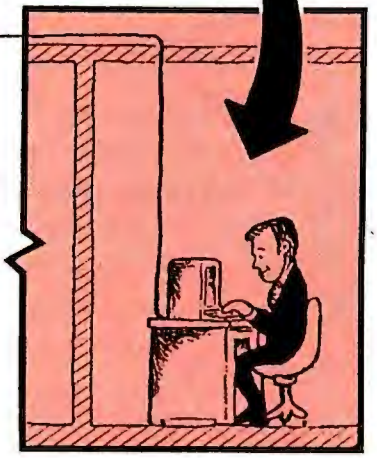

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2MB	33475B	$99	4MB	33477B	$159
HP LaserJet II & IID					
2MB	33444B	$99	4MB	33445B	$159
IBM Laser 4029 all models					
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Canon LBP-4, 4Lite, 4Plus					
1MB	563-2730	$119	2MB	N/A	$169
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Panasonic 4410 & 4420					
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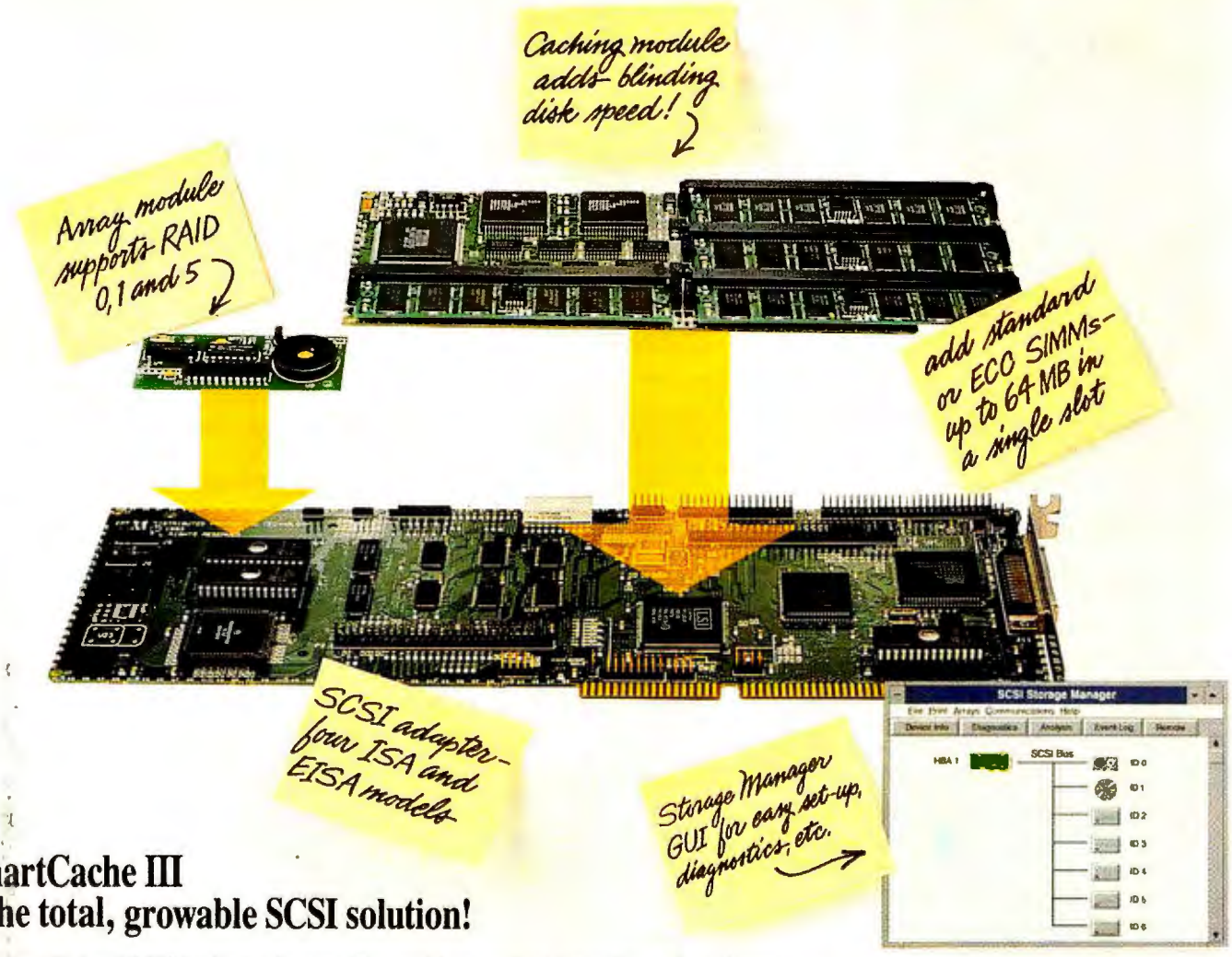

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LXT535A (HH)	535MB	13MS	IDE	$849
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	2MB	30F5360	$84
PS/2 35SX, LS, 40SX,70 E61; 061; 121 Adpt Brd 6450609; 34F3011; 34F3077, 502 55SX, 65SSX, P70, 55LS, 65LS XStation 120 & 130	1MB	6450603	$49
	2MB	6450604	$79
PS2 50, 50Z, 55SX, 60, 65SX	2-8MB	1497259	$259
	2-16MB	6450609	$308
2-8 MB FOR PS/2 50 & 60, 2MB $99, 4MB $159, 8MB $289			
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series	4MB	N/A	$159
	16MB	N/A	$699
PS/2 70-A21; A61; B21; B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450603	$49
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PS/2 35SX; LS, 40SX, 55SX; LS, 65SX;	4MB	34F2933	$168
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T2000 SXE/T2200SX/T1800 T1850, C	2MB CARD	PA2000U	$89
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	4MB MOD	PA8309U	$164
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T3300SL	2MB CARD	PA2006U	$98
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Lte Lite/20, 25, 25C	2MEG BRD	129769-001	$138
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32KB	8.95	7.75	
64x1	9.95	8.45	7.95
64x4	10.95	8.95	7.95
16x4	8.95	5.45	4.95
128x8		59.00	49.00

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AST POWEREXEC, DEC PALMTOP, DELL 320SL, GRID GRIDPAD, HP 95LX, IBM PC RADIO, MOMENTA PENTOP, NCR 3125 NOTEPAD POQET, SHARP PC3000/3100, SHARP PC-6700/6741/6781/6785, SHARP PC-6800/6841/6881/6891, ZEOS POCKET PC

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MODULE	1MEG	2MEG	3MEG	4MEG	5MEG	8MEG
Apple Laserwriter	CALL					
Brother HL-10V/DV	$165	$264				
Canon LBP4, 4 Lite & 4+	$118	$184				
Compaq Pagemark 15 & 20		$189				$320
Epson Action Laser II, 8000 .. $95		$163			$229	
Epson + 6000 and many more	$98	$168				
Fujitsu 7100 & 7200	$129	$229				
HP Deskjet 500, 500C and 550C	$59 (256K)					
HP2, 2D,	$89	$146				
3, 3D, 3P, 2P, 2P+	$103	$159				
HP Laser Jet 4, 111Si, XL300	$59	$99	$158			$298
IBM Laser 4019, 4019E (3.5MB)	$119	$169				
IBM Laser 4029 ALL MODELS	$99	$149				
NEC 90, 290	$118					
NEC 95	$98					
OKI 400	$78	$98				
Packard Bell PB9500	$105	$178				
Panasonic 4410/4430	$109	$178				
Panasonic 4420/4450	$118	$188				
Panasonic 4450	$105					
Panasonic 4455	$119					
QMS 410	$119	$159		$249		
Star LS04	$129	$179		$269		
StarScript 4	$128	$178		$258		
Tosiba Page Laser 6	$99			$168		
TI XL/PS17/PS35	$48					

Major Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
AT&T Safari	2MB	37650	$128
	4MB	37651	$238
Bondwell B-310	1MB	23050-09100	$128
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$345
Dell Laptop 212, 320N; 320N+	1MB Mod	310-3203	$79
	2MB Mod	310-3204	$109
Dell 325N; NC; Notebook P.C.	2MB Mod	310-3210	$119
Dell NL20 & NL25 NTBK	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808511	$198
Epson NB-SL/20;25	2MB Mod	A808771	$138
25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$87
Everex Carrier	2MB	00263-00	$97
Grid 1500	2MB	52587	$198
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$248
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$88
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA165	$64
Samsung Notemaster 3865	2MB	SNM002	$195
	4MB	SNM004	$395
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Sharp 6220	1MB	CE-6218	$88
Sharp 6640	2MB	N/A	$198
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8500 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$88
TI Travelmate 3000SX; WINSX	2MB	2566996-0001	$98
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	8MB	500824-002	$319
ADVANTAGE 386SX/20;25, PRO SX/25 BRAVO 3/33'S	2MB	500962-001	$75
	8MB	500962-002	$339
ADVANTAGE PRO 486DX/33,SX/25, BRAVO LC 4/25S; 33; 33S; 50; 4'66D	2MB	500987-001	$88
	4MB	500987-002	$148
PREMIUM 386/25; 33; 33I # 386SX/16;20;25	1MB	500780-003	$59
	1MB	500780-002	$59
ADVANTAGE 486/25, 33,33P,SX20, BRAVO 4/33;486/25;PREMIUM 4/25; 33TE, SE 4/33	2MB	500718-004	$119
	2MB	500780-005	$119
ADVANTAGE 486/25,33,33P,SX20,POWER PREMIUM 3/33,4/33,33S;500;660; PREMIUM 386/33TE,486/25;E-25TE,33,33TE, PREMIUM II 386/25,33,486/33,486SX/20			
PREMIUM SERVER SE 4/33	4MB	500780-004	$158
	8MB	500780-001	$318
POWER-EXEC 3/25SL, 3/25SL-CEL	4MB		$179
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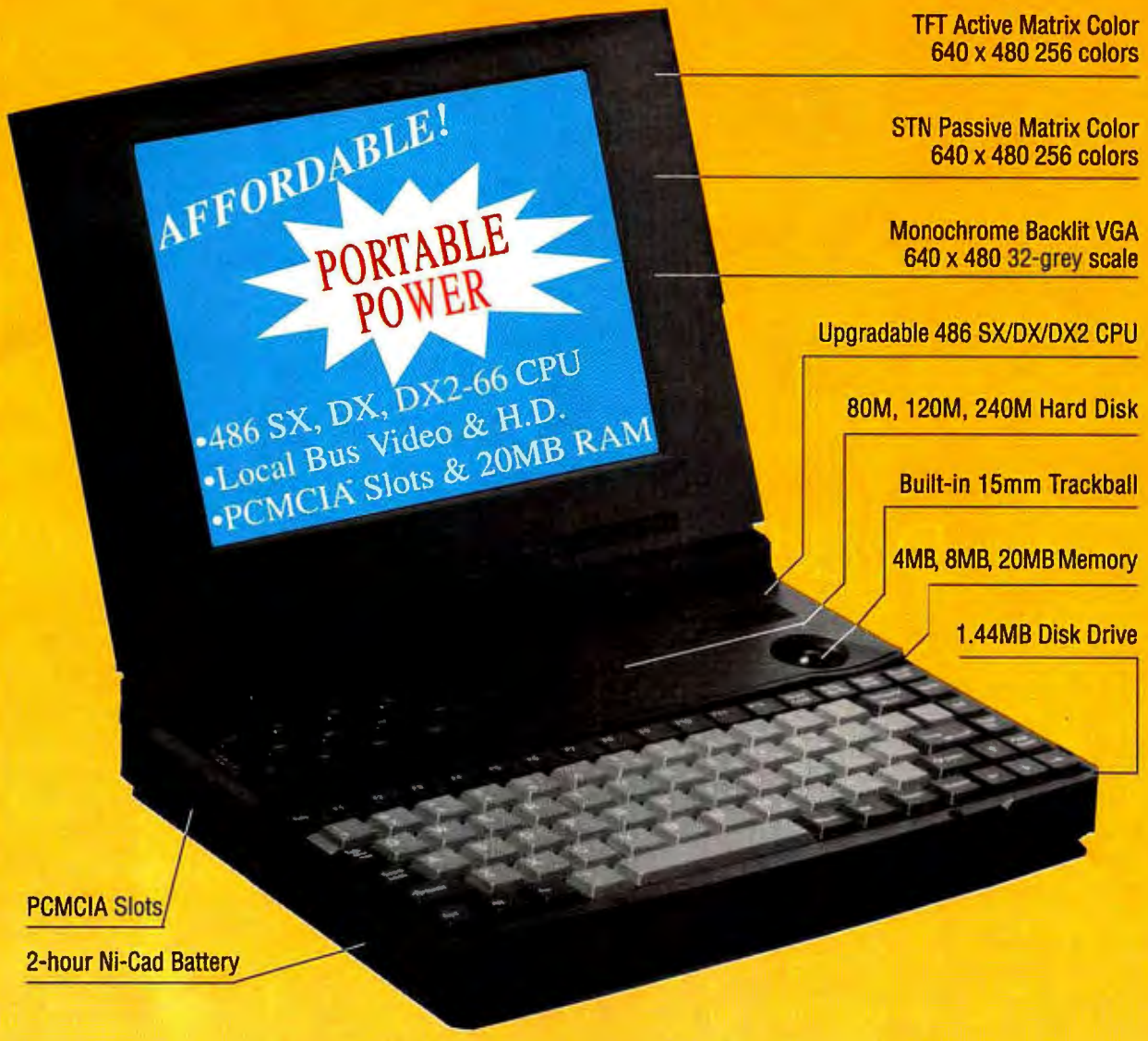

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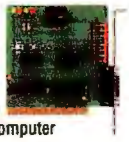

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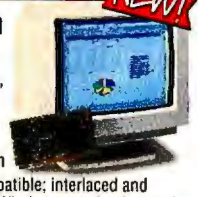

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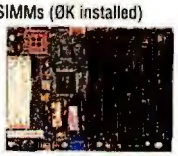

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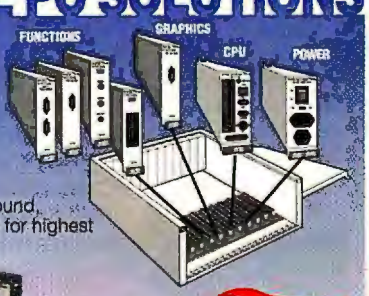

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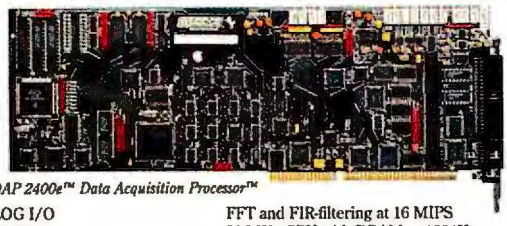

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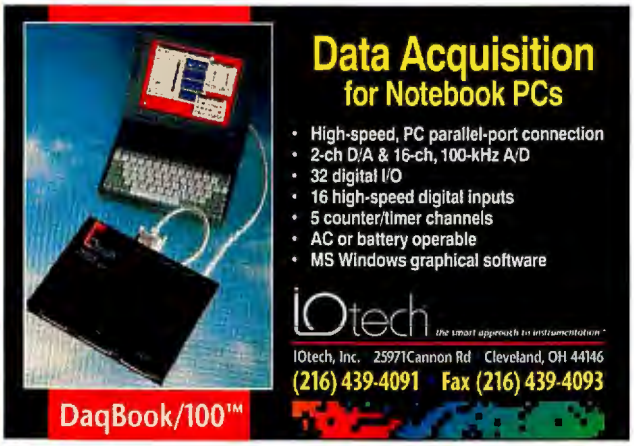

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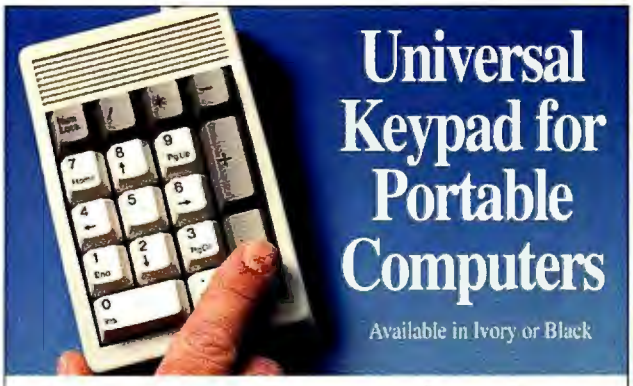

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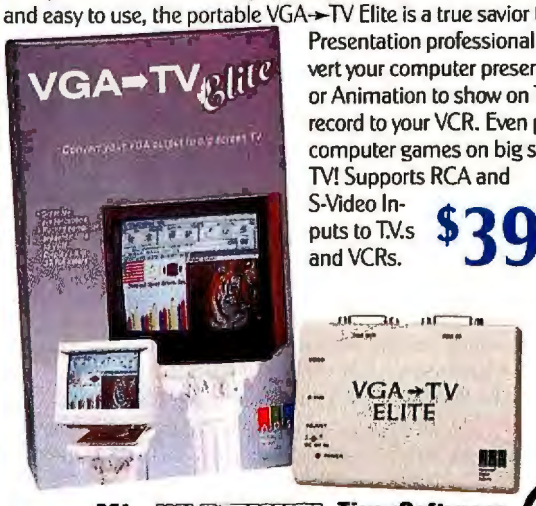

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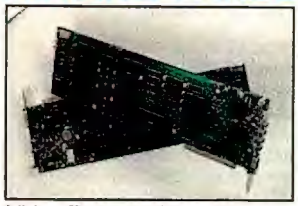

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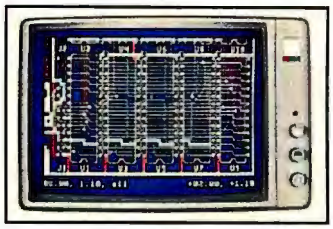

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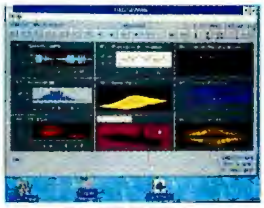

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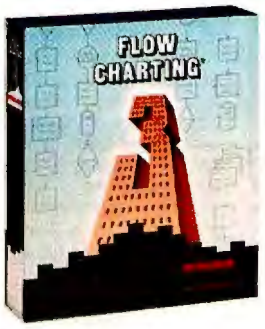

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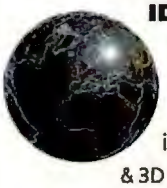

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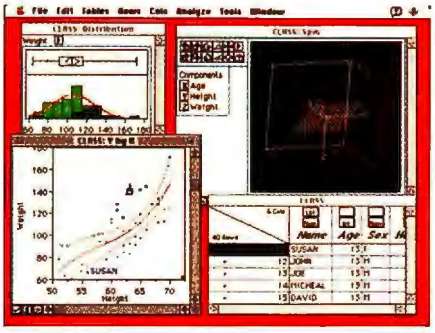

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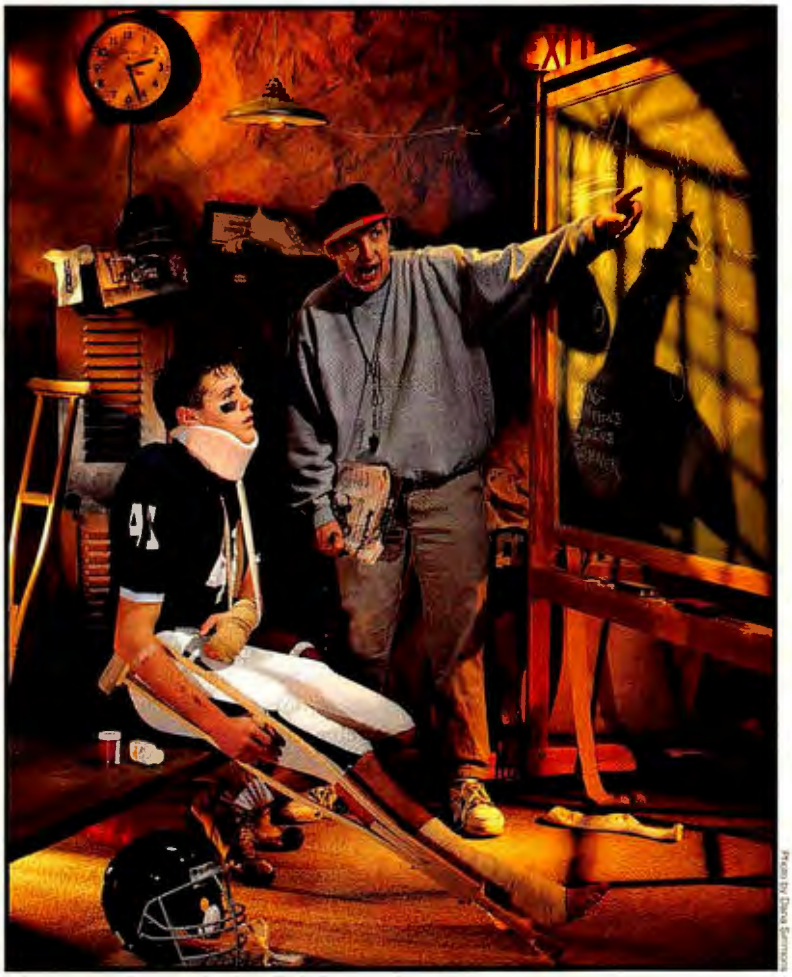

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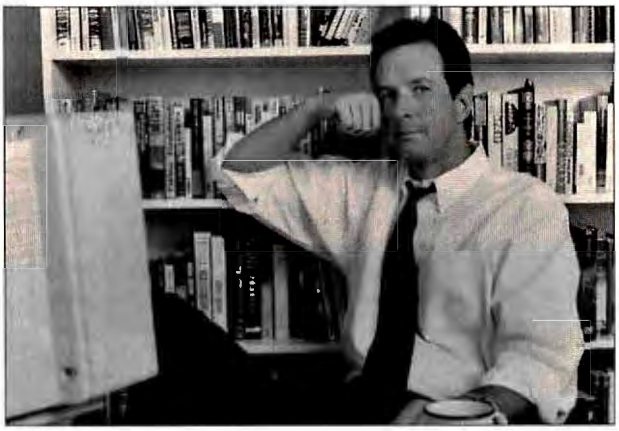
Commentary Michael Crichton

Installer Hell

Designed to help users, auto-installers often wreak havoc behind the scene



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"Open your mouth and close your eyes," goes the children's rhyme, "and I'll give you something to make you wise." The unsuspecting child then gets a mouthful of dirt. We usually learn this particular bit of wisdom around the age of five, and it's a lesson we don't forget. Never again will we stand passively with our mouths gaping and our eyes closed.

Never, that is, until we buy a computer. Modern computer users face this childhood trick in its bland adult form: "Insert Disk 1 and Run the Installer." Dutifully, we do as we are told, swapping disks and hoping for the best.

We have no choice these days; nearly all software vendors deliver their applications with installers. Vendors say installers are necessary because programs are more complicated. Large applications may require dozens of separate files to be located at specific places on the disk.

Furthermore, we are told, a new generation of computer users doesn't know much about the workings of the computer and doesn't want to learn. These users require automatic installation. Fair enough. But the method that assists naive users assists lazy vendors, too. And we learn the consequences.

My niece calls me up. She's 10. "My computer crashed."

"What happened?"

"I installed something called Computer Fun Disk."

"Is it compatible with your operating system?"

"It doesn't say."

"What'd it do?"

"I don't know. I just followed the directions."

Before we were done, she had to reformat her hard drive and reinstall her system and all her files. There wasn't any choice, because we had no way to know what the installer did, what files it placed, or where.

Or: My DOS portable has a relatively small hard drive. I'd like to dump files I don't need. I just installed an update of my word processor, and when I look at the directory, I see what look like all sorts of drivers and converters. I'm sure I don't need them all. But which can I safely discard? Good luck. There's no documentation. Those files in my directory might as well be Mayan hieroglyphs.

Or: I've got my PowerBook while I'm on vacation, and I want to call my office and transfer files. But I can't connect, and a call to Apple doesn't help. It turns out that a file called Serial Port Arbitrator is necessary. I dumped it because I have only one port on this machine, so what's to arbitrate? Wrong. Reinstall, dummy.

When I reinstall, I get 25 drivers for modems that I don't have in my system. But am I going to take the drivers out? Not on your life. Because now I understand the modern rule of computers: Don't touch anything.

At one time, in the early days of personal computers, a friend proudly showed me his method of booting, driven by a batch file he'd gotten from a friend. It turned out he was loading his word processor, quitting it to install a keystroke macro, and reloading his word processor again. Watching him, I realized I was seeing superstitious behavior in a college graduate. My friend had no idea what he was doing—he was just blindly following directions, like one of those Skinnerian pigeons that walk in a semicircle while waiting for the food to drop from the bin.

My friend's case was extreme, and his batch file easy enough to fix. But these days, undocumented, obligatory installation programs turn us all into superstitious pigeons. For those who have lived through the evolution of computers, this is an ironic outcome. The early promise of personal computers was freedom and knowledge, not mysterious machines that we couldn't understand. Particularly with Apple computers, the interface guidelines were meant to enable users to understand what their machines were doing.

But all that is gone. Now we must install.

What does the installer-driven future hold? Increasingly passive users, increasingly lazy vendors, and much bigger hard drives to hold the accumulated junk. More inexplicable crashes. More undocumented incompatibilities. More time on the phone with vendors and dealers. More time on-line with other users, trying to figure out what is going on. In short, installer hell.

What's the solution? It's simple: Make obligatory installers a thing of the past. They're fine for naive users. But every application should also come with adequate instructions to enable you to install manually. This should include a detailed list of what all those files are, what they do, and where they go. There should also be a clear list of minimum system requirements.

Anything less is treating you like a child. A dumb child. ■

Michael Crichton is the author of such best-sellers as Jurassic Park *and* Rising Sun. *You can reach him on bix c/o "editors."*

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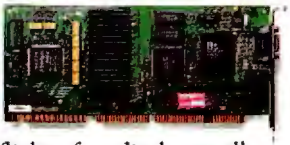

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