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DECEMBER 1995

BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

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Compared! 133 MHz Pentium Desktops

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AND WHAT YOU CAN DO ABOUT IT

PLUS

Artificial Intelligence Builds A Better Factory

AND

NexGen's Hot Nx686: Why AMD Needs It

Lessons from Air Traffic Control, page 48

12>
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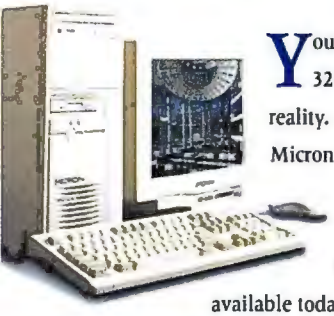

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May 30, 1995
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- PCI 64-bit graphics accelerator (2MB)
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intel inside pentium

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PC MAGAZINE EDITORS' CHOICE
May 16, 1995
P90 HOME MPC

PC WORLD WORLD CLASS 1 5 9 5
July 1995
P90 HOME MPC

intel inside pentium

P75 HOME MPC

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- *Tool-free* mini-tower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 CD
- Microsoft Works 95 CD
- *Microsoft Scenes: Sports Extremes; Microsoft Bob CD; Microsoft Encarta 95 CD; Quicken Deluxe Edition CD; Microsoft Dangerous Creatures CD; Microsoft Golf Multimedia CD; Trial subscriptions for Compuserve, Prodigy and America On-Line.*

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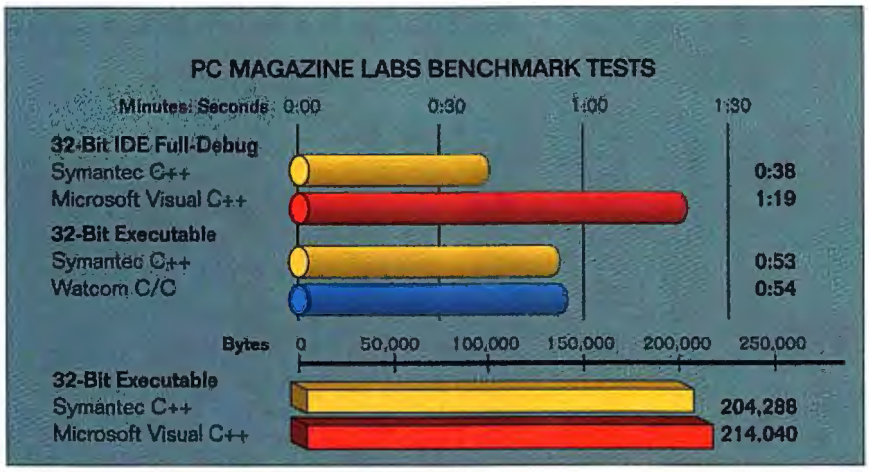

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"Symantec C++7.0 achieved a clean sweep on our 32-bit C++ compiler tests. The sample application that we created in Symantec C++ 7.0 was smaller and faster than those produced by the best products in our last C-compiler roundup (April 11, 1995)."
– PC MAGAZINE – August 1995

in background and allows you to go anywhere in your program instantly — even before compiling. It also lets you graphically view your class hierarchy and add new classes simply by dragging and dropping. You can also modify any class's inheritance hierarchy graphically. And you have the ability to automatically locate any class

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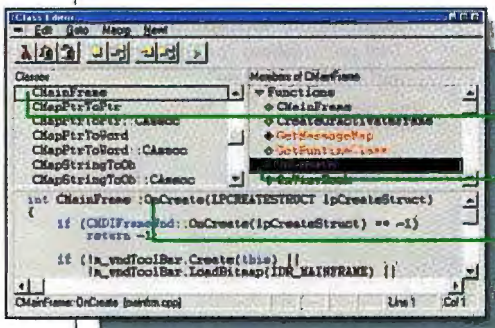

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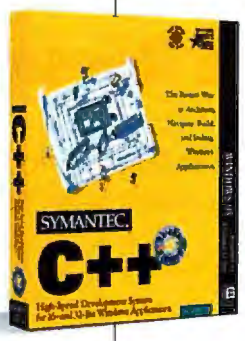

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BYTE

DECEMBER 1995 VOL. 20, NO. 12

Cover Story

How Software Doesn't Work 48

BY ALAN JOCH

Bad code can lead to disaster. Here's why there's a software crisis. And here's what you can do about it.

How to Build Reliable Code—50

Make Quality Job 1—54

BYTE Guide to Games

3-D Action 123
BY REX BALDAZO
Three-dimensional games have changed enormously since the days of Atari Battlezone.

Multimedia Masterpieces 129
BY TOM R. HALFHILL
A look at the technology behind the scenes of two dazzling, movie-like adventures: Phantasmagoria and Buried in Time.

The Games People Write 135
BY JOHN MONTGOMERY
Microsoft's Win32 development kit will help make designing games for Windows 95 a less-scary adventure.

I'm Game 139
BY JERRY POURNELLE
All work and no play at Chaos Manor? Not hardly.

Perl Magic 115
BY JON UDELL

Our Webmeister explains the Perl and HTML programming tricks under the hood of the new Virtual Press Room.

Features

Talking to Machines 97
BY JUDITH MARKOWITZ
Star Trek officers talk to their computers. Here's how we can, too.
Speech-Recognition Products—98
Hidden Markov Models—100

Solutions Focus: DragNET 106
BY PETER WAYNER
G-men get a new weapon. The FBI's DNA database is helping police nab suspects.
DNA by the Numbers—110

Untangling Wireless 96NA 1
BY SALVATORE SALAMONE
Advice on choosing the right technology and service for your unplugged applications.

State of the Art

COMPUTER-CONTROLLED MANUFACTURING

Manufacturing Data 63

BY EDMUND X. DEJESUS
Big changes on the factory floor. New technology for data acquisition is changing the way that manufacturing works.

A Fine MES 67
BY JIM ESCH
Manufacturing execution systems unite factory computers from the planning level to the machine level.
A New Dimension in Bar Codes—68

If AI Ran the Zoo 79
BY LAWRENCE GOULD

Ready to turn your operation over to a bunch of algorithms? Neural networks and fuzzy logic are helping to control complex manufacturing processes.

Keep the Data Moving 87
BY CLAIRE TRISTRAM
With ruggedized computers and PC Cards, you can computerize collection of data in the factory or field.
Buying Rugged Hand-Held Computers—90

News & Views

ON-LINE COLLABORATION

Groupware Taps the Internet 24
The planned merger between Netscape and Collabra will result in a Notes-killer of an application, some say.

WINDOWS ON THE WEB

New Suites Embrace the Web 25
Software houses are adding much more to their Windows communications programs than just data comm and fax.

PROGRAMMING TOOLS

CodeTalk: New Micro Focus Tool Converts COBOL into Components 36
Organizations with beaucoup lines of COBOL code can now wrap it all in OLE controls and bring it into the world of Windows.

Reviews

NETWORK SOFTWARE

Virtual CDs on the LAN 153
BY REX BALDAZO
CD-QuickShare speeds up your shared network CD-ROM drives.

NEW-MEDIA TOOLS

Software Roundup: Web Publishing Made Easier 170
BY REX BALDAZO AND STEVEN J. VAUGHAN-NICHOLS
HTML authoring and editing tools promise to make your documents Web-ready in no time. But few live up to their claims.

PRODUCTIVITY SOFTWARE

The Penthouse Suite 179
BY STAN MIASTKOWSKI
Microsoft Office 95 moves up to true 32-bitness, provides full OLE 2 support, and introduces the Bindery for mixing data from different applications.

DATABASE SOFTWARE

Access 95 Advances Database Design 181
BY RICK DOBSON
Microsoft's new version of Access gets more than just the Windows 95 look. Replication technology helps coordinate changes.

PROGRAMMING TOOLS

Symantec C++ Differences 183
BY RAYMOND GA CÔTÉ
Symantec's new object-oriented compiler lets you distribute compilation jobs across the network.

PROGRAMMING TOOLS

Systems Design in ObjecTime 189
BY MIKE BIENVENU
ObjecTime can reduce development time.

MEMORY MANAGERS

More RAM for Win 3 Holdouts 191
BY JOHN M. GOODMAN
Some RAM doublers can help Windows 3.x manage physical and virtual RAM. And some can't.

INFO ANALYST

Data to the Nth Dimension 193
BY EDMUND X. DEJESUS
Arbor Software's Essbase adds multidimensional analysis to familiar front ends, such as Lotus 1-2-3.

OS EMULATOR

The Better Virtual PC 195
BY TOM THOMPSON
SoftWindows 2.0 puts a 33-MHz 486 inside your Power Macintosh.

HIGH-SPEED DESKTOPS

Lab Report: 16 Pentiums High on Win 95 156
BY ANTHONY J. LENNON AND JOHN MCDONOUGH
Can't get enough speed? We test the latest 120- and 133-MHz Pentium machines using new Windows 95-based benchmarks.

120-MHz Pentiums—158
32-Bit Performance Advantages—158
133-MHz Pentiums—160
Triton-Based Pentiums—161
Honorable Mentions—161
How We Tested—164

Core Technologies

OPERATING SYSTEMS

Not Just Another Free Unix 207
BY JORDAN HUBBARD
FreeBSD is fast and open, it runs powerful applications, and it won't cost you a cent.

CPUS

Two Turbocharged PowerPCs 209
BY TOM THOMPSON
IBM and Motorola rev up the 603 and 604 and reduce their chips' hunger for power.

PROGRAMMING

How to Build an Internet App 211
BY BRETT GLASS
With a bit of Visual Basic code, the author builds his own weather channel in a flash.

NETWORKS

Untangling Fast Ethernet Cables 213
BY PAUL CUNNINGHAM
The Fast Ethernet standard specifies a variety of cabling types used in 100-Mbps networks.

BENCHMARKS

BYTEmark Bug Bashed 25
An update to our tests of the P6 chip.

MEDIA PROCESSORS

Multimedia x86 CPUs Coming in 1996 30
New x86 microprocessors will integrate DSP functions.

COMPRESSION

Wavelets Challenge MPEG, Fractals 34
Developers claim 300-to-1 compression.

NEW PRODUCTS

What's New 216
Previews of HP's CopyJet color printer/copier and Delrina's WinFax Pro for Windows 95.

Opinions

Pournelle: A New Mutation 197
BY JERRY POURNELLE
Jerry provides advice for dodging a new breed of virus and then returns to his explorations of Windows 95.

Books and CD-ROMs: How Microsoft Works 41
A wealth of detail on how Microsoft operates; plus, a CD-ROM satire on bad art.

Commentary: CyberDavid Rocks Goliath ... 268
BY JAMES MARTIN
You don't have to be a giant to succeed.

Editorial: The Butterfly Effect 10
BY RAPHAEL NEEDLEMAN

Letters 18

READER SERVICE

Alphabetical Index to Advertisers 262
Editorial Index by Company 266

Index to Advertisers by

Product Category 264
Inquiry Reply Cards: 134A, 264A

BUYER'S GUIDE 225

Mail Order
Hardware/Software Showcase
Buyer's Mart

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BYTE Contents by Platform

DOS/WINDOWS

New Suites Embrace the Web.....25
Terminal emulation is dead. Well, not quite. But vendors are adding much more to Windows communications programs than just data comm and fax.

Multimedia x86 CPUs Coming in 1996.....30
Thanks to upcoming chips with integrated DSP functions, your next PC could be a real smoker when it comes to running mixed-media applications.

Memory Price Relief to Come in Late 1996.....34
If you've been holding out for lower prices before buying more memory, that hungry little beastie inside your Windows PC will have to wait a while for its next feeding.

CodeTalk: New Micro Focus Tool Converts COBOL into Components 36
Something old—COBOL—meets something new—Windows 95—in Micro Focus's Visual Object COBOL for Win 95.

Keep the Data Moving.....87
Handy Intel-based computers and PC Cards are helping mobile data collectors who work in rugged environments. Plus, tips on buying a hand-held computer.

Talking to Machines.....97
"Wuzzatdoonear?" Your PC might not understand that question, but some speech-recognition products would recognize "What's that doing here?"

3-D Action 123
The latest DOS and Windows shoot-'em-up games show how far we've come since Battlezone.

The Games People Write.....135
Microsoft's new Game SDK takes some horror out of designing for Windows 95.

16 Pentiums High on Win 95 156
If you've upgraded to Windows 95, you might want one of these speed demons to go along with it. We test the latest 120- and 133-MHz Pentium PCs.

The Penthouse Suite 179
Forget the Windows 95 hype for a while. Office 95 really delivers: true 32-bit code, full OLE 2 support, better integration, and a great way to mix files from different applications.

Access 95 Advances Database Design 181
Combine the Windows 95 Briefcase with Access 95's powerful replication features and you can take your corporate databases to the remotest places.

Symantec C++ Differences 183
The latest edition of Symantec's C++ package adds network-distributable compiling and an object-oriented editor. Version 7.2 ensures Windows compatibility via MFC 3.0, ODBC, and OLE 2.

More RAM for Win 3 Holdouts.....191
If you like Windows 3.x but not its memory confusion, maybe it's time to buy one of these RAM doublers.

Data to the Nth Dimension 193
This drill-down info analyzer works with a variety of DOS and Windows front ends, including Excel and 1-2-3.

The Better Virtual PC 195
If you need to run Windows applications but would rather use a Power Mac, SoftWindows 2.0 will let you do it.

Pournelle: A New Mutation 197
Jerry gets a hesitation problem in his DOS word processor. To solve it, he decides to install his shrink-wrapped copy of Windows 95. Adventure ensues.

How to Build an Internet App 211
Brett Glass explains how to take a bit of Visual Basic code, some knowledge of Internet protocols, and build an on-line application—during your lunch break.

MACINTOSH

3-D Action 123
A look at the making of two slick games for the Mac: Dark Forces and Marathon.

Symantec C++ Differences 183
The new edition of Symantec's C++ for the Macintosh supports the PowerPC.

Data to the Nth Dimension 193
You can soup-up Excel for the Mac with the high-end data-analysis and development capabilities of Arbor's Essbase Analysis Server 3.2.

The Better Virtual PC 195
Insignia Solutions' SoftWindows 2.0 lets you run DOS and Windows applications on your Power Mac in a networked PC environment.

UNIX

Systems Design in ObjecTime 189
With this modeling program, you can build an object-oriented system from the top down. ObjecTime runs on workstations from Sun and Hewlett-Packard and the IBM RS/6000.

Not Just Another Free Unix.....207
FreeBSD can be used for everything from commercial Internet service to a home-desktop solution, running on relatively inexpensive PC equipment.

NETWORKS

Tools Cover Big and Little Iron 26
New enterprise client/server programs provide tools for writing applications that span mainframes, workstations, and personal computers.

DragNET.....106
G-men use a network of databases and POTS to track down public enemies.

The BYTE Network Project: Perl Magic 115
Have you visited BYTE's Virtual Press Room and wondered how we built it?

Virtual CDs on the LAN.....153
CD-QuickShare offers a cost-effective alternative to hanging gangs of CD-ROM drives off your network.

Web Publishing Made Easier.....170
A review of Cyberleaf, HotMetal Pro, HTML Assistant Pro, and Spider.

The Better Virtual PC 195
SoftWindows 2.0 not only puts a 486 inside a Power Mac; it gives DOS and Windows programs access to the Mac's Ethernet port.

How to Build an Internet App.....211
Thanks to the Net's protocol suite, it's not as hard as you might think.

Untangling Fast Ethernet Cables 213
This faster standard will run over a variety of wires. We help you sort them out.

Index

AI 79
Bar codes 68
C/C++ 183, 189
CD-ROM 38, 153, 197
Chips 30, 40, 79, 209
Client/server.....26
Communications 24, 25
Compression 34
Control systems.....67, 79
Data acquisition.....87
Data analysis 193
Databases...36, 67, 106, 181
Desktop PCs 156, 195, 216
E-mail 106
Emulation.....195
Ethernet.....213
Fuzzy logic 79
Games ...123, 129, 135, 139
Groupware 24
HTML.....115, 170
Internet.....24, 25, 40, 115, 170, 211
Memory 34, 191
Mobile computers 87, 216
Modems.....40
Multimedia 30, 129
Networks.....106, 115, 124, 153, 184, 195, 211, 213
Neural nets.....79
OLE.....179
PCI 156
Perl.....115
P6.....25
PowerPC.....209
Programming 26, 36, 48, 115, 123, 129, 135, 170, 181, 183, 189, 211
Speech recognition.....97
3-D.....30, 123, 129, 135
World Wide Web 24, 40, 115, 170

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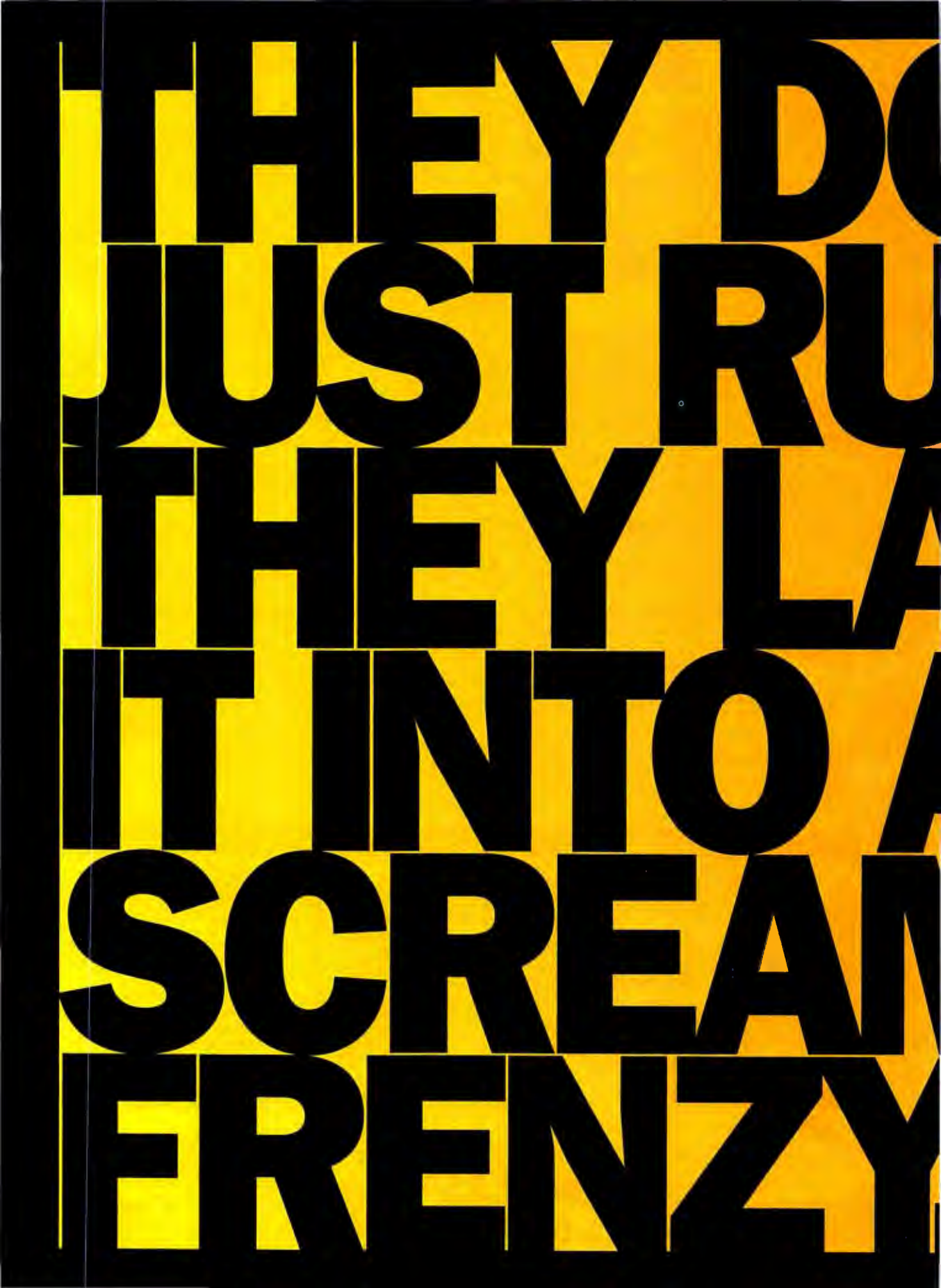
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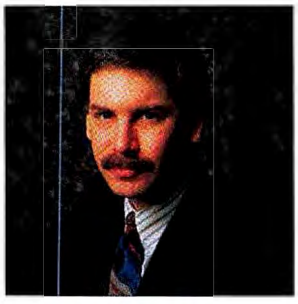

The foundations of hypertext and multimedia computing go back to a paper published by an atomic scientist in 1945

I began this column on a sunny Sunday afternoon in a coffeehouse in Cambridge, Massachusetts. No ordinary coffeehouse, this is the Cybersmith Café, one of the strange keyboard-and-coffeehouses that are springing up around the world. I came to have lunch and check out the emerging cyberscene. I also got in a few rounds of the addictive virtual-reality game Virtuality.

Who could have predicted this fantastic world, a world in which you can connect to a worldwide hive-mind from a coffeehouse or play a game that places your eyes and ears in a completely synthetic but convincing universe? As it turns out, there was such a man, Vannevar Bush, science advisor to President Franklin Roosevelt. In 1945, he published an article in the *Atlantic Monthly* called "As We May Think." In this work, Bush foresaw a lot of technology we take for granted today: Hypertext and multimedia are the most important, but there were also pen-based computing, microcameras, and high-density optical storage.

Bush's broad vision was amazingly astute, but he got the details wrong. None of his predictions were based on digital technology, for example. Bush, the inventor of an analog differential-equation solver, saw a technological future made up of microfilm-based hypertext and mechanical retrieval engines.

Isn't it interesting how easy it is to predict the far future—and how difficult it is to get the details even close to correct? The way things are going, can you imagine a future 10 to 20 years from now where we'll type on computers instead of speak to them or use archaic glass tubes as display devices?

But what of the next six months? Or the next year?

Big parts of the future are obvious. It's the details that stymie us—and that make our jobs so interesting. Every small decision a company makes to invest in one technology over another can influence the future in a small way or a big way. It's the butterfly effect of technology. For example, early windowing interfaces were not the simple one-click wonders we use today. Instead, they were complicated marvels of efficiency, and they contained hyperlinks between windows to keep information references alive. The Mac and Windows systems we use today are, in fact, descendants of a simplified windowing system based on an experiment Alan Kay designed to make computers easier for children to use. His educational experiment helped the windowed interface find the level that got it the acceptance it has today.

In broad strokes, everybody seems to be convinced that the convergence of telecommunications and computing will change our lives and our businesses dramatically. No one is quite sure about the details, though. Exactly when will the changes happen? And how? Where are the seeds of the next important technologies? Where is the next student whose simple vision will change the world? Those are the important details, the answers to which make some graduate students billionaires or push a global corporation into bankruptcy.

The fiftieth anniversary of Bush's vision was celebrated in October at an MIT symposium. Speaking there, and showing us their visions of the future and their visions' linkages back to Bush, were several architects of the computer revolution: Tim Berners-Lee, Alan Kay, Doug Engelbart, and others.

Space won't permit me to list all the current technologies that can be traced back to Bush's visions. But you might be interested to know that several technologies you might have thought of as completely fictional are, in fact, close to reality. At the symposium, Raj Reddy, dean of the school of computer science at Carnegie Mellon University, showed demonstrations of speaker-independent continuous-speech voice recognition, as well as technology that can create models of the 3-D physical world the same way we humans do: from visual input.

I'm pretty sure that technology in the next 50 years is going to progress at the same breakneck pace it has in the past 50. It may even accelerate. But I have absolutely no idea which of today's technologies will be the building blocks of tomorrow and which will become merely quaint. Do you? ■

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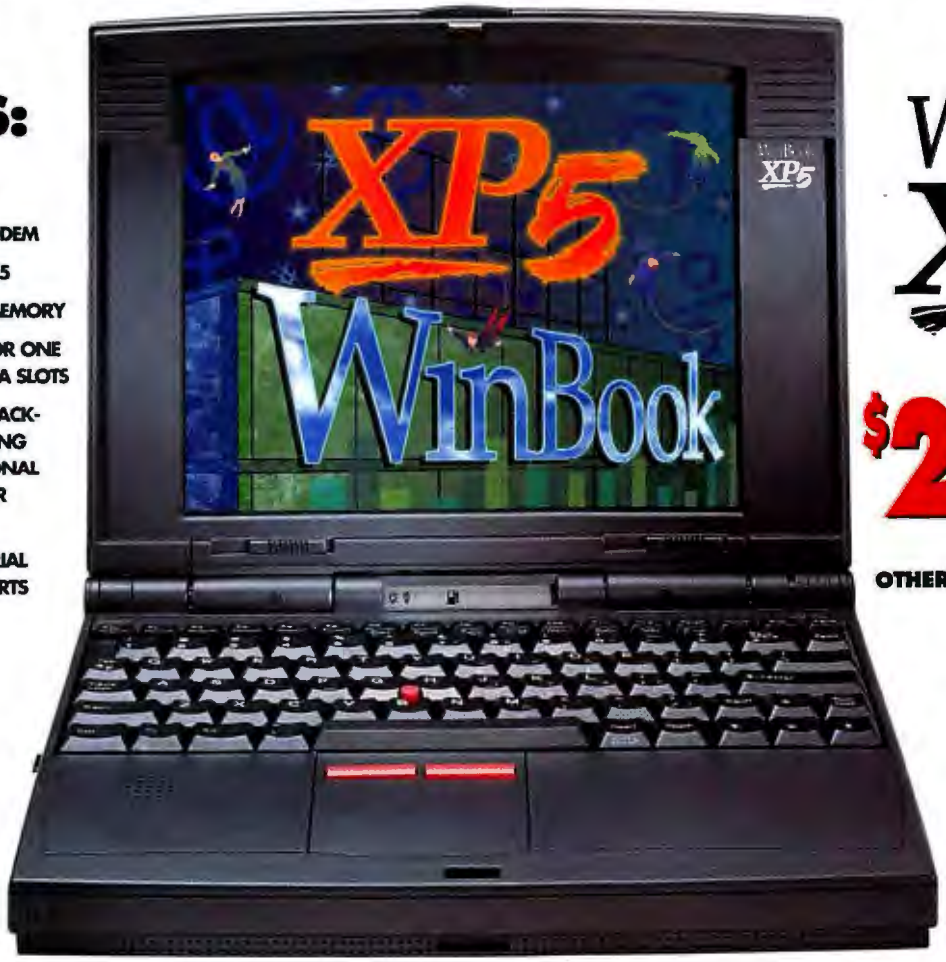

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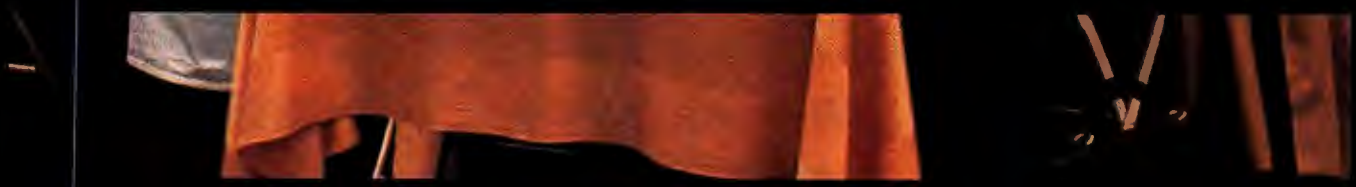

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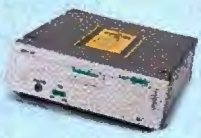

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Windows 95 32 bit mode included	Yes	No	No	No
Windows NT 32 bit mode included	Yes	No	No	No
Microsoft MS Backup compatibility included	Yes	No	No	No
Kodak PhotoCD creation software included	Yes	No	No	No
Audio Editing utility included	Yes	No	No	Yes
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Source: pricing and information obtained directly from manufacturers on 10/12/95

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Death to the PC

To those of us who have been making a living on mainframes and minis for the past 25 years, your October [cover] headline "The PC Is Dead" was quite amusing. I can't count the times I've read that the mainframe is dead, or the AS/400 is dead, or an operating system is dead, or a programming language is dead. Meanwhile, our business just continues to grow and grow among all these technologies tech writers have written off.

Hank Heath
Medco Systems Inc., Marlton, NJ
HankHeath@aol.com

The inside headline ("The New PC") is not quite as sensational; neither is my story. However, if prodded (not very hard), I would say that the PC should *be dead. Today's PCs are a shameful hodgepodge of clumsy technologies that waste untold hours of users' time and soak up productivity like a sponge. If BYTE made fun of this situation by indulging in a little hyperbole, then I plead guilty and throw myself on the mercy of the court.*

—Tom R. Halfhill, senior editor

Web Crawl

Your review of World Wide Web/Internet access from the Big Three on-line service providers ("Gateways to the Internet," September) had one blind spot: a "reference" direct Internet service provider. You would have found that such direct service is much faster than the fastest of the Big Three. I have accounts with a local Internet service provider and with America Online. I find the latter unworkably slow when poking around on the Net. Thanks otherwise for your high standard of technical journalism.

Tony Hurson
tony@oldnick.ross.com

A reference Internet service provider to compare with the Big Three information services would be great, but it's a little more complicated than just looking at speed. I can connect to America Online via a T-1 link and it zips along as fast as any ISP I've used. CompuServe and Prodigy probably would be screamers over T-1, too. On the other hand, an ISP with too few modems or too small a connection to the Internet could provide users with problems simply connecting (as do the Big Three at some hours in some locations) or with slowness born of bandwidth congestion. Perhaps instead of a reference ISP we need a true benchmark for evaluating real-world bit-transfer rates, something that would take into account local conditions as well as general Internet conditions.

—George Bond

Macs Serve the Web

Jon Udell's response to Mark Eaton's letter in the September issue revealed his naiveté when it comes to Mac-based Web servers. I can accept that he's more comfortable with other OSes—but it's not fair for him to imply that Mac servers are useful only on modestly trafficked Web sites. I refer him to http://brad.net/webstar for a list of several hundred Mac Web servers. And I recommend that he try Apple (http://www.apple.com and http://quicktime.apple.com), Warner Brothers Records (http://www.wbr.com), and other sites for examples of Mac Web servers that get pounded by thousands of hits every hour.

Charles Wiltgen
cwiltgen@fancymedia.com

Fair comment. We have an Apple Workgroup Server 6150/66 in-house now, so we can find out firsthand.

—Jon Udell, executive editor

Linux Please

While BYTE seems to cover OS/2 in proportion to its market share, you don't cover Linux at all. With all the trash talk the Internet is getting regarding pornography, some coverage of Linux would be good. Linux is being developed by people all around the world using the Internet as a forum for discussion and distribution. It demonstrates the true spirit and power of the Internet.

Nathan C. Burnett
Portales, NM

We've scheduled a feature story on the technical underpinnings of Linux for the first quarter of 1996. Also see the article "OS Paradise," part of the special report in our November issue, and our review "Power of Cooperation" in the September '94 issue. —Eds.

P6 Revisited

When is someone going to write an "emperor's new clothes" story about Intel's P6 chip? If I compile a word processor with a 32-bit compiler, it still does byte manipulation, and if it uses the string manipulation instructions for string searches, it will have target bytes in registers, etc. Why should such software speed up on a P6 if compiled with a 32-bit compiler as compared to a 16-bit compiler?

I think the P6 team really blew it. The Pentium is the last x86 chip to give great gains in existing software without recompilation. It will be interesting to see if Intel can convince people to drop their Pentiums for P6s. I wouldn't.

Bob Morris
morris@sce.carleton.ca

We've published two stories (plus a sidebar) on the P6's problems with 16-bit software (September and October BYTE). The fact is, our own benchmarks—as well as other widely used benchmarks, such as SysMark—confirm that the P6 does a very good job of running 32-bit software. I don't think the P6 team "blew it." I do think that Intel misjudged how long it would take for Microsoft to ship a mainstream 32-bit OS, and also how much old 16-bit code would be left in that "32-bit" OS.

The P6 is optimized for 32-bit code, not a specific flavor of 32-bit code, and the software industry—pushed by Microsoft's Win32 API—is moving to 32 bits independently of the P6's characteristics. The P6's product life will probably extend to the end of this decade. I can't fault Intel for designing the chip with the future in mind.

—Tom R. Halfhill, senior editor

For an update on BYTE benchmarks and the P6 chip, see "BYTEmark Bug Bashed" in this issue's News & Views section, page 25. —Eds.

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

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LETTERS

"It Was 20 Years Ago Today . . ."

I thought you might like to know what happened to the first copy of the first edition of BYTE. Editor Carl Helmers had brought a few copies with him to an amateur radio meeting in Virginia. At the meeting, Carl announced the launch of BYTE and gave me the first copy because I had designed and built the Mark-8 computer, which had gotten many of the hams started using their own computers. Several years ago, my collection of the first 10 years of BYTE went to the Smithsonian Institution, along with the original Mark-8 and many long-forgotten publications that contributed a great deal to the early development of what we now know as the PC.

Jonathan Titus
Editorial director, Test & Measurement World
Newton, MA
jontitus@cahners.com

Not the First Spreadsheet

You keep printing the statement that Dan Bricklin wrote the first spreadsheet program ("The 20 Most Important People," September). No doubt VisiCalc was the first successful commercial spreadsheet, but hardly the first spreadsheet. In the early '70s, I used a mainframe program called Omnitab II, from what was then the National Bureau of Standards. It used a fully developed spreadsheet metaphor, but given the scientific and engineering emphasis of the program, it was referred to as a "lab notebook." The mathematical facility was extensive and accurate. It had a macro language, and it produced graphical output. In short, it had all the attributes of the modern spreadsheet program.

Steve Tedder
stedder@tulsix.utulsa.edu

It Keeps Ticking . . .

Where was the Timex Sinclair in your Anniversary list of top 20 systems? Many of us cut our teeth on a TX-80, and I still haven't seen another system with more elegant syntax. For three years I did all the word processing, spreadsheets, and accounting for my consulting business on my Timex. Thousands of people were doing similar things long before many of the systems you highlighted.

Bruce W. Heckman
Troy, MI

Re: M

Wow—finally a little respect for M! We were truly gratified to have this ANSI (1977) and ISO (1993) standard language "consecrated" by a mainstream publication ("A Brief History of Programming Languages," September). Today M is installed in tens of thousands of sites worldwide and is available on platforms ranging from Windows to Unix and mainframes. BYTE itself has indirectly featured the language twice in the last 18 months (in both cases spotlighting the 4000-node installation at Brigham and Women's Hospital in Boston). Of course, today it's hard to be taken seriously when the entire M language and its integrated hierarchical database management take up only about 512 KB.

Board of Directors
M Technology Association, Europe
100332.670@compuserve.com

More Weird Error Messages

I came across this error message when attempting to compile a Clipper program: *Control level closure leaves gaping wound in control stack.*

All for the want of an ENDIF.

D'Arcy Craig
Ottawa, Ontario

FIXES

The caption for the Panda Technologies system on our October cover should have read "Panda's Archistrat."

In our September review "Gateways to the Internet," we said that Microsoft had licensed NCSA Mosaic from Spry International. In fact, Microsoft licensed Enhanced Mosaic from Spyglass.

In our 20th Anniversary Issue ("A Brief History of Programming Languages"), we incorrectly identified PL/I as PL/1. It was not formally announced until late 1965. APL\360 was launched within IBM in 1966, not in 1964, but was not made available to customers until 1968.

In our 20th Anniversary Issue ("The 20 Most Important People"), we incorrectly identified Philippe Kahn as the creator of Turbo Pascal. According to Borland and a few readers, the true creator was Anders Hejlsberg.

In the list of telephony application generators in the September State of the Art (page 213), we listed Voice Information Systems' VFEdit. We should have listed the application generator TI/F DLL, for Windows 3.1 or Windows 95/Visual Basic, priced at $195.

The correct URL for Steve Mann's Web page (cited in the October Editorial) is: http://www-white.media.mit.edu/~steve/netcam.html. We inadvertently substituted a space for the hyphen between "www" and "white." ■

COMING UP IN JANUARY

- **SUPERCOMPUTERS**
  Slimmed-down machines sporting commodity processors—and popular operating systems—are replacing the liquid-cooled brutes of yesteryear. We tell you how Convex, Cray Research, IBM, and others build today's big iron, who buys it, and why.
- **HOTJAVA**
  Distributed applications for the Internet? BYTE looks at a new kind of Web browser, one that can download programs and run them on a Web page.
- **AMD–K6**
  An inside look at the architecture of AMD's new acquisition: an answer to the P6?
- **WHERE'S THAT FAX?**
  We deploy fax-on-demand software to test support for document catalogs, fax-back services, and multilevel mailboxes.
- **ART 95**
  A design professional tests the creative capabilities of CorelDraw 6.0 and Micrografx ABC Graphics Suite under Windows 95.
- **COMPONENTWARE**
  BYTE takes a State of the Art view of real-life application development, tips and traps, and evolving standards.

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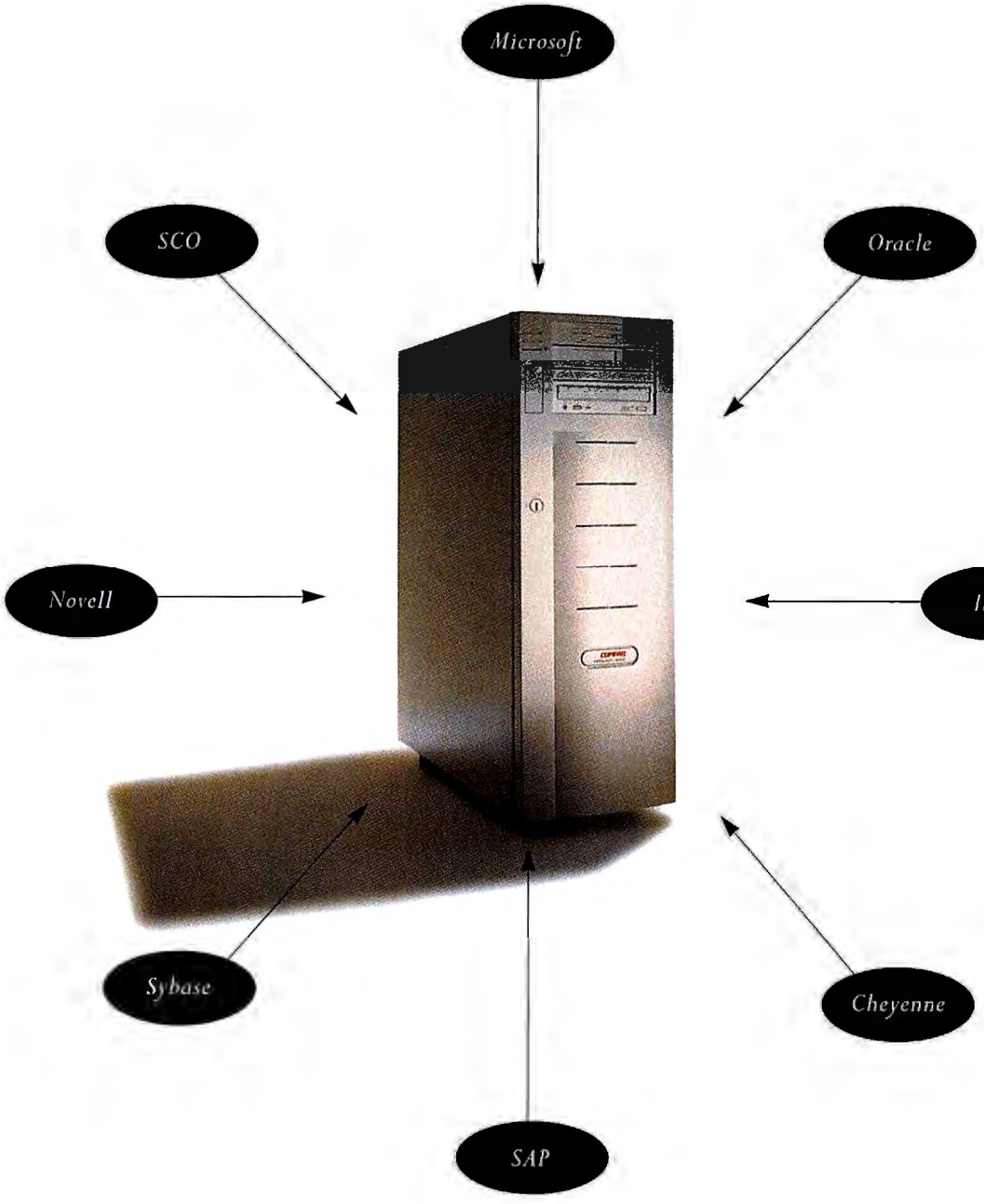

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You see, they may be Compaq servers. But they are Compaq-Microsoft-Oracle-SAP-Intel-Novell-SCO-Sybase-Cheyenne solutions. (We just couldn't fit all those logos on them.)

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NEWS & VIEWS

BUSINESS COMMUNICATIONS

Groupware Taps the Internet

New groupware products that run on the World Wide Web enable businesses to maximize their Internet investment

PETER JERRAM

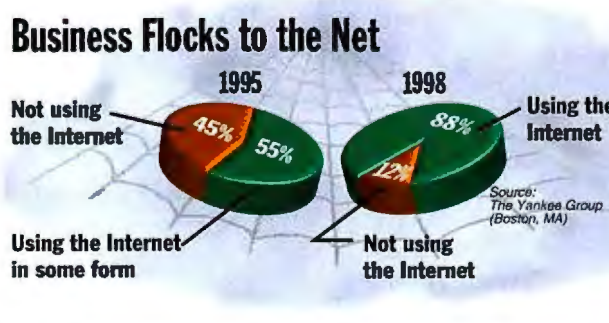
Nearly every aspect of the computer industry has been influenced by the unchecked growth of the Internet. The latest beneficiary may be groupware, a market that the Gartner Group predicts will top 50 million users in the next four years.

Many corporations have quietly invested in TCP/IP *intranets*, which are corporate networks based on open Internet protocols for E-mail, discussion forums, and file transfer. The World Wide Web's strengths in document publishing have especially spurred the growth of intranets. "We get more than 70 percent of our revenue from internal corporate networks," says Mike Homer, vice president of marketing for Netscape Communications (Mountain View, CA), publisher of the popular Netscape Navigator Web browser.

Analysts see these basic protocols and the intranets themselves as an ideal—and largely untapped—platform for groupware applications. "Many Fortune 500 companies are asking themselves, 'Why should I invest in a new infrastructure like Lotus Notes when I can leverage what I already have?,'" says Hal Bennett, an Internet commerce consultant in Menlo Park, California.

Acting on that premise, software makers are developing integrated Internet-based packages with groupware features. The most prominent indication of this trend is Netscape's recent acquisition of Collabra Software and its Collabra Share workgroup-conferencing software. Executives from both companies say Collabra Share will be fully integrated with Netscape Navigator sometime in 1996.

Collabra Share's discussion-group features are based on a proprietary protocol (called the Collaborative Object Store) rather than the Internet's Network News Transport Protocol. "As part of the merged Netscape Navigator product, we'll move to an open-systems store," says Bob Lisbonne, vice president of marketing for Collabra.



More businesses will use the Internet in the future, according to the Yankee Group's recent survey of 200 companies. However, the results of the survey also indicate that security is a big concern.

Other companies are bringing groupware to the Web. For example, Digital Equipment's ((800) 344-4825; fax (800) 723-4431; Internet http://www.digital.com) $1995 Workgroup Web Forum adds basic conferencing capabilities to Web browsers. Infinite Technologies' ((800) 678-1097; fax (410) 363-3779; E-mail info@infinite.ihub.com) new WebMail software lets remote users connect to their Microsoft Mail, cc:Mail, and other mail systems over the Web.

In addition, Lotus Development's ((800) 343-5414; fax (415) 335-2280; Internet http://www.lotus.com) $195 cc:Mail for the Web is similar to Infinite's WebMail but supports only cc:Mail. Insitu ((617) 720-0821; fax (617) 279-4436; E-mail sales@insitu.com) sells Windows application-sharing products for the Web.

Also, White Pine ((603) 886-9050; fax (603) 886-9051; E-mail info@wpine.com) plans on releasing an enhanced version of the CUSeeMe videoconferencing and whiteboard software for the Internet by the end of the year. Officials at White Pine say about 500,000 copies of the public domain version of CUSeeMe have already been downloaded.

For certain types of groupware, however, products like Lotus Notes, which offer sophisticated work-flow features, have advantages over current Internet-based E-mail, discussion groups, and document publishing. "On an information-exchange level, the Web is very good," comments David Marshak of the Patricia Seybold Group in Boston. "However, it's in the support of business processes that products like Notes really show their strengths."

Business processes are key corporate functions, such as product development, sales, order processing, and technical support. Work-flow software can meet the demands of

these complex processes by, for example, routing information through discrete phases and to multiple individuals. "The Web is great for broadcasting information, but work flow requires interaction," says David Coleman, the author of *Groupware: Technologies and Applications*.

Many groupware products can also synchronize shared information, and security tends to be stronger than it is in Internet-based products. This was amply demonstrated this fall by several high-profile Netscape security breaches.

Netscape is addressing the security problems, but many businesses apparently think the Internet is an inherently insecure medium. A recent poll by The Yankee Group, a Boston-based data communications and computing consultancy, indicates that security is the main concern of corporations with regard to using the Internet. When asked to rate issues delaying implementation, security scored a 4.8 (on a scale of 1 to 5), while support capabilities (3.37) and cost (3.34) ranked lower.

Lotus Development and other companies have strengthened Web/Notes interoperability with the release of Internet publishing tools, such as InterNotes (see "Notes Meets the Internet," July BYTE). But Lotus officials say groupware encompasses much more than software: It also requires a secure, reliable network that you get in platforms like Notes. "We look at groupware as infrastructure rather than as simply a collection of applications," says Andrew Mahon, manager of Lotus's communications product marketing.

Netscape and other Internet players are mounting a serious challenge to proprietary systems, but long-term success is less certain. Says Karl Wong, a groupware analyst at Dataquest (San Jose, CA), "We have a way to go before we see the features of a product like Notes showing up in Web browsers."

BENCHMARKS

BYTEmark Bug Bashed

A problem with the BYTEmark benchmarks has been located and corrected. Specifically, the logical unit (LU) decomposition test—a component of the FPU benchmark portion of BYTEmark—behaved erratically under certain OSes. One unfortunate outcome of this problem resulted in BYTE's publishing low benchmark numbers for Intel P6 processors.

The BYTEmark's component tests are all run multiple times by the benchmark, and the program passes the results through statistical calculations to yield the final indexes. In the case of the erratic LU decomposition test, the resulting scores for the P6 were sometimes low (which yielded an index of about 1.7) and sometimes high (yielding an index of about 3.6). The test showed its worst behavior under Windows NT.

The problem concerned data alignment. The LU decomposition algorithm solves linear equations, which are represented by coefficients stored as doubles (an 8-byte floating-point data type) in a 2-D array. As the LU decomposition algorithm does its work, it quickly processes data in the array while making numerous 8-byte fetches.

Because the BYTEmark is self-adjusting (i.e., each test component makes proportionally more or less work for itself, depending on the power of the system under test), the array is not statically allocated. The LU decomposition test calls the library routine `malloc()` to allocate space for the array.

Under the Windows NT compilers we tested—Visual C++ and Watcom C++, the latter being the compiler used to generate the release version of the BYTEmark—`malloc()` always returns data that's aligned to 4-byte boundaries. (This makes perfect sense, since NT is a 32-bit OS.) However, it doesn't always return data aligned to 8-byte boundaries.

Nonaligned memory accesses on Intel processors are always slower than aligned accesses. Consequently, whenever `malloc()` returned a non-8-byte-aligned array to LU decomposition, the algorithm proceeded much more slowly than when it received an aligned array.

A modified version of the benchmarks run on an Intergraph 150-MHz P6 machine scored 2.1 on the integer test and 2.6 on the floating-point test. (This was a dual-processor machine, but the current BYTEmark tests are single-threaded only.)

By the time you read this, an update to the BYTEmark will be on the BYTE World Wide Web page. In addition, for Intel P6 processors, we'll be reporting the proper numbers as returned by the aligned accesses.

We apologize for the confusion this has caused. We would like to thank the people at Geodesic Systems, Intel, Watcom, and—in particular—Rob Barris of Quicksilver Software for their help in tracking down and correcting this problem.

—Rick Grehan

WINDOWS COMMUNICATIONS

New Suites Embrace the Web

Windows communications software developers are preparing new communications suites that integrate data communications, fax, and Internet connectivity. In addition to providing more robust multitasking support, these applications are targeted to capitalize on the current interest in the World Wide Web.

"Our product has certainly been evolving," says Howard Myers, senior product manager of the Procomm Plus line at Datastorm Technologies ((314) 443-3282; fax (314) 875-0595). Procomm Plus was formerly a public domain program primarily used for data communications and terminal emulation. The Windows 95 version, which is slated for release in the first half of 1996, will offer a Web browser, a news reader, telnet, and FTP, plus data communications and fax.

Mustang Software (Bakersfield, CA, (805) 873-2500; fax (805) 873-2599) has already released a Windows 95 communications program, called QmodemPro, which offers terminal emulation; the ability to view GIF, JPEG, and BMP files; an Internet telnet client; and support for TAPI and OLE 2.0 drag and drop. Company officials say a future version might have a Web browser.

Meanwhile, Delrina ((416) 441-3676; fax (416) 441-0333), publisher of the popular WinFax program, says that a new version should be available this month for Windows 95 (see the What's New Preview on page 220). Delrina is also working on a suite, called CommSuite 95. Along with the new version of WinFax, CommSuite 95 offers general-purpose communications software, built-in links to Internet sites, a Web browser, FTP, Internet Relay chat, telnet, and other features.

CLIENT/SERVER DEVELOPMENT

Tools Cover Big and Little Iron

Enterprise client/server tools are expanding their coverage to all platforms found in an organization, from mainframes to PCs. Now into their second or third generation, many new client/server tools let users use one environment to develop custom applications that can run on a variety of platforms and hook into most of their databases.

Over the next several months, nine leading vendors will update their software to work across three tiers: PCs, workstations, and mainframes. All nine vendors are adding or improving their software's object-oriented capabilities. Most already offer fourth-generation language (4GL) coding, which lets users develop applications in a graphical environment without having to do any actual programming.

Particularly important this year has been the addition of partitioning to tools from the PC and Unix arenas. Partitioning allows users to write one application and later break it up into client/business logic/server components to run in a distributed fashion on systems ranging from PCs to mainframes.

Several vendors are adding drag-and-drop application partitioning. Dynasty Technologies has updated its partitioning with a graphical tool (see the screen below) that lets users specify on which machines certain parts of applications will run by dragging and dropping them onscreen, rather than having to write code. The tool also supports automatic partitioning, which lets the software specify where parts of the application will run.

Four Seasons Software offers a similar drag-and-drop configuration and, like InSync Software, offers a feature that lets users move partitions around while an application is running. This feature is useful for on-the-fly load balancing and moving an application to another server when the primary server goes down. Unify added partitioning to its software earlier this year.

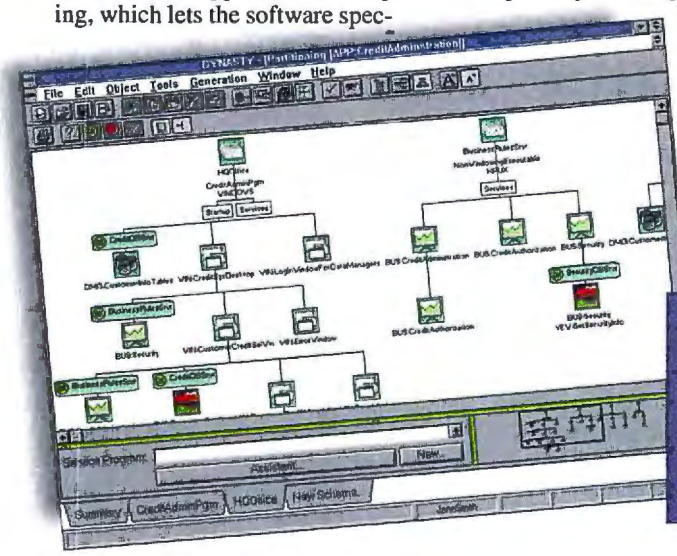
To address users' heterogeneous environments, every tool company is extending its support for new platforms, messaging standards, and database formats (most already support third-party design and analysis tools). For example, the new version of the Antares Alliance Group's Huron ObjectStar lets you develop applications that support OLE 2.0 and Open Database Connectivity (ODBC) and can run on Windows 3.1, NT, and OS/2. Compuware, whose strength is in databases (its tools work with at least 24), has improved its mainframe connectivity with support for CICS and Tuxedo transaction monitors. Other vendors are also improving the breadth of platforms that they support (see the text box "Enterprise Client/Server Tools at a Glance" above).

On the object front, Four Seasons Software has developed its own distributed file-object support, which enables users to access files anywhere in an organization. Progress is adding object orientation to its Progress 8.0 through reusable applications components. And Texas Instruments' new Arranger product lets nonprogrammers assemble applications using objects that have been created by a more technical programmer using TI's Composer software development tool.

—Cate T. Corcoran

ENTERPRISE CLIENT/SERVER TOOLS AT A GLANCE

- **Antares Alliance Group** (Dallas, TX, (214) 447-5500; fax (214) 447-5783): Huron ObjectStar release 3 ($8000 and up) supports more platforms and standards.
- **Compuware** (Farmington Hills, MI, (810) 737-7300; fax (810) 737-7513): Uniface ($4000 and up) and Uniface Distributed Computing Manager 1.0 support mainframe-transaction monitors.
- **Dynasty Technologies** (Lisle, IL, (708) 769-8500; fax (708) 769-9903): Dynasty 2 ($7995 and up) supports auto-partitioning and now works with Tuxedo, Oracle 7, Sybase 10, and DB2/2.
- **Forte Software** (Oakland, CA, (510) 869-3400; fax (510) 834-1508): Forte 2 ($225 to $6000 per seat), which already supported partitioning and platforms, ranging from VAX and Data General to Windows and Macs, adds support for NT; applications can communicate with Forte through DCE RPC or CORBA.
- **Four Seasons Software** (Edison, NJ, (908) 248-6667; fax (908) 248-6675): SuperNova 5.0 ($990 to $2490) adds dynamic partitioning, new objects, and new support for 16- and 32-bit Windows and other platforms.
- **InSync Software** (Ronkonkoma, NY, (516) 981-3000; fax (516) 981-3082): Passport 8 ($3995 and up) adds dynamic partitioning; still supports Unix and offers new support for Windows 95, NT, and MVS in October; will add OS/2 and Mac support in 1996.
- **Progress Software** (Bedford, MA, (617) 280-4000; fax (617) 280-4095): Progress 8 (price not available) supports reusable objects.
- **Texas Instruments Software Business** (Plano, TX, (214) 575-3758; fax (214) 575-4144): Arranger 1.0 ($495 and up) and Composer Version 3 ($11,000 and up) support application assembly with reusable objects.
- **Unify** (Sacramento, CA, (916) 928-6400; fax (916) 928-6406): Unify Vision 2 ($4995 and up) offers auto-partitioning and an object repository and supports Unix, adding Windows 95 and NT in 1996.



Dynasty's partitioning editor shows the result of automated partitioning performed by the program's partitioning assistant. The original client application is shown at top left (HQOffice); locations of partitioned server objects are indicated.

Watcom C/C++

The High-Performance, Multi-Platform Development System

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Now with Windows®95 Support & Visual Programmer by Blue Sky Software

Watcom C/C++ accelerates development of high-performance, multi-platform 16 and 32 bit applications. The integrated development environment simplifies application development and makes it easy to exploit the power of Watcom C/C++. In a single package, Watcom C/C++ provides a comprehensive development environment with the tools, SDKs and libraries you need to create powerful 16 and 32 bit applications for popular PC platforms.

Leverage Your Time and Code Investment

Watcom C/C++ supports a wide range of host and target platforms including Windows 95*. Reliable, high-performance code generation and consistent C and C++ language implementation are delivered across all supported platforms, making it easy to develop applications for several targets from a single source code base. For example, C++ templates and exception handling are provided on all supported platforms including 16-bit Windows.

Host Platforms: Windows 95, Windows NT, Windows 3.x, OS/2 Warp, OS/2 2.x, DOS

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

Accelerate Your Windows Development

For rapid 16 and 32 bit Windows development, Watcom C/C++ includes the Microsoft Foundation Class (MFC) libraries and Visual Programmer (VP) by Blue Sky Software. VP is a fast MFC code generator for quick, easy and intuitive development of Windows applications. With VP, application user interfaces are designed visually using point-and-click interaction. Functional preview mode allows for quick testing of the user interface.

High Performance

Watcom's advanced compiler technology generates fast, tight code, optimizing your application's performance. Superscalar optimization strategy uses "riscification" and instruction scheduling to deliver optimum performance on 486 and Pentium processors.

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

PC MAGAZINE EDITORS' CHOICE
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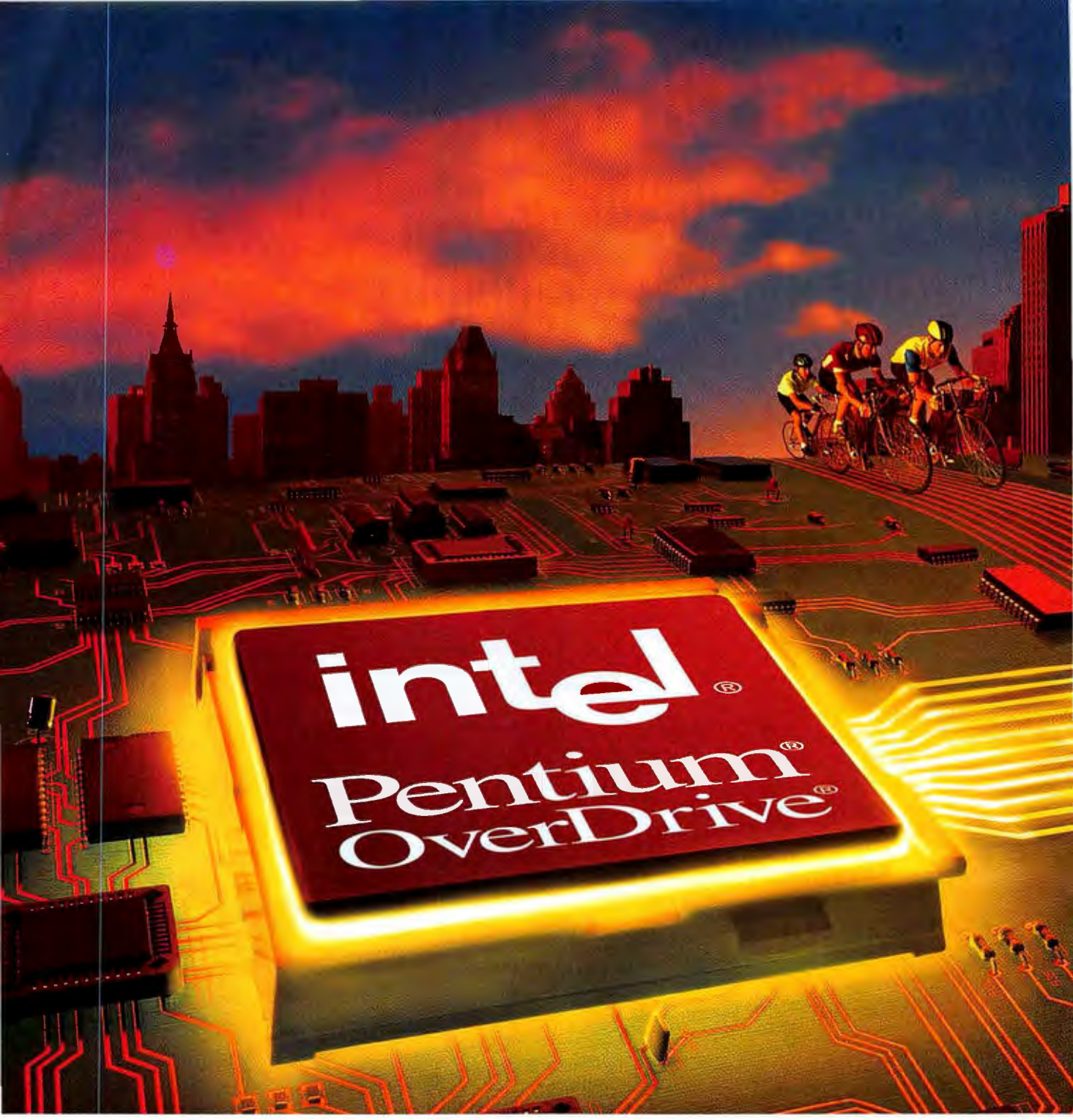

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Is your PC stuck in the slow lane? A Pentium® OverDrive® processor can dramatically boost your current CPU's performance and get your software really moving. So, if you're not planning to move up to a Pentium processor-based PC just yet, then this is a good alternative for you.

As our fastest single-chip processor upgrade, the Pentium OverDrive processor is a very affordable way to upgrade many Intel486™ processor-based PCs.

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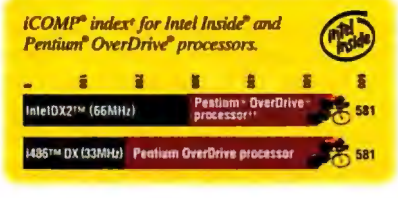

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MULTIMEDIA PROCESSORS

Multimedia x86 CPUs Coming in 1996

Look for new x86 microprocessors that integrate digital signal processor (DSP) functionality to arrive next year. These chips, some of which may ship as early as the first half of 1996, will perform some high-speed operations typically done by DSPs. Thus, they will give PC manufacturers a more integrated appoach to implementing such capabilities as software modems and MPEG playback than relying on separate, more expensive add-in cards.

Details were sketchy at press time, but three major x86 vendors—Intel (Santa Clara, CA) Cyrix (Richardson, TX), and NexGen (Milpitas, CA)—are reportedly going to announce "multimedia" CPUs in the coming months (see the box "Likely Multimedia x86 Road Map").

DSP functionality is one intriguing new feature of a forthcoming processor from NexGen, which at press time announced that it will merge with Advanced Micro Devices (Austin, TX). The company is developing a new x86-compatible microprocessor that it says combines the best features of Intel's Pentium Pro (aka the P6) and a rumored "multimedia Pentium" (code-named the P55C). According to NexGen, the upcoming Nx686 chip will recognize a new subset of extended x86 instructions that mimic DSP operations, thus bridging the gap between CPUs and DSPs.

NexGen's chip integrates a DSP-like execution unit that's designed to greatly accelerate such multimedia functions as MPEG video decoding, audio playback, and 3-D graphics rendering. To make this practical, however, the extended instructions will require industrywide support from chip manufacturers, compiler vendors, and software developers. NexGen hints that a group of companies has been quietly working for months to gather that support and to standardize the extended instructions. Numerous compiler and OS vendors that BYTE contacted declined to comment.

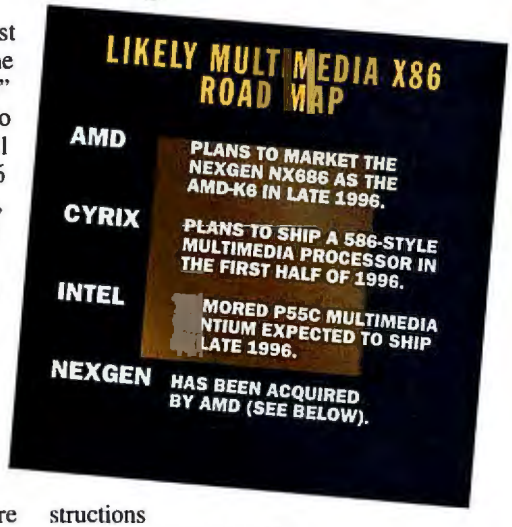
The Nx686 implements the new instructions within a special DSP-like execution unit that uses a single-instruction/multiple-data (SIMD) architecture. The instructions are fairly general in nature, so they will work with a wide variety of algorithms. One example is multiply/accumulate (MAC), a common DSP instruction that repeatedly multiplies and adds a series of integers. NexGen says the Nx686 can execute as many as 6 billion of these operations per second, which is an impressive level of performance, even when compared to dedicated DSPs.

These chips won't be the first processors to marry DSP and CPU functionality: Current PowerPC processors, including the 601, 603, and 604, already implement DSP instructions, including MAC. And adding DSP functions to a CPU is not without controversy. DSP proponents caution that you can bring a CPU to its knees when you overload it with too many tasks.

AMD agrees. "High-performance CPUs combined with low-cost DSPs is not a bad approach," an AMD representative says. "That's why we don't have a CPU that combines DSP functionality on our road map." However, with NexGen in the fold, AMD's position may now change.

One source that BYTE contacted, who wished to remain anonymous, says chip vendors might encourage applications developers to implement a few DSP operations that the CPU will handle well. In addition, the source says, other, more intensive DSP operations will be off-loaded to fixed-function or programmable DSPs.

—Tom R. Halfhill



AMD ACQUIRES NEXGEN'S NX686

AMD's surprise acquisition of NexGen should give a significant boost to both companies. NexGen will become a subsidiary of AMD and will continue designing new x86 microprocessors. NexGen's latest CPU, the Nx686, has been renamed the AMD-K6 and will be marketed as a sixth-generation competitor to Intel's Pentium Pro. AMD says it has halted its own K6 project and is reassigning that project's engineers to help NexGen finish the Nx686/K6. Their goal is to ship the CPU in late 1996, ramping up to volume production in 1997.

Thanks to the merger, AMD will manufacture the K6 at its new wafer-fabrication plant in Texas. Until now, NexGen was a so-called fabless company whose chips were manufactured by IBM Microelectronics. NexGen also stands to gain from AMD's superior marketing muscle and established customers.

AMD wins, too. In October, AMD admitted that its long-delayed K5 processor would be stalled another three months, pushing volume shipments back to late 1996. Meanwhile, AMD's own K6 project was falling behind schedule. By acquiring NexGen, AMD gets a nearly complete sixth-generation design and some breathing room to finish the K5, which will be positioned as a lower-cost alternative.

The new K6 introduces several improvements over NexGen's Nx586. It has an integrated FPU, better branch prediction, two x86 instruction decoders, more registers, larger caches, more execution units, and the ability to retire up to four instructions per cycle instead of three. Like its predecessor, it executes instructions speculatively and out of order.

Two important features of the Nx586 that won't be carried forward are an integrated cache controller and a dedicated I/O bus for the secondary cache. NexGen has decided to make the K6 pin-compatible with Intel's Pentiums. That means discarding the high-speed cache bus.

NexGen says that the K6 will debut at 180 MHz and will roughly match the performance of a similarly clocked Pentium Pro when running 32-bit software. However, NexGen also says the K6 will not suffer the Pentium Pro's loss of performance when running 16-bit code.

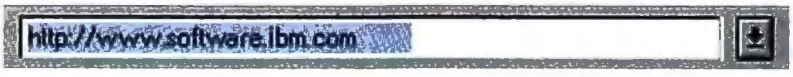
—T.R.H.

Kevin invented automatic 16/32-bit thunking.

Bob is an architect of IBM Open Class.

Lee co-wrote the book on the technical use of C++.

And they're all dropping by for a conversation.



No hype. No rules. Just person-to-person dialogue with the IBM researchers who have helped make C++ what it is today – and who are working on even hotter products for tomorrow. They'll be appearing at our web site in monthly forums devoted to the edgiest topics in the object-oriented world. So bring your ideas and, of course, those burning questions. Our people are eager to talk.

October	Design Patterns Visual Programming	John Vlissides Rod Smith
November	Writing Efficient C++ Code Class Library Design	Kevin Stoodley Bob Love
December	Incremental C++ SOM Programming	Lee Nackman Christina Lau

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New Back-UPS®: $119 blackouts, brownouts

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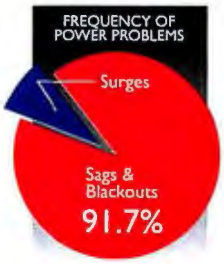
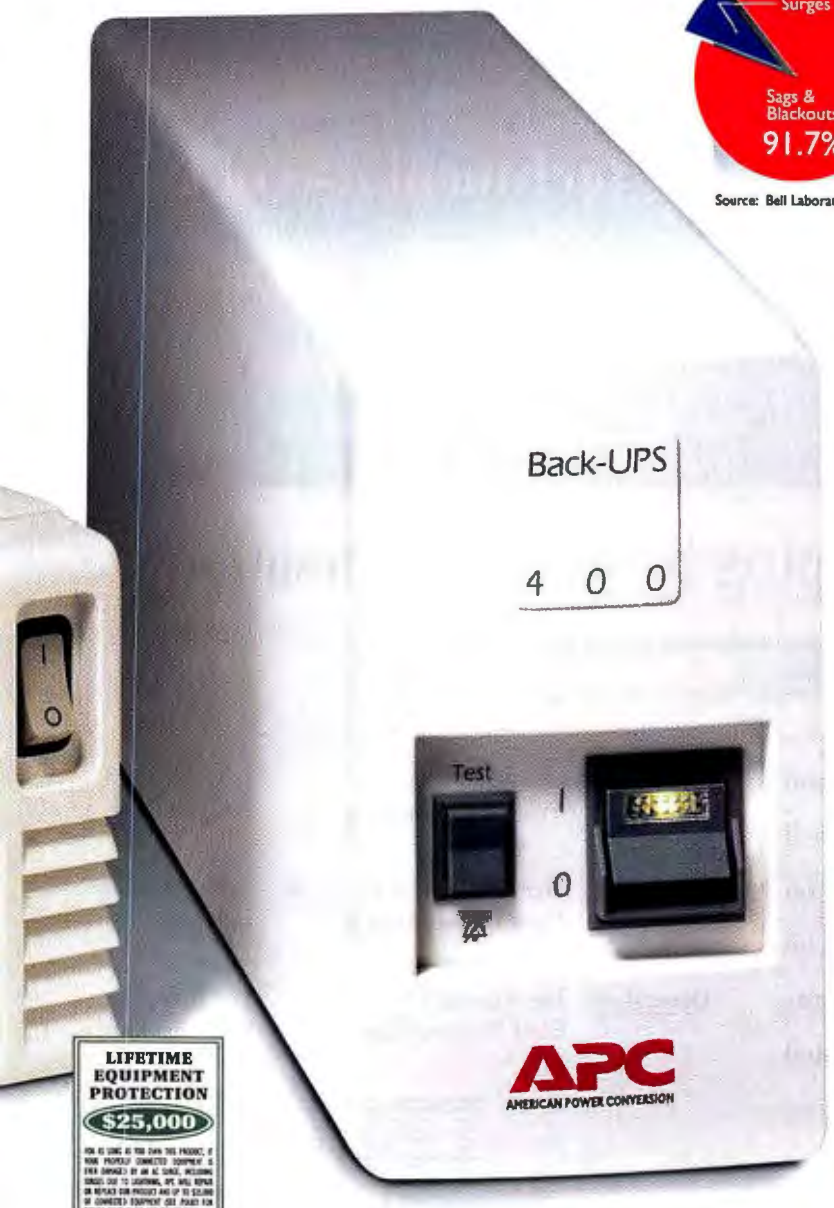
That's why we've just introduced new models in our award-winning Back-UPS line, now delivering reliable protection for just $119.

Source: Contingency Planning



Source: Bell Laboratories



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

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

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

WHY A $119 APC UPS COSTS LESS THAN A $9.99 "SURGE PROTECTOR"...

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

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

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

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

PC World Top 20 Upgrade

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

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

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

PC MAGAZINE UK

"The clear winner in price performance... it's unbeatable..." --PC Magazine UK

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protection against and other trials by fire

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

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

Trial by Fire

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

Trial by Air

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

Trial by Earth

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

Trial by Water

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- Site diagnostics automatically spot missing ground and reversed polarity
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- User replaceable, hot swappable batteries insure uptime safe disposal. Batteries will last 3-5 years under normal use.
- $25,000 lifetime Equipment Protection
- 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

Model	Application	Sugg.List
200 **NEW**	"Green" PCs	$119
280 **NEW**	LAN Nodes	$139
400	Desktop 486/386 systems	$199
450	Tower 486/386 systems	$254
600	CAD/CAM workstations	$359
900	Longer runtime	$529
1250	Multiple systems	$689

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

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COMPRESSION

Wavelets Challenge MPEG, Fractals

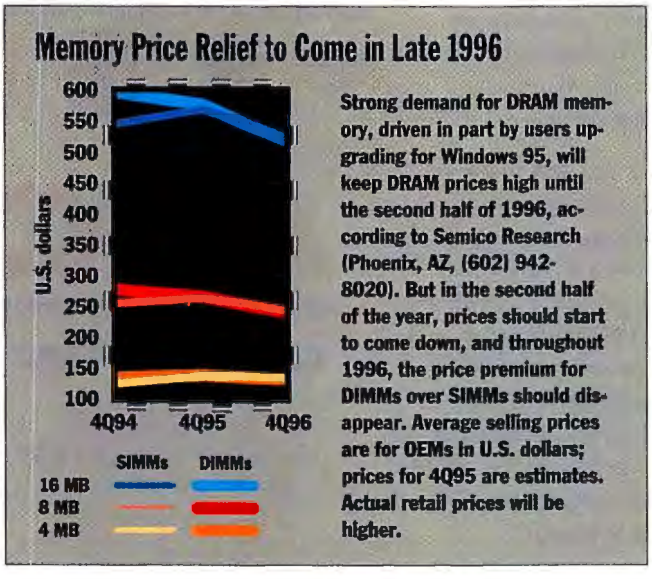
New compression products based on wavelet technologies will soon challenge MPEG- and JPEG-based products. By delivering higher compression ratios and better encoding techniques, wavelet technology could impact the retrieval and transmission of still and video images by allowing faster transmission speeds and clearer pictures. Users of the Internet, CD-ROMs, interactive TV, archive libraries, telemedicine, and other applications could all benefit.

The Houston Advanced Research Center says its wavelet-based HARC-C compression algorithm can take an original photo (left) and achieve a 300-to-1 image-compression ratio with little quality degradation.

Today's mainstream MPEG standard is geared toward transmission of sequences of images, such as videos, while JPEG concentrates on still images. These algorithms use a type of compression known as discrete cosine transform (DCT).

The idea behind DCT is to represent the detail of an image as a series of mathematical terms. Image areas containing very fine detail or sharp edges have higher spatial frequencies than areas that are rather course in detail. The goal is to get a high compression ratio so that images transfer faster or take up less storage space. But compress it too much, and annoying artifacts appear.

Wavelet-based compression is based on mathematical theories that are over 100 years old. This technology has recently made news due to the combination of improved algorithms and more powerful computers.



Strong demand for DRAM memory, driven in part by users upgrading for Windows 95, will keep DRAM prices high until the second half of 1996, according to Semico Research (Phoenix, AZ, (602) 942-8020). But in the second half of the year, prices should start to come down, and throughout 1996, the price premium for DIMMs over SIMMs should disappear. Average selling prices are for OEMs in U.S. dollars; prices for 4Q95 are estimates. Actual retail prices will be higher.

Digital signal processor (DSP) vendor Analog Devices (Norwood, MA) says one advantage of wavelet compression is that, unlike MPEG, it requires about the same processing power to encode as it does to decode. Because MPEG requires much more processing power to encode a movie, MPEG compression solutions are far more expensive (over $5000) than decoders, which sell for about $70 or less.

Analog says that it will release in early 1996 a wavelet encoder/decoder chip that will sell for under $50. Other companies that are planning to bring wavelet-based products to market soon include Microsoft, which will use wavelet compression in the Microsoft Network and in its Blackbird on-line content development software, and Intel, which will use it in its next version of Indeo.

Another company making wavelet news is the Houston Advanced Research Center (Houston, TX). HARC claims its wavelet compression algorithm, called HARC-C, can achieve still-image compression ratios of about 300 to 1 and video-compression ratios up to 480 to 1. The highest MPEG video compression is about 200 to 1.

"HARC-C gives very good performance in high-end applications, such as HDTV or navigation of 3-D volumetric data sets," says Tom Linehan, a researcher at HARC. But Linehan says it's too early to compare HARC-C to established products, or even to Intel's Indeo wavelet-compression technology.

Richard Doherty, an analyst at the Envisioneering Group (Seaford, NY), a technology performance and assessment consultancy, cautions that HARC-C has not yet been proven commercially. However, Doherty adds that the commercial arrival of wavelets will trigger a review of video-compression alternatives, forcing MPEG and fractal proponents to evolve and improve their systems. "Sony is introducing a smart MPEG encoder, and Iterated Systems is focusing on fractal video at more economical compression ratios than MPEG or wavelets," he adds. Iterated is also investigating the ability of fractals to encode images with added intelligence for use in image searching. —Chris Chinnock

Do you know which CD-recorder is best for you?

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Anyone can sell you a CD-ROM recorder. But can they help you make sure you get the one you need? With so many recorders on the market, PC, Mac and Unix platforms, and over 25 different premastering and mastering software packages available, which one is the best for you?

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DATABASE MANAGEMENT

Swiss Army Knife for Data Replication

Replication is becoming a popular technology among database vendors. Most current databases, however, require identical source and target file structures when they replicate.

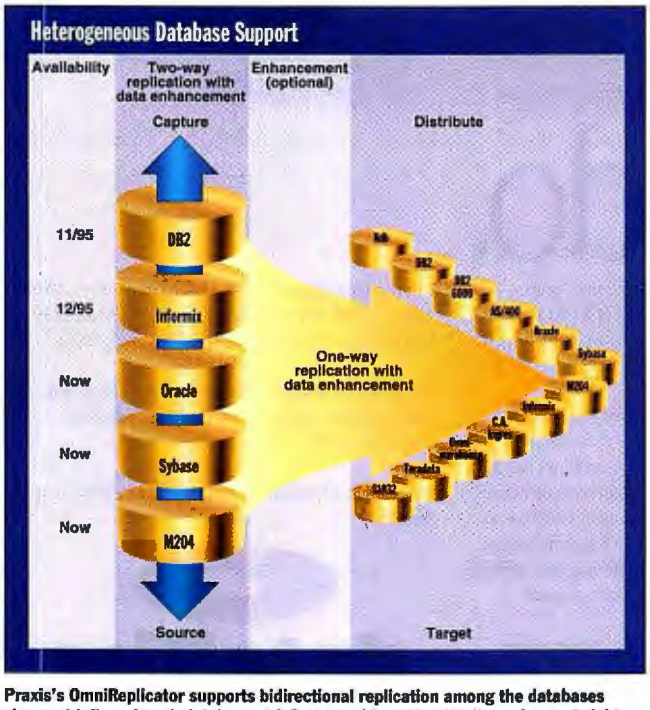
Some databases can replicate to a limited number of other vendors' databases, but most of the time you have to purchase a software-gateway product. These products can cost $100,000 or more, and they don't typically support bidirectional replication. Praxis (Framingham, MA, (508) 270-6666; fax (508) 270-6688) has released a new product, called OmniReplicator.

"OmniReplicator's strength is its ability to replicate among multiple environments, and we have clients that are struggling with this on a day-to-day basis," explains Cathy Hirsh, vice president at American Management Systems (Fairfax, VA), a systems development consultancy.

OmniReplicator supports asynchronous replication and a variety of replication strategies, including master/slave, bidirectional, broadcast, and store and forward. Praxis says its program works efficiently with transaction databases. The package can also "massage" data, performing the necessary conversions (e.g., currency and time/date) as it replicates data.

OmniReplicator currently supports a variety of OSes, but its support is not as strong for desktop databases. However, Praxis officials say the company plans on adding support for more databases, including desktop databases and possibly Lotus Notes, in 1996.

—Dave Andrews



Praxis's OmniReplicator supports bidirectional replication among the databases shown at left, and each database at left can update every database shown at right.

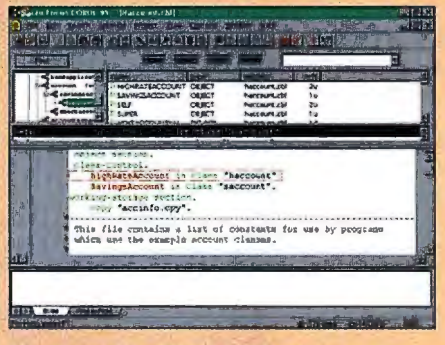
CODE TALK

RICK GREHAN

New Micro Focus Tool Converts COBOL into Components

I am now convinced that my great-grandchildren, should they choose to become programmers, will at least encounter—and may possibly use—some recognizable descendant of COBOL. Micro Focus ((800) 872-6265 or (415) 856-4161, or contact http://www.mfltd.co.uk/win95.html on the Internet) has helped ensure COBOL's long life with its new Visual Object COBOL for Windows 95. This $499 product brings interesting OLE Automation capabilities to legacy COBOL code. From one who does most of his work in C and C++: I am impressed.

I've already written about ANSI's efforts to bring about an object-oriented COBOL (see "Object-Oriented COBOL," September 1994 BYTE). Micro Focus's object COBOL is a "snapshot" of the draft standard, which is not slated for adoption until 1997. With Visual Object COBOL, Micro Focus has inserted its object COBOL compiler into an integrated development environment. And its IDE looks as robust as many I've seen elsewhere.



Micro Focus's Visual Object COBOL includes an integrated development environment that includes a class browser and an editor.

One intriguing capability of this product is its support for OLE Automation. You can use Visual Object COBOL to write a program that can control other programs with OLE Automation server capabilities (e.g., Excel). More intriguing: You can use Visual Object COBOL to convert COBOL programs into OLE Automation servers. This means you can bring business logic that's currently written in COBOL into the new world of OLE and componentware.

Visual Object COBOL for Windows 95 will produce 32-bit executables. It can also generate multithreaded applications. Objects within Visual Object COBOL support inheritance (albeit single inheritance), polymorphism, and late binding.

When I first considered that last fact, I guessed that Object COBOL used late binding only because the syntactical changes necessary for early-binding support would be horrendous. However, Gary Crook, Visual Object COBOL's project development manager, pointed out that late binding is actually an advantage with large-scale development projects. If you make an alteration to an object's method that's early-bound, it's likely you'll have to recompile the entire application. With late-bound methods, you need only recompile the module that's been altered.

Visual Object COBOL arrives with an extensive class library that supports (among other things) all the significant Windows GUI objects: dialog boxes, push buttons, scroll bars, and other controls. What's missing (and what I anticipate in an upcoming release) is a visual builder extension to the IDE that lets you drag and drop your controls into place and automatically backfills your project files with COBOL source code (à la Visual Basic).

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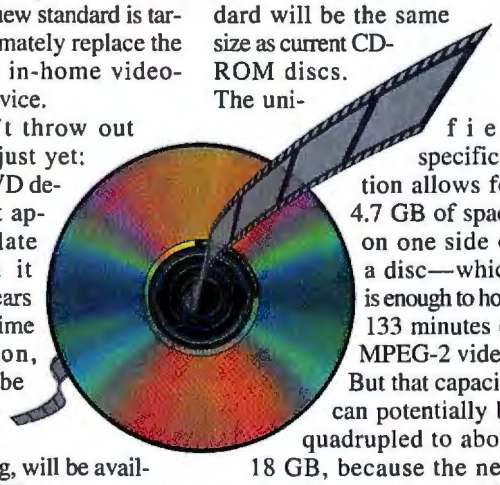
HIGH-DENSITY CD-ROM

DVD May Eventually Threaten VCRs

Two opposing industry factions have reached a compromise on the standard for future Digital Videodisc (DVD) devices, which are expected to replace today's CD-ROM drives. The new standard is targeted to ultimately replace the VCR as an in-home video-playback device.

But don't throw out your VCR just yet: The first DVD devices won't appear until late 1996. And it may take years before real-time compression, which will be required to record TV programming, will be available for DVD at consumer-level prices.



The new standard combines elements of two different proposals. A proposal from Philips and Sony, called Multimedia CD-ROM (MMCD), specifies that future DVD devices will be able to play current CD-ROM discs. A consortium led by Matsushita, Time Warner, and Toshiba favors a higher-capacity specification, called Super Density (SD), that's incompatible with current CD-ROM discs.

Backward compatibility has been incorporated into the new standard: All DVD devices, including TV set-top boxes and computer drives, will be able to read regular CD-ROMs. Also, discs for the new standard will be the same size as current CD-ROM discs. The unified specification allows for 4.7 GB of space on one side of a disc—which is enough to hold 133 minutes of MPEG-2 video. But that capacity can potentially be quadrupled to about 18 GB, because the new standard incorporates double-sided and double-layer options.

The specification calls for four formats in all. Philips and Toshiba officials say the single-sided, single-layer approach will likely dominate as the preferred medium for the first DVD titles, because 4.7 GB is enough to satisfy most computer applications and to run many movies. The other formats are single-sided, dual-layer (about 9.4 GB); double-sided, with single-layer on one side and dual-layer on the other (about 14.1 GB); and double-sided, with dual-layer on both sides (about 18.8 GB). The double-sided option, proposed by the Toshiba consortium, requires you to manually flip the disc.

Double-sided and double-layer technologies are not new, but neither has ever been produced in mass quantities. But neither group anticipates problems with manufacturing the new media. Rob van Eijk, director of recordable products at Philips Key Modules (San Jose, CA), expects the cost of single-sided, single-layer DVD media to be comparable to that for CD-ROMs. He dismisses as pessimistic estimates that double-sided or double-layer discs could cost about twice the price of CD-ROMs.

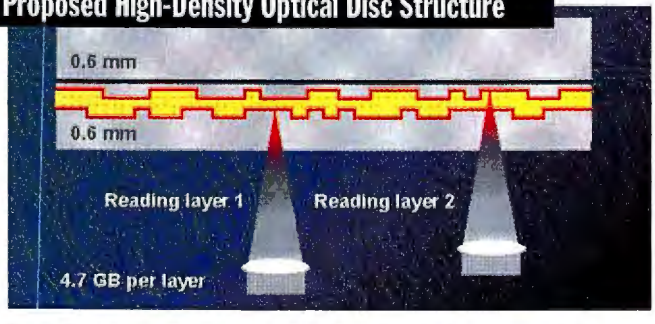
Performance will be another DVD benefit. No benchmarks exist as yet for the new unified format, but van Eijk says that Philips/Sony MMCD drives have a 1.4-MBps data transfer rate (roughly equivalent to a ×8 or ×10 speed), versus about 0.6 MBps for a quad-speed CD-ROM drive.

DVD computer drives will probably arrive in late 1996, shortly after the first DVD TV set-top boxes are released. Officials at Philips wouldn't provide pricing estimates for the first DVD devices, but Toshiba says its eventual target price for a set-top box is $500.

Infotech (Woodstock, VT), a CD-ROM research firm, predicts that more than 2 million high-density CD drives will be sold in 1997, the first full year the technology will be available. The firm also predicts that 60 percent (1.2 million) of those drives will be used in personal computers, primarily for games and reference titles that often require more than one CD-ROM now.

—Michael Nadeau

Proposed High-Density Optical Disc Structure



The unified DVD specification allows the option of bonding two translucent data layers together to allow about 9 GB of data storage per side. The DVD reader merely adjusts the focus of the laser to read a given layer.

Whatever Happened to . . .

The Soldier's PC?
(see "Proposed 'Soldier's Computer' Holds Commercial Promise," August 1991 Microbytes, page 30)

Texas Microsystems originally envisioned a computer that would let foot soldiers view images on a heads-up display. That vision evolved into a rugged, 3-pound, hand-held PC. Company officials say they will continue to investigate new head-mounted-display technologies. However, they add that technologies such as Reflection Technology's Private Eye display don't support high-enough resolutions and couldn't withstand the extreme environmental conditions of a battlefield.

Texas Microsystems ((713) 541-8200; E-mail sales@texmicro.com) plans to release a Windows-based commercial version of the system (see the photo) this year. Initial plans called for a 486DX2 processor running at 75 MHz on nickel-metal-hydride batteries with 8 to 10 hours of battery life.

BYTE saw a preliminary version of the unit, and its transflective 6-inch VGA LCD display was easily readable in sunlight. For global positioning and other applications, the system provides two PC Card slots. Shock resistance is rated at 20 g's (about a 3-foot drop). —D. A.

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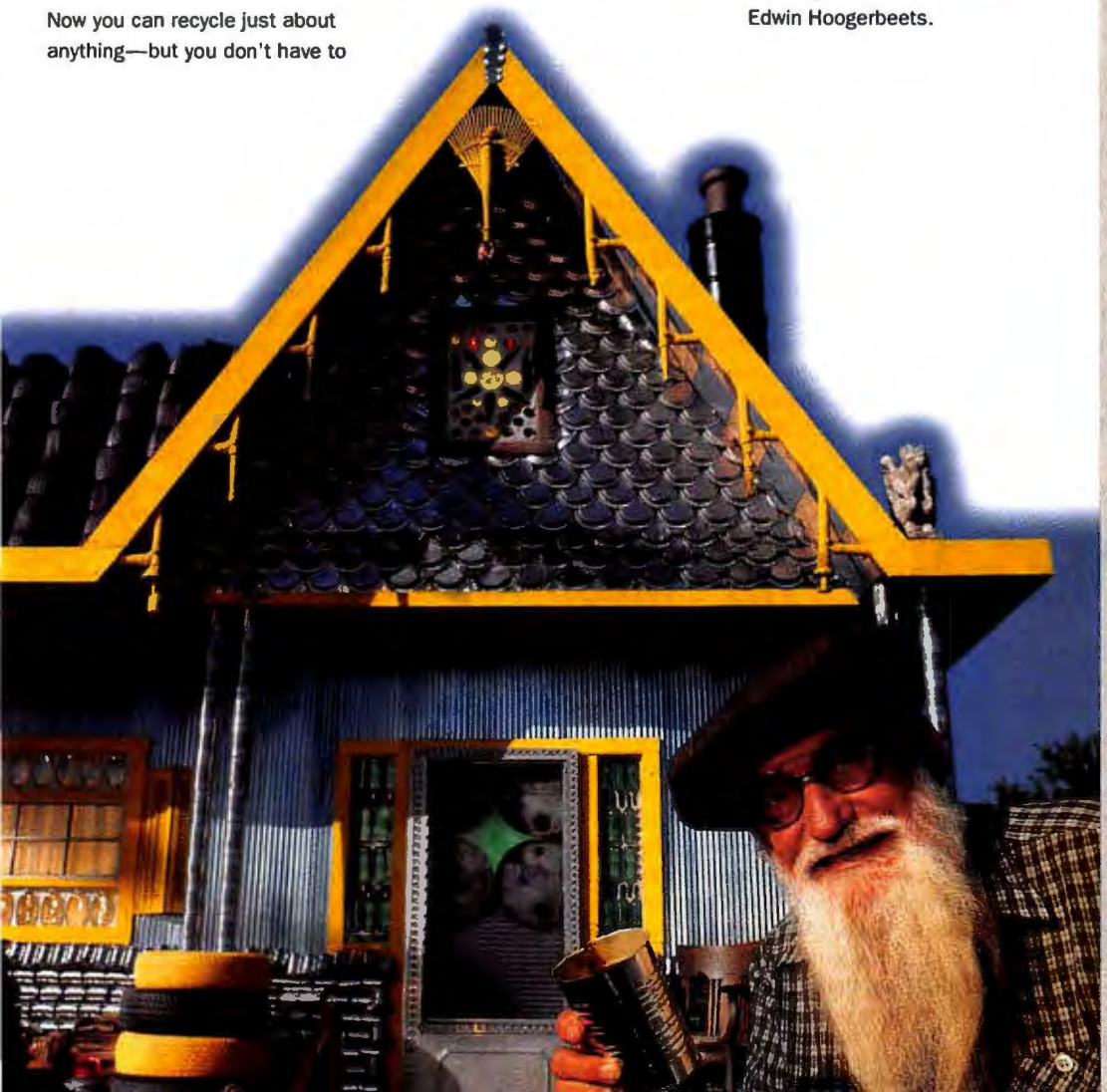

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COMMUNICATIONS

Cable TV Meets the Internet

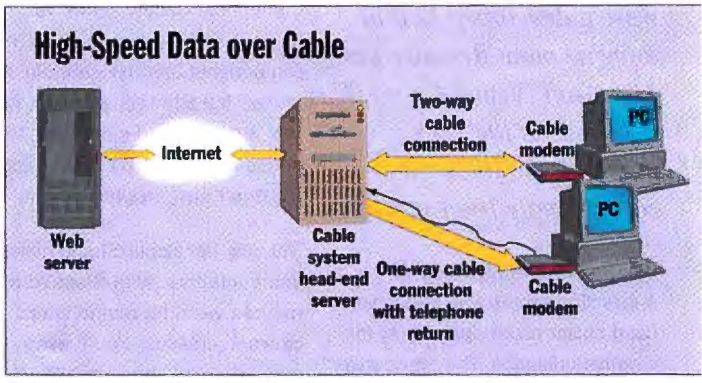
Cable-TV providers, hoping to make money on something besides TV programming, are looking at ways to offer users 10-Mbps access rates into on-line databases or the Internet. The results of these efforts might make 1996 the year of the cable modem.

Cable modems are devices that offer 10-Mbps data-delivery rates over existing cable-TV wiring. Such devices, which include an Ethernet connection to which you attach your PC, connect to the coaxial wiring that delivers your cable-TV signal.

Several cable modems are on the market today, and many more are coming from vendors such as Digital Equipment, Intel, Hewlett-Packard, LANcity, Motorola, and Zenith Electronics. Typically, these modems offer two Ethernet connectivity choices (10Base-T and 802.3) and require an Ethernet adapter card to be installed in the desktop computer. Several of the modems, such as the CyberSurfer, from Motorola, and the LANcity workgroup cable modem, offer advanced features, such as support for SNMP management.

Before you can use these cable modems, your cable-TV provider needs to deliver the appropriate service. Although most cable companies don't currently provide this service, the situation should be remedied soon. Virtually all the large cable-TV providers, including Continental Cablevision, Rogers Communications, Tele-Communications, Inc. (TCI), and Time Warner, either have already launched projects or are currently conducting pilot projects that will deliver high-speed data services to personal computers.

Once these services get launched, power users working from home will be able to enjoy a new level of remote connectivity. For example, access to the Internet at Ethernet rates would far exceed anything most users would ever have available in their office. Anyone who has browsed World Wide Web sites via a 14.4-Kbps modem can understand the appeal of cable modems, which would offer nearly 700 times the delivery rate of current devices.



Cable modems, which include an Ethernet connection to which you attach a PC, connect to the coaxial wiring that delivers your cable-TV service. In systems that don't have the infrastructure to support two-way service, existing phone lines can be used for the return signal.

In addition to Web browsing, another application for these devices is the delivery of high-speed on-line services. Intel estimated that in 1994, 26 million homes already had both a PC and cable service.

Today, the bulk of the exchanges on commercial on-line services and the Internet are E-mail messages. With 10-Mbps bandwidth, service providers could start delivering multimedia applications into the home. Such systems would be capable of, for example, delivering virtual reality and 3-D entertainment.

Or the additional bandwidth could be used to enhance the types of information commonly available today. For instance, a cable-TV provider might offer a live shot of a location linked to a weather report instead of a static, four-year-old photo of a city center with the temperature superimposed over it.

While the appeal of higher-speed access to on-line services is high, there are several roadblocks that might limit deployment of such systems. First, cable-TV providers must support such equipment. Not all cable systems are set up to provide two-way service; some are designed for broadcast only. Such systems will require you to use an existing telephone line for the return signal.

Second, they must partner with Internet-service providers and other information providers to make the system work. To ensure that equipment from different vendors and service providers offers a common way to connect and use high-speed services, CableLabs, an R&D consortium of cable-TV system operators, will help these operators to test and evaluate different vendors' equipment.

—Salvatore Salamone

PROCESSORS

Coming: More-Powerful Notebooks

The performance gap between Pentium desktops and mobile Pentium notebooks should shrink this fall, thanks to Intel's new 120-MHz Pentium for mobile computers.

Like Intel's other mobile Pentiums, which run at 75 and 90 MHz, the 120-MHz Pentium employs voltage-reduction technology to run at 2.9 V internally as it talks to other components at 3.3 V externally. However, the 120-MHz version is the first mobile processor to be built on Intel's 0.35-micron manufacturing process, which allows for a 3.3-million-transistor chip that's about the size of your pinkie fingernail.

The new chip has a typical power dissipation of 2.5 to 3.5 W while in use, and less than 1 W while idle. Vendors (e.g., Intel) have developed new, complementary, high-performance Peripheral Component Interconnect (PCI) chip sets.

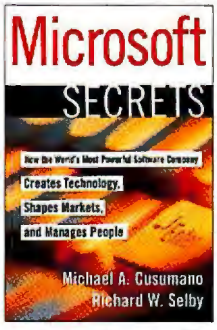
Look for many notebook vendors to announce 120-MHz Pentium-based portables this fall. "The 120-MHz Pentium brings mobile systems closer to being true desktop replacements," says Jason Glover, portable marketing manager at Gateway 2000. "It delivers better performance at equivalent heat and power dissipation as previous mobile Pentiums."

How Microsoft Works

RUSSELL KAY

Microsoft Secrets is just like one of Microsoft's own software applications: It tries to say everything there is about its subject, it's full of interesting ideas implemented with varying degrees of success, and it's so big that it sometimes gets in its own way. Just look at the subtitle.

Cusumano and Selby document what's responsible for Microsoft's commercial success, describe its procedures for developing software, and discuss how Microsoft manages its people and periodically restructures itself. There's a wealth of detail on how Microsoft operates.



Perhaps the most revealing segment describes the synch-and-stabilize process by which Microsoft controls software development. If you've never worked on a mammoth programming team (and I haven't), this is an eye-opening look at how to schedule, organize, and track a big, multiperson, multilayer, multiyear project.

The heart of the process lies in integrating, every day for applications and slightly less often for system software, all newly completed and debugged program modules into the existing code base. The idea is that on any given day, a product team always has a working code base that could conceivably ship. The product may not yet have all its planned features, some sections might not run efficiently, and parts of the program may not work together as well as desired. But this process gives Microsoft a complete, up-to-the-minute snapshot of the product in process—and it's tested code that runs.

To make such frequent builds possible, every programmer works one-on-one with a tester to find bugs before checking code back into the master library. As an incentive to keep new code bug-free, Microsoft teams impose penalties for "breaking the build"—ranging from a $5 fine to wearing goat horns to taking over responsibility for creating the daily builds until someone else breaks it.

My major criticism is that the authors fail to recognize Microsoft's unique nature. Instead, they attempt to use Microsoft as a model for what every software company could and should be. They extract strategies and guiding principles from Microsoft's success that sometimes sound downright silly. Their very first principle is: "Hire a CEO with a deep understanding of the technology and the business." It's not exactly earthshaking advice, and it bears no relation to how Microsoft's CEO got where he is—the company has never hired a CEO.

The book also points out many Microsoft mistakes: a preoccupation with features over architecture, too many specification changes, a focus on user activities rather than behavior, and too little appreciation of product interdependencies. These have led to such miscues as the massive underestimates of development time for successive Windows versions and the failure to anticipate problems with MS-DOS 6's SmartDrive caching and DoubleSpace compression. The authors note organizational deficiencies, including weak middle management and an over-dependence on Bill Gates's leadership and vision.

But Microsoft has its strengths, too: comprehensive testing, a willingness to reexamine goals and change course, and a dogged pursuit of new markets. These will be crucial in a future where OSes disappear from view, customers are less technical and more consumer-oriented, and growth will come largely in global markets. ■

MICROSOFT SECRETS: HOW THE WORLD'S MOST POWERFUL SOFTWARE COMPANY CREATES TECHNOLOGY, SHAPES MARKETS, AND MANAGES PEOPLE

Michael A. Cusumano and Richard W. Selby
The Free Press
ISBN 0-02-874048-3

$28

Russell Kay is a BYTE technical editor. You can reach him on the Internet or BIX at russellk @bix.com.

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You've probably never set foot inside the Museum of Bad Art, possibly because it doesn't exist. But that little technicality certainly won't stop you from enjoying the Virtual Museum of Bad Art (MOBA), the funniest CD-ROM satire I've ever seen. Using a mouse, you can wander from room to room, eavesdrop on staff and visitors, and view the artwork itself (which is not a particularly recommended option).

There's a guy bemoaning having been stood up on a blind date at the museum and gradually becoming aware of the painting that's in front of him ("This is really bad."). A connoisseur extolling the virtues of the frames ("A good frame, and you're halfway there."). Some pseudointellectuals discussing the remarkable variety of styles by Unknown (the artist who has the most pictures hung at MOBA). There's even a gift shop, where clicking on an item produces an order form to fill out.

Is the merchandise real? Is any of it real? How do you create a tour of someplace that doesn't exist? The art is definitely real—plucked from various trash heaps over the years by curator Scott Wilson and director Jerry Reilly and usually on display in Reilly's basement—and hung temporarily in various Boston locations to be photographed along with visitors and staff played by the "Friends of MOBA."

I had to fiddle around a good bit to set up and run the CD-ROM, and the graphics were sometimes posterized—all of which seemed to blend with the charm of MOBA itself. Do you expect perfection at MOBA? This is the perfect gift for that artsy—or antiartsy—friend. Real or imaginary or somewhere in between, MOBA is a hoot.

—Edmund X. DeJesus

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Nine ways to make your code more reliable

HOW SOFTWARE DOESN'T WORK

Alan Joch

The next time you board a plane, try not to think about this: Flight Simulator running on your notebook may be more reliable than the software that keeps planes from colliding in midair. That's because the FAA's air-traffic-control system still uses software from the 1970s. It runs on a vacuum-tube IBM 9020e mainframe that dates back a decade earlier. This system contributed to almost a dozen failures at air-traffic-control centers in the past year, including unnerving back-to-back breakdowns on July 23 and 24 in Chicago, the Santa Monica Freeway of the skies.

For more than a decade, the FAA has been working to replace this antiquated system. Sadly, the alternative, the Advanced Automation System with its million-plus lines of code written since the early 1980s, is riddled with bugs. And six years late. Computer scientists from two leading universities have had to comb

PHOTOGRAPH: TODD BUCHANAN © 1995

How to Build Reliable Code

OLIVER SHARP

The first thing to understand: It is hard to build complex software that works well. In the search for salvation, or what software engineer and author Fred Brooks calls the silver bullet, many people look to models, techniques, and tools. Once upon a time, the solutions were structured programming and high-level languages; now, they're applications builders, componentware, and object-oriented-programming (OOP) techniques. However, evangelists for all these solutions ignore an uncomfortable truth: Reliable software can be written using gotos and assembly language, and truly dismal code has been produced using impeccably modern tools and techniques.

The reality is that one factor completely dominates every other in determining software quality: how well the project is managed. The development team must know what code it is supposed to build, must test the software constantly as it evolves, and must be willing to sacrifice some development speed on the altar of reliability. The leaders of the team need to establish a policy for how code is built and tested. Tools are valuable because they make it easier to *implement* a policy, but they can't define it. That is the job of the team leaders, and if they fail to do it, no tool or technique will save them.

One reason that quality often takes a backseat is that it is not free. Reliable software often has fewer features and takes longer to produce. No trick or technique will eliminate the complexity of a modern application, but here are a few ideas that can help.

Fight for a Stable Design

One of the worst obstacles to building a good system is a design that keeps changing. Each change means redoing code that has already been written, shifting plans in midstream, and corrupting the internal consistency of the system.

The problem is that often nobody knows what the program should do until there is a preliminary version to run. An excellent strategy is to build mock-ups and prototypes that potential users can start working with early, so that the design settles down as soon as possible. Once designers hammer out the basic structure of the system, any changes that aren't critical should wait until the next version. This is a hard line to hold, but the closer developers can come to it, the better off the code will be.

Cleanly Divide Up Tasks

When designing a complex system, divide the work into smaller pieces that have good interfaces and share the appropriate data structures. If you get that right, you can make many bad implementation decisions without ruining the overall design and performance of the system.

Object-oriented languages can be a useful way to express and enforce the decomposition strategy, but they don't tell the designer how to do the job. It is infinitely better to have a good design implemented in C than a poor one in C++.

Avoid Shortcuts

Programmers often don't take time to fix a design error as the code evolves. Those decisions can come back to haunt everyone. Avoid shortcuts by insisting that each one is carefully documented. The pain of writing something up can act as a useful deterrent.

Use Assertions Liberally

An assertion is simply a line of code that says, "I think this is true. If it isn't, something is wrong, so stop execution and let me know right away." If a value is supposed to be within a certain range, check first. Make sure that pointers point somewhere and that internal data structures are consistent.

Just like other debugging code, you can compile assertions out of production code before it enters final testing stages. There is every reason to litter your code with assertions. You will find problems quickly, making them much easier to track down.

Use Tools Judiciously

Tools are not a panacea—they can't help you fix a project that is being administered badly. But tools can make it easier for development teams to put good policies into effect. Source code management tools, such as the public domain RCS or PVCS from Intersolv, help you coordinate modules being used by multiple developers.

There are also some tools that can find certain errors in your code instead of forcing you to do it. The Unix utility

9 Ways to Write More-Reliable Software

- ✔ Fight for a Stable Design
- ✔ Cleanly Divide Up Tasks
- ✔ Avoid Shortcuts
- ✔ Use Assertions Liberally
- ✔ Use Tools Judiciously
- ✔ Rely on Fewer Programmers
- ✔ Diligently Fight Featuritus
- ✔ Use Formal Methods Where Appropriate
- ✔ Begin Testing Once You Write the First Line of Code

through it to see if any code is salvageable. Faced with software that's too unreliable to trust in life-and-death situations, the FAA must rely instead on its old and collapsing—but well-understood—air-traffic-control system.

Unfortunately, this isn't the only example of unreliable software:

Item: In the summer of 1991, telephone outages occurred in local telephone systems in California and along the Eastern seaboard. These breakdowns were all the fault of an error in signaling software. Right before the outages, DSC Communications (Plano, TX) introduced a bug when it changed three lines of code in the several-million-line signaling program. After this tiny change, nobody thought it necessary to retest the program.

Item: In 1986, two cancer patients at the East Texas Cancer Center in Tyler received fatal radiation overdoses from the Therac-25, a computer-controlled radiation-therapy machine. There were several errors, among them the failure of the programmer to detect a race condition (i.e., miscoordination between concurrent tasks).

Item: A New Jersey inmate escaped from computer-monitored house arrest in the spring of 1992. He simply removed the rivets holding his electronic anklet together and went off to commit a murder. A computer detected the tampering. However, when it called a second computer to report the incident, the first computer received a busy signal and never called back.

We've known for decades that software is too complex to develop without adequate quality control. Books, conferences,

lint (or the turbo-charged version offered in Centerline's Code Center) will find syntax errors and mismatches between different source code files. Purify, from Pure Software, and BoundsChecker, from NuMega Technologies, catch a wide variety of memory errors when they occur, rather than when they manifest themselves later on. Other tools perform regression tests or do code-coverage analysis to see if there are dusty corners of your program that are not being exercised.

Rely on Fewer Programmers

An easy way to reduce the number of bugs in a project is to cut down on the number of people who are involved in it. The advantages are less management overhead, less need for coordination, and more contact among the team members who are building the system.

You can reduce the number of people by having individual programmers produce code more quickly or by reducing the amount of code that needs to be written. CASE tools, applications builders, and code reuse are all attempts to meet one or both of these goals. While these products don't always live up to their promise, they can simplify a project so that a smaller team can handle it.

Oliver Sharp is the director of consulting services at Colusa Software (Berkeley, CA). You can contact him on the Internet at oliver.sharp@colusa.com.

Five Easy Steps Toward Disaster

Although there are an unlimited number of ways you can foul up a programming project, here are a few particularly popular ones:

1: Pile on the Features

The easiest way to ruin a program is to add a whole series of features to it without enough time to integrate them properly. Under heavy time pressure, the natural tendency is to glue the new functionality anywhere you can, without thinking about how you're affecting the core design of the program.

After you have done this several times, the resulting program becomes a diffuse and unwieldy collection of modules, and nobody understands how they interact. Making any further changes requires an act of faith.

2: Target Heterogeneous Environments

It is hard to support the kind of hardware and software variations that are common in the PC industry. Because no organization can try every possible system configuration, programs refuse to install, run poorly or not at all, and interact unpredictably with other applications.

Here are two ways to make the problems worse. First, take undocumented shortcuts that probably will not be supported in future releases. Second, don't bother to follow the standard interface guidelines of the system. This ensures that users and other programmers are confused.

3: Test Inadequately

Because formal proofs won't eliminate bugs anytime soon, careful testing is the only way to be sure that a program works correctly. Consequently, disaster aficionados should delay systematic product testing until coding is almost finished. At that point, programmers can't easily undo faulty design decisions, and it's hard to isolate bugs.

4: Document Poorly

Most programmers don't like to write documentation. This is a real aid to disaster because good notes on the basic internal systems design are valuable when it's time to update. Reliability will result if development team leaders make sure programmers write the documentation and keep it up to date.

If the documents do go out of date, whatever you do, don't schedule extra time to clean them up at the end of the project. If you're a disaster seeker, you can take comfort in the fact that memories will fade quickly when programmers move on to a new task.

5: When In Doubt, Vacillate

The team leaders should avoid clearly defined project specifications and change specifications whenever pressure to do so strikes.

RICHARD GOLDBERG © 1995

and formal methods prescribe ways of coping with the complexities of software development: Plan. Sweat over the design specification. Isolate critical functions. Document the development process. Comment your code. Test extensively, both the individual components and the interworkings of the entire system. Independently validate the product. Include backup systems. Eat your vegetables.

Why don't we do all this? Because it's expensive. Each line of the space shuttle's flight-control software costs NASA contractor Loral about $1000, or 10 times more than for typical commercial software. Would you buy a word processor or a spreadsheet for $5000, no matter how bug-free it was? Or would you rather pay 90 percent less and live with the bugs?

Clearly, the commercial market has spoken. But users of business-critical software demand that we carefully weigh the trade-offs between delivering a program and assuring reliability. Software developers will always make mistakes, but a slow, careful—and costly—development process can minimize them (see the text boxes "How to Build Reliable Code" and "Five Easy Steps Toward Disaster").

There are three important battles developers must fight. Managers and customers often find it extraordinarily difficult to specify how a proposed program is supposed to perform. Second, commercial pressures and tight deadlines practically guarantee chaos during the development process. Third, no program is immune from featuritus. Even if the drive for high quality motivates managers and programmers, an ever-expanding features list keeps program specifications in flux and compounds the chances for introducing bugs.

continued

Often, the first breakdown in quality control occurs before developers write a single line of code. The New Jersey murder case illustrates how hard it is to write a comprehensive specification. The computer that detected the inmate's tampering correctly reported the action to the second computer. But no one responsible for the software required that the call had to be redialed if there was a busy signal.

C. FATTA © 1995

"Tools are so volatile, and platforms are moving all the time," says Roger Blais, manager of software process improvement at Tasc, a systems integrator. "But if you have a process in place, you have a glue that you can always count on."

When commercial pressures produce crises that masquerade as projects, people often cut corners by skimping on testing. This was the case with the telephone example. DSC Communications chose not to retest because it wanted to give customers a new feature *right now*.

One of the most celebrated cases of featuritus happened in 1993, when Silicon Graphics, Inc. (SGI) released version 5.1 of Irix with over 500 serious bugs. Management had pushed for a new OS, a new user interface (UI), better compilers and tools, and new multimedia features—everything in version 5.1 was supposed to be better. No sacrifices were to be made. But nine months before the release, when morale was low and the bug count high, two senior engineers pointed out the impossibility of the task. Management responded by hiring two contractors who were strangers to SGI's software and organization.

"The desperate attempt to do everything caused programmers to cut corners, with disastrous effects on the bug count," said Tom Davis, principal scientist, in an internal company memo. It described the struggle and lamented the OS's bloated code, sluggish performance, and unrealistic memory requirements.

SGI's schedule imposed a code freeze before code was stable, which resulted in a familiar problem. "We're trying to wrap up the box before the stuff inside is finished, and then trying to fix things inside the box without undoing the wrapping," the memo said. Energies are diverted at a key moment, as everyone looks for ways around the rule that says they can't change things anymore. But sometimes they must make changes.

Either way leads to a familiar crisis: the meeting in which features are cast out of the release. In the SGI case, the company exiled entire applications wholesale, but it was too late to do much good. "We bit off more than we could chew," Davis concluded. "As a company, we still don't understand how difficult software is."

Adding to SGI's problems, the memo leaked to the Internet. The response was revealing: fan mail. Davis received scores of messages from similarly beleaguered developers, and the software community as a whole tacitly owned up to the problem. This reaction helped remind salespeople at SGI's competitors that they were not immune to similar charges.

Despite the embarrassment, the memo may ultimately prove a boon to SGI because the author spoke so passionately about quality. And support came from a key corner. "The instant the [software] release hit the street, customers started screaming.... It helped management read the memo with an open mind," says Davis.

SGI responded with a six-week software summit for all departments: engineering, management, testing, marketing, manufacturing, documentation, and field service. It invested in integrated measurement tools and ensured they'd be documented and always available. The company identified process bottlenecks and upgraded equipment.

Librarians came on-board to ensure that project documentation was up to date. Managers received software-development books. SGI sought ways to integrate quality assurance throughout the development process. The direct costs: tens of thousands of dollars for new tools, hundreds of thousands of dollars yearly for new staff, and inestimable millions of dollars in additional engineering time.

What SGI did *not* do in the aftermath is also interesting. It didn't mandate any specific new type of development process. Instead, the groups chose the tools and methods they thought best. The result: Version 5.2 fixed bugs, improved performance, and added no new features. Version 5.3 added a few strategically chosen features.

Managing Chaos

While SGI learned its lessons the hard way, other companies look to a variety of techniques and tools to save them from bug-infested nightmares. Most business software isn't as life-critical as the digital flight-control system in Boeing's 777. Nevertheless, Boeing's development process illustrates how a firm managerial hand can help every company fight featuritus.

About 400 people spent five years working on the Boeing 777's flight-control software. Jim McWha, the Boeing Commercial Airplane Group's chief engineer for flight-control systems, worked hard to make sure the 777 team got the requirements right. To ensure that errors were caught early, when they're cheaper to fix, the 777 team solicited input from all the key people in the life of a jet—everyone from pilots to manufacturing personnel. They evaluated the results of simulations for a year in the laboratory and another year in the "iron bird," a full-scale mock-up of the airplane. Boeing's goal was to have a complete specification before developers wrote any code.

McWha also resisted cancerous growth of the wish list once coding started. To

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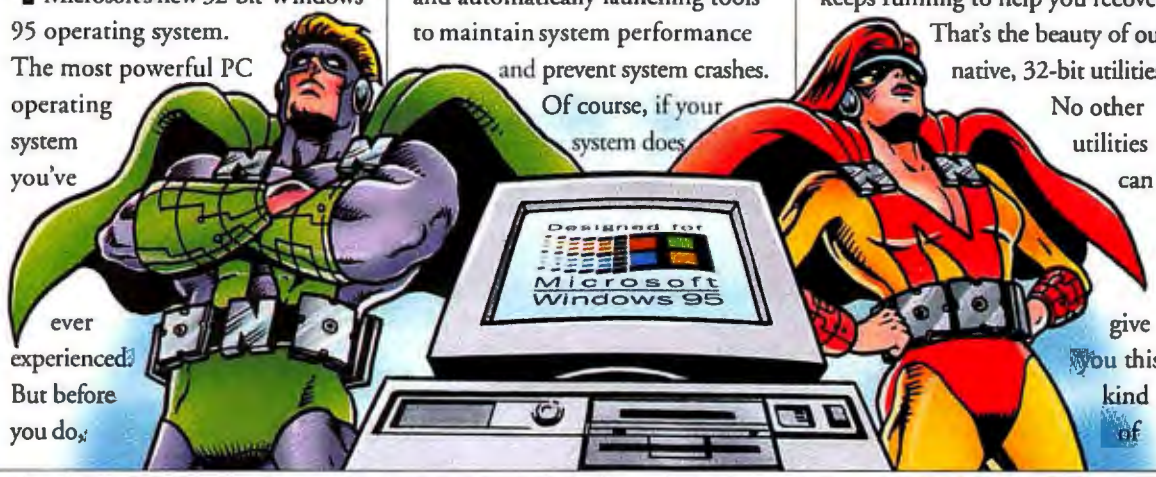

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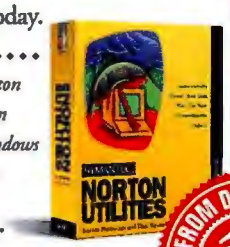

FROM DAY ONE NORTON FOR WINDOWS 95

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Make Quality Job 1

JOHN MONTGOMERY

Creating reliable software is hard. Creating it consistently sounds like something you do with eye of newt and a bubbling caldron. But it's not: It's a product of the management of process, methods, and tools—basic quality management. Applying concepts from total quality management to software engineering isn't new, but adopting a complete structure for this application is just becoming popular.

Supermodel

One of the leading structures comes from the Software Engineering Institute (SEI) at Carnegie Mellon University (http://www.sei.cmu.edu/). The Department of Defense sponsored the SEI with a charter to "advance the practice of software engineering." One of the prime areas of SEI's focus is process, and the lens it uses is the Capability Maturity Model (CMM).

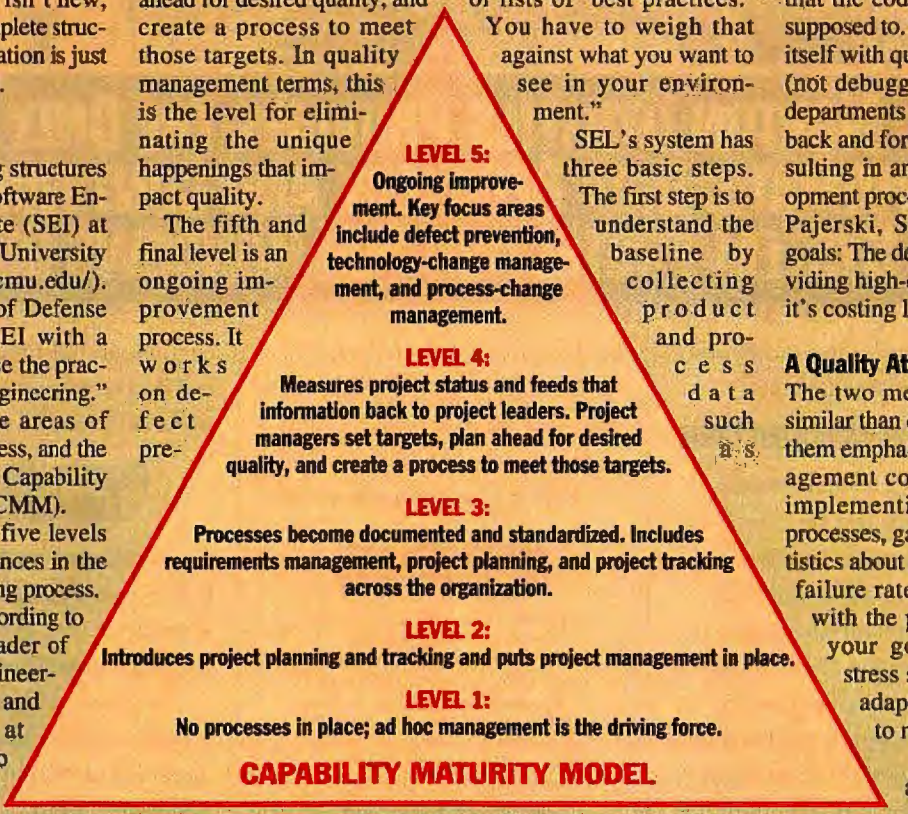
The CMM has five levels that describe advances in the software engineering process. The first level, according to Dave Zubrow, leader of the Software Engineering Measurement and Analysis Team at SEI, "is really no level—there's no real process at all, and everything is pretty much done ad hoc."

The second level implements processes that make software engineering repeatable. It introduces project planning and tracking, and, most important, it gets project management in place.

The third level documents and standardizes processes at an organizational level. The keys of this level are requirements management, project planning, and project tracking across the organization.

The fourth level focuses on product and process quality—being able to take measurements about what's happening and feed that information back in a way that project leaders can react to it and use it to make improvements across the organization. At this level, project management can set targets, plan ahead for desired quality, and create a process to meet those targets. In quality management terms, this is the level for eliminating the unique happenings that impact quality.

The fifth and final level is an ongoing improvement process. It works on defect prevention, technology-change management, and process-change management. Says Zubrow, "The idea is to proactively make changes to your software engineering environment to become more efficient and effective."



NASA's Three Rules

SEI's model isn't the only one. For 20 years, the Software Engineering Lab (SEL) at NASA's Goddard Space Flight Center (http://fdd.gsfc.nasa.gov/seltext.html) has been working on improving software quality. Where SEI's CMM takes a top-down approach and works with processes and practices, SEL assumes "that each organization is unique, and because of that, we don't think there is a set of universal practices," according to Rose Pajerski, director of SEL. "There are lots of lists of 'best practices.' You have to weigh that against what you want to see in your environment."

SEL's system has three basic steps. The first step is to understand the baseline by collecting product and process data such as error characteristics and also more subjective information (e.g., what mangers think). This step culminates with identifying improvement opportunities and setting clear, measurable product goals. The second step is to experiment with the process and assess the impact of the experiments on the product. The third step is packaging, where SEL pushes the baseline data, experiment results, and updated process into the organization.

SEL has applied its method to itself. Its business goals were to improve software-development and testing processes and reduce its budget. The practice it employed was a software clean room. The clean room's goal is to build error-free software through statistical quality control.

This means, among other things, that development and testing occur separately—developers rely on peer review and code reading to ensure that the code does what it's supposed to. Testing concerns itself with quality assessment (not debugging). These two departments pass information back and forth frequently, resulting in an iterative development process. According to Pajerski, SEL reached its goals: The developers are providing high-quality code, and it's costing less.

A Quality Attitude

The two methods are more similar than different. Both of them emphasize quality management concepts, such as implementing repeatable processes, gathering hard statistics about elements such as failure rates, and working with the process to reach your goals. And both stress setting goals and adapting the method to meet them.

These ideas aren't new—they've been around at least since Philip Crosby penned *Quality Is Free* in 1979. So why isn't everyone implementing them? The answer is attitude. An understanding of how to achieve quality must permeate an organization. "People are looking for silver bullets.... But it's about instilling a new discipline," Zubrow concludes.

John Montgomery is BYTE's features editor You can reach him on the Internet or BIX at jmontgomery@bix.com.

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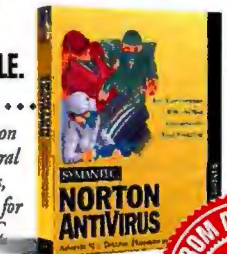

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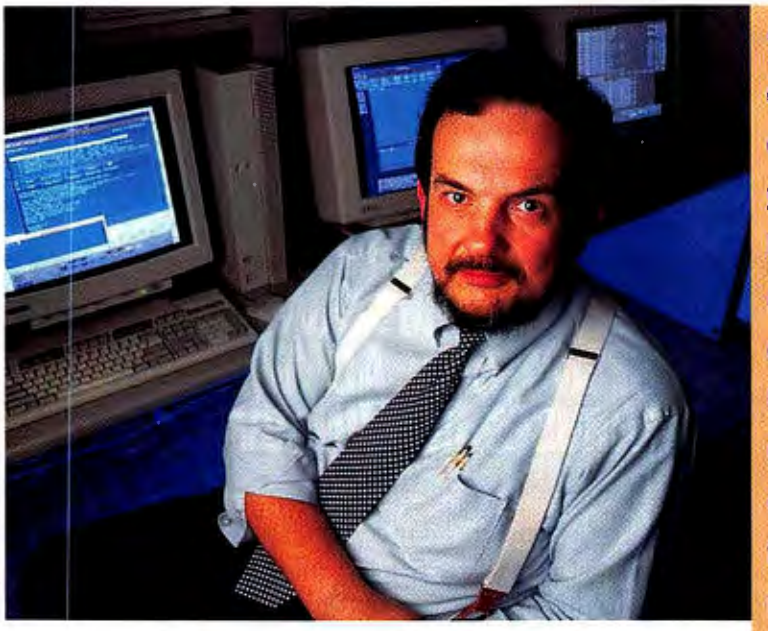
hold the line, Boeing set up review boards to evaluate every change request; it refused about half of them, but credit undoubtedly goes to McWha's air of authority. He's a no-nonsense guy; a large sign on his desk reads: NO! (What part of this don't you understand?).

Most educational was the approach it abandoned. Boeing contracted with GEC Marconi Avionics to write three versions of the flight-control software, each to execute in its own lane. Working from the same requirements, three groups (who were not supposed to communicate with each other) coded in Ada, C, and PL/M.

The strategy, called *n-version programming*, is that if each lane executes code written by different minds, errors in one lane will be eliminated by the other two lanes. In practice, n-version programming is no magic bullet; independently written programs tend to have trouble in the same spots. The hard parts are hard for everybody. Boeing eventually decided to refocus its resources on these areas.

The three groups proceeded independently for about 18 months before the approach became more pain than it was worth. The systems people had to communicate continually with three software teams without influencing their directions. Developers found it almost impossible to keep code in the three lanes synchronized, leading to nuisance disconnects.

Finally, expertise became too valuable to squander—skilled people needed to be working together, not separately. So members of the C and PL/M teams joined the Ada team or took on testing or verification chores. The three lanes now use dissimilar processors and different compilers, but one group produced the code.



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"It's the minor changes that can come back to bite you," says Tom Milkowski, a manager of software development at Dow Jones Telerate. He expects a code review every time a programmer makes a change, no matter how minor, to the code.

Formal Methods

Some developers address reliability with the Capability Maturity Model (CMM) from Carnegie Mellon University's Software Engineering Institute. The CMM rates software-development processes on a five-level scale (for details on this and a NASA quality model, see the text box "Make Quality Job 1"). Items that are considered in the CMM range from how unambiguous specifications are to whether a program's reliability receives independent verification. A level 1 rating means the organization practices ad hoc chaos; level 5 identifies superlative discipline from management and engineering.

"It's hard to argue with the CMM," says Roger Blais, manager of software process improvement for Tasc, a government and private-sector systems integrator in Reading, Massachusetts. The company has used the model for five years and is in the process of being CMM-certified by a Software Engineering Institute–accredited evaluator. Blais believes the CMM is valuable because it puts importance on the process of software development. "Tools are so volatile, and platforms are moving all the time," he says. "But if you have a process in place, you have a glue that you can always count on."

But nothing is perfect. Space-shuttle software developers claim to be doing everything recommended by the CMM. Even so, the program has experienced numerous software problems, including errors on *Discovery* that made it improperly position itself for a laser-beam experiment over an observatory in Hawaii.

Additional help against development chaos comes from formal methods designed to bring scientific principles to a largely creative process. Blais says formal methodologies play key roles in helping Tasc make products ranging from document management to avionics systems. The company builds most of its applications for Windows and Unix using C, C++, or Visual Basic.

Customers sometimes specify that a formal methodology be used. Other times, Tasc uses a variant of the spiral-development life-cycle methodology, a model for iteratively combining pieces of a project as they evolve. Blais says spiral development is valuable for its ability to provide a framework for each project. The framework helps when requests surface for changes to the design specification.

Tasc also relies on Atria's ClearCase, a software-configuration management tool, which Blais calls the core of Tasc's development efforts. It tracks changes to code, records which programmers made the changes, and analyzes how the changes impact other areas of the program. This information helps the company manage releases and "keeps everyone honest," according to Blais.

Testing Is Everything

Other companies use quality assurance as the key tool for producing reliable software. It's never too early to think about testing, according to Tom Milkowski, a manager of software development at Dow Jones Telerate, a financial-services company in Jersey City, New Jersey. "As you're writing code, you should be creating tests. If you put an IF statement in the code, you should make a note to test this call while it's fresh in your mind," he says.

Milkowski helps manage 35 developers who are building a real-time system based on HP-UX to deliver financial information to the company's clients over a private WAN. In the past 18 months, the development staff has written about 800,000 lines of C and C++ code. At the system's rollout, slated for next April, the

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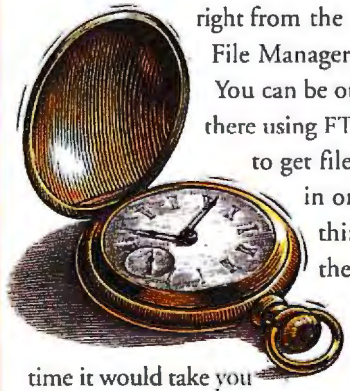

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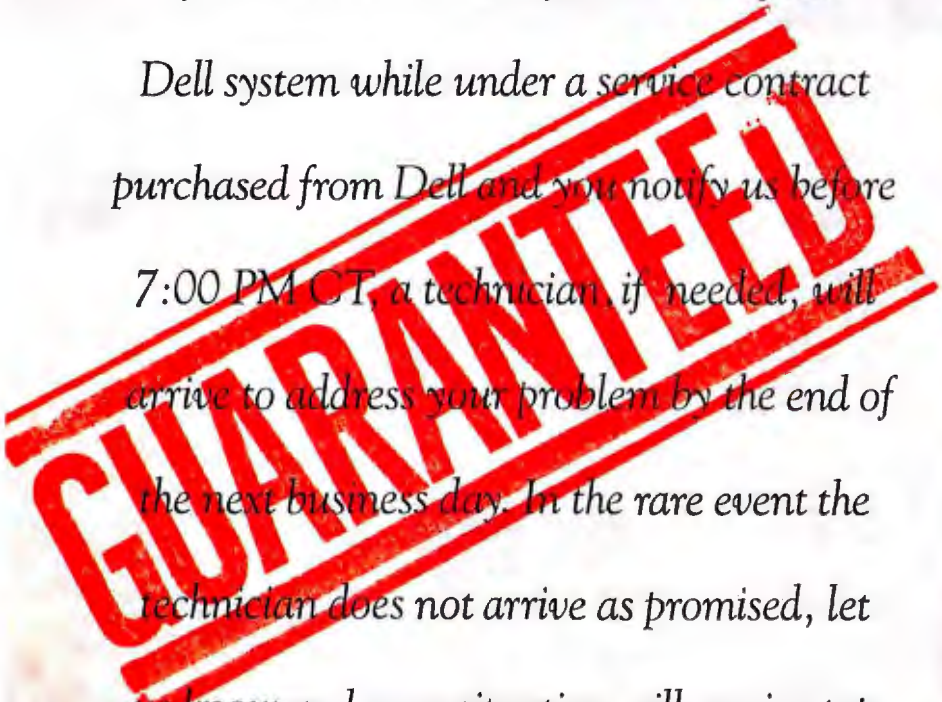

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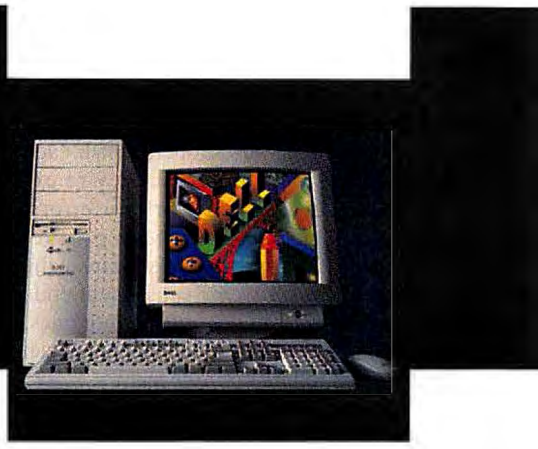

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intel inside pentium PROCESSOR

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program will consist of about a million lines of code.

When Telerate developers finish each component in the program, they're expected to review their work for errors. Next, each module undergoes a code review, where other developers evaluate the code. Milkowski wants subsequent code reviews if any changes, even minor ones, are made. "It's the minor changes that can come back to bite you," he says.

But the complexity of Telerate's financial-information system makes testing a challenge. For example, Telerate designed one of the four servers to handle 120 or more concurrent clients at a transaction rate of 1000 per second. Some of the servers in the system have 1 GB of RAM. Developers can write code that accesses memory anywhere in that gigabyte of space. "Everything is potentially so interconnected through RAM, there's almost a limitless opportunity for problems," says Milkowski.

He relies on his "tool bag" to reduce these opportunities. Hewlett-Packard's SoftBench and the Discover Development Information System, from Software Emancipation Technology, analyze legacy code to build structure diagrams and help the staff decide what code is reusable. If a module's call functions are longer than a page or two, Telerate developers start to worry. The more complex the code is, the greater the likelihood of a defect. "The tools help us focus our attention on the appropriate modules during our code reviews," Milkowski says.

REFERENCE SHELF

Code Complete: A Practical Handbook of Software Construction by Steve McConnell. A comprehensive overview of software-development techniques that help produce robust and reliable code.

Computer-Related Risks by Peter G. Neumann. An excellent discussion of why computer programs often fail. It is filled with anecdotes from Neumann's tenure as the moderator of the Usenet Risks group.

Fatal Defect: Chasing Killer Computer Bugs by Ivars Peterson. A comprehensive look at real-life cases when life-critical computer systems failed.

Safeware: System Safety and Computers by Nancy Leveson. A thorough introduction to risk analysis and other techniques for building programs that can endanger lives or cause a great deal of damage if they fail.

Wicked Problems, Righteous Solutions by Peter DeGrace and Leslie Hulet Stahl. An irreverent look at software development models such as the waterfall and the spiral. The book is seasoned with critical comments on how they work in practice.

To find memory and resource leaks, the staff uses Purify, from Pure Software, and Sentinel, from AIB Software. Also important are test-coverage analyzers, which help make sure that the tests Telerate creates exercise all the code. Iterative tests of each program component give useful feedback on the quality of the code, but developers still won't know how well the entire system will work under real-world pressures. When it's time to simulate heavy-load conditions, Telerate uses client-loading tools such as Empower, from Performix, and LoadRunner, from Mercury Interactive, to run multiple clients and processes according to preset schedules.

Tools such as these make the testing of complex programs possible, but the tools are not problem-free. It takes a lot of work to get them running right, Milkowski concedes. Also, managers must budget for additional support costs in the form of systems-administration staff and training for the people who use the tools. "But in most organizations, it's easier to get money for tools than for more programmers," he says.

Adobe Systems (Mountain View, CA) also uses testing as an early-warning system. Marc Aronson, the director of Adobe's Software Productivity Group, established a testing strategy that builds the interpreter every night and runs it on several print engines that Adobe designed for testing. The system uses a subset of the standard QA test suite, and it logs errors. Because the programming environment tracks code changes made since the previous day, programmers know where to look when a new problem crops up.

Although in-house testing is the first line of defense, a thorough beta-testing program can be invaluable. Some programs, like Windows 95, attract enough interest that there is no shortage of testers.

America Online also finds it easy to get volunteers. Mike Fairbarns coordinated the beta-test process for the Macintosh version of the code. The company categorizes each user response depending on whether it is a suggested improvement or a bug catch. It further divides the bugs into types and sets priorities to identify the ones to address most urgently.

The Cost of Complexity

No tool or methodology provides the perfect answer to creating great code in an imperfect world. But legal and ethical consideraations aside, making software as reliable as possible from the beginning has become a mantra among developers. It's good business. As Dow Jones Telerate's Milkowski points out, if a bug costs a dollar to fix when it's discovered by a programmer during code generation, it will cost $1000 if no one finds it until the program ships to the end user.

Still unclear, however, is whether quality-from-the start programming means software will become more reliable or whether developers will merely keep from falling backward in the face of ever-ensnarling complexity. ■

Oliver Sharp also contributed to this article.

Alan Joch is a BYTE senior editor. You can reach him on the Internet or BIX at ajoch@bix.com.

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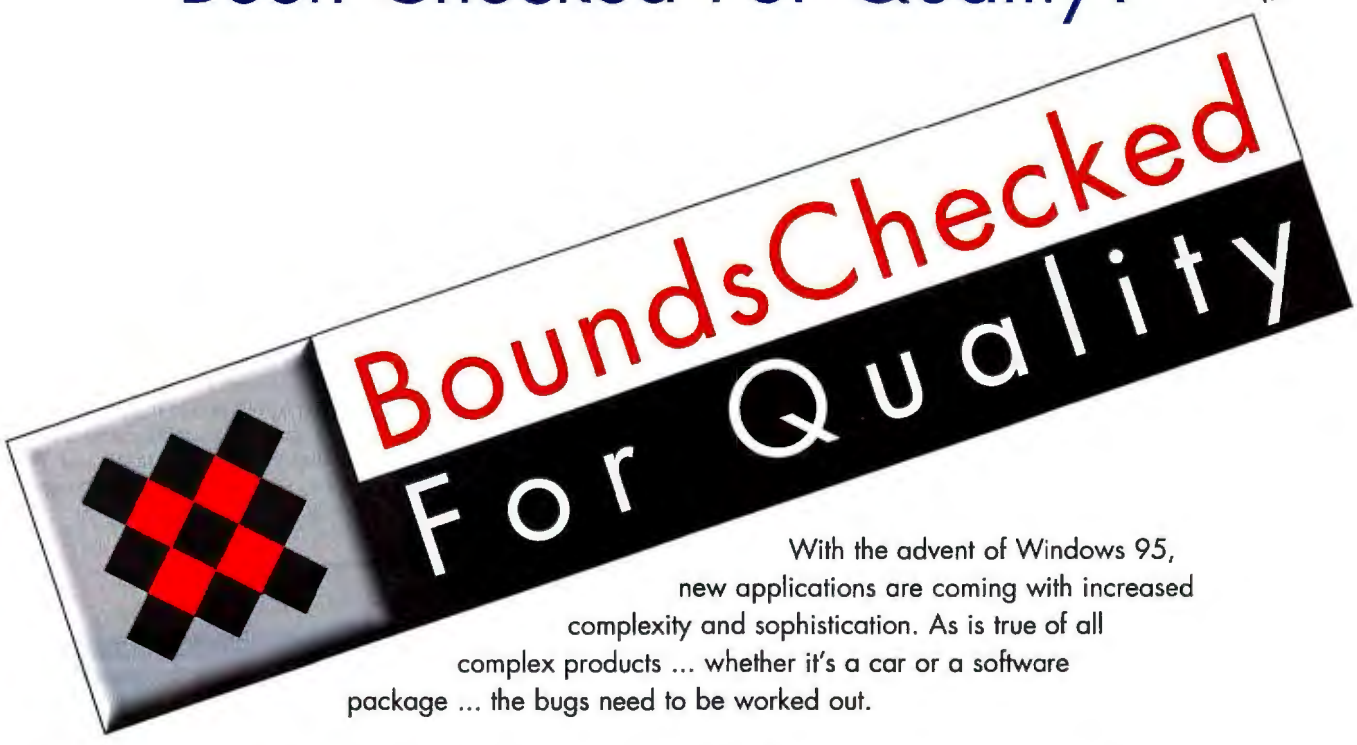

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Circle 242 on Inquiry Card (RESELLERS: 243).

MANUFACTURING DATA

New systems for data acquisition supply the senses, nervous systems, and brains needed to monitor and control manufacturing operations

Data acquisition is the sensory input to the nervous system and the brain of the modern automated factory. The greatest productivity gains from the ongoing computer revolution have been in factories. Computers now span the factory from top to bottom, from performing high-level planning and scheduling to controlling the actual machines of production.

Although computers are everywhere within a factory, that doesn't mean they can all communicate with each other, or even that there are necessarily connections between them. Rather, computers in a manufacturing environment are like a chain of disconnected islands. The milling machines don't talk to shipping; planning doesn't talk to the warehouse.

A manufacturing execution system (MES) provides the nerve connections among several levels of factory computing, including machine-level data acquisition and high-level planning and scheduling. In "A Fine MES," Jim Esch shows how systems that bridge this existing gap can provide information that is valuable—some would say indispensable—to the factory as a whole. These systems have open architectures and mesh with many existing software solutions.

Manufacturing often means dealing with hundreds, even thousands, of separate parts. How can we automate the process of keeping track of the technical specifications of so many components? One solution is the use of bar codes. But these aren't just the little lines on your package of waffles from the grocery store. The new generation of bar codes is *two-dimensional* and packed with information about each component. Bert Moore gives a brief tour of these 2-D wonders in the text box "A New Dimension in Bar Codes."

Data acquisition methods are the senses of the factory. To gain full use of this sensor data, we have to channel it from its source to a database or a network. This becomes a problem with mile-long factories or remote facilities. It would be a tad expensive to string miles of cable to some remote site just to gather sensor data, as valuable as that data might be. That's why some new techniques of mobile data acquisition are becoming so popular.

Data acquisition cards are now available in the PC Card form factor. Pairing such miniature input ports with rugged notebooks running ordinary DOS and Windows—or with specialized handheld computers—yields a mobile data acquisition platform of great flexibility. In "Keep the Data Moving," Claire Tristram traces each link in the chain, from sensors to factory database.

If MES is the nervous system, and data acquisition is the sensory apparatus, then AI is the brain of a factory. For many complex industrial processes, including chemical and petrochemical operations, situations change too rapidly and unpredictably for mere humans to keep track of and control them.

Fortunately, several types of AI, including expert systems, fuzzy logic, and neural networks, are proving able to handle such control tasks. By learning what to do in various circumstances, monitoring conditions using data acquisition, and responding with the speed of modern computers, AI systems are controlling many of the most complex industrial operations. In "If AI Ran the Zoo," Lawrence Gould shows us how.

With such smart and feeling factories, manufacturers fully expect to continue the quest for more efficient and consumer-responsive operations. ■ **—Edmund X. DeJesus, Senior Editor**

A Fine MES
Manufacturing execution systems unite factory computers from planning level to machine level.....67

If AI Ran the Zoo
AI techniques have the ability to monitor and control complex manufacturing processes.....79

Keep the Data Moving
Rugged mobile computers and PC Cards simplify data acquisition in factories and remote sites.....87

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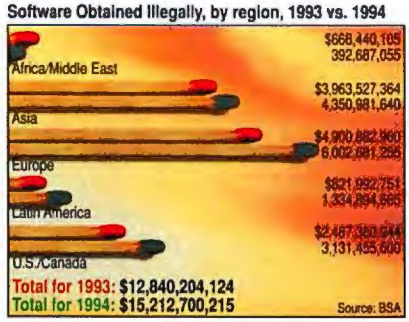

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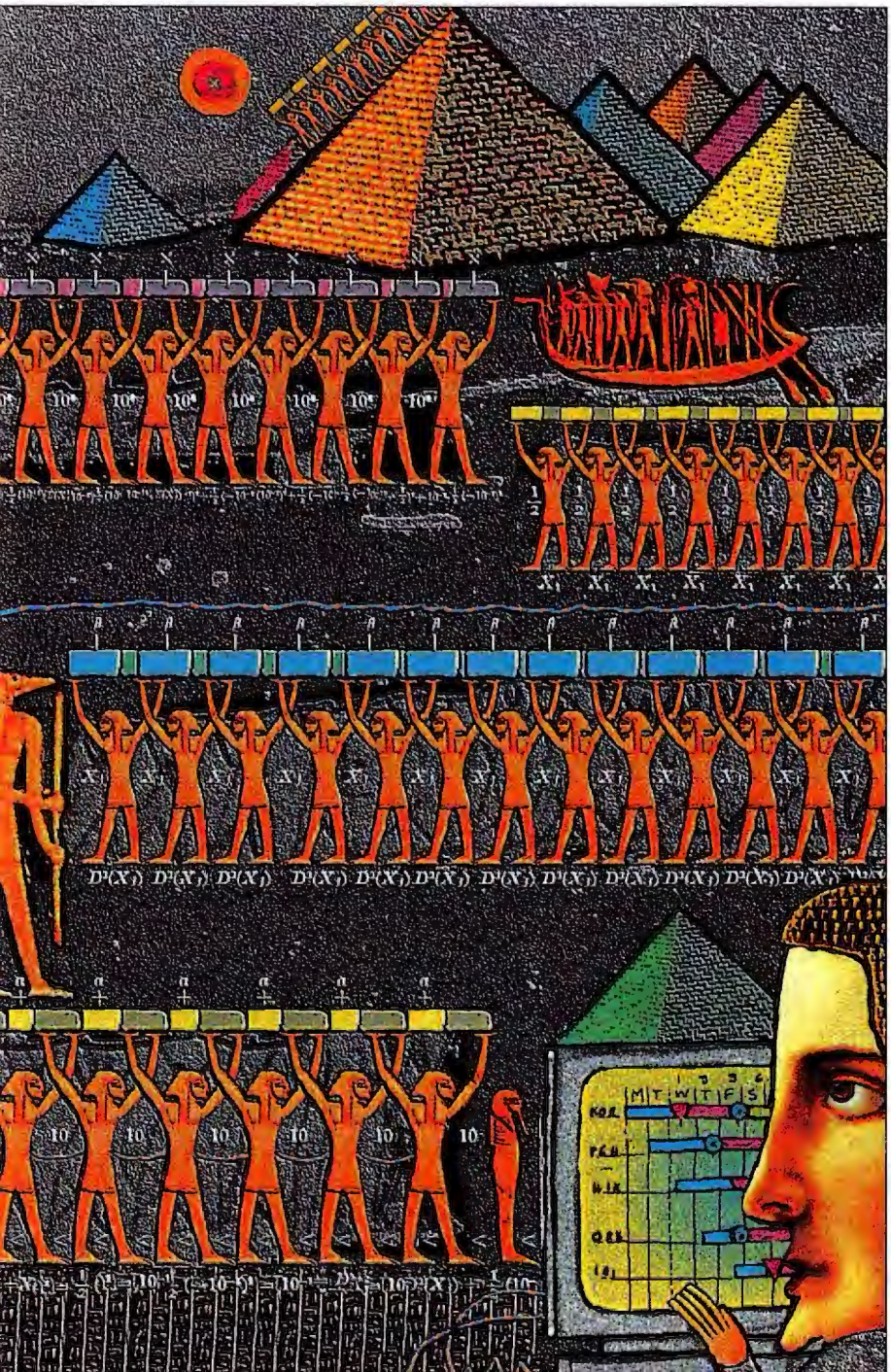
A FINE MES

Real-time manufacturing execution systems bridge the gap between planning and the plant floor

JIM ESCH



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Welcome to a typical day on the factory floor: Chris went home sick. The red-widget bin is empty. Jan can't find the all-important metric pliers. Hey, wasn't this run supposed to come out larger than the others? Piece by piece, a carefully constructed production schedule is coming apart. Again. And poor, unsuspecting Lee up in Planning is already hard at work on tomorrow's plan.

Planning systems are good at accounting functions. But in the real world, we know what happens to the best-laid plans: They gang aft agley. Sometimes way agley. Neither material-resource planning (MRP) nor manufacturing-resource planning (MRP II) were designed to respond to real-time data as it happens on a shop floor.

Although enterprise or material planning systems could create a shop schedule weekly or even daily, as the workday wears on and nothing goes as planned, you wind up tracking all the variables on wall charts, notepads, or departmental PCs. "[As a result,] people were just juggling balls," says Tom Allen, vice president of sales and marketing at Effective Management Systems. "So, there's always been an informal system to do this—but the informal system by definition doesn't have everybody in the loop, and it can't possibly react on a timely basis."

Thus, a rift opens between the planning and production stages. What's needed is an execution layer to ensure that the plans coming from planning systems actually get done and, if they don't, to make sure that the planning systems are notified and updated. That's where a manufacturing execution system fits in.

An MES manages the key elements of production—materials, equipment, personnel, process instructions, and facilities. An elaborate tracking system, it bridges a company's planning layer with its shop-floor-control layer. An MES distinguishes itself by its underlying attitude to the data

it receives: It focuses on the product rather than on materials or processes. While it gathers data on all productive resources, its purpose is to historically track how products are being made on the floor.

Core Technology

The heart of an MES is typically a SQL-capable relational database. Such a database stores several types of information: material-tracking data, statistical quality-control data, equipment- and labor-tracking data, product and raw-material inventory data, laboratory data, process data, and plant documents. The MES adds computer-aided systems-engineering tools and often supplements them with document management tools, statistical process-control tools, and statistical quality-control tools.

An MES usually employs a standard GUI. For example, Consilium's FlowStream uses OSF/Motif, and Georgetown Systems' Lookout uses Windows. MES interfaces tend to be highly customizable, and therefore well-suited to their heterogeneous users.

An MES typically builds on an open client/server architecture to enable it to sit comfortably amid the systems already installed. The most common networking topology is Ethernet running TCP/IP, especially at mid- to large-size plants. High-volume MESes, managing plants that employ hundreds of workers or more, usually run on Unix servers, such as the HP 9000 series, Sun SparcStations, and Digital Alpha–based systems—with either X Window System or PC clients. Windows NT is also emerging as a viable MES platform.

MES in the Middle

Acting as a sort of "middleperson," an MES interfaces to a distributed control system (DCS), a supervisory control and data acquisition (SCADA) system, or a process-control system, as well as planning systems—all in real time (see the figure "Data Flow from MES to Shop Floor" on page 70). The DCS feeds data (via SQL) to the MES about the status of job completion, raw-material performance, labor,

A New Dimension in Bar Codes

Bert Moore

Even the most powerful process-control computers can't control what they don't know about. But the traditional method of tagging pieces and parts as they wend their way through the manufacturing process—the venerable bar code—doesn't work when the size of the bar code is substantially larger than the part itself.

Enter 2-D bar code symbologies. Able to encode up to 2000 characters in a single symbol measuring no more than a few square inches, these efficient symbologies offer new possibilities for automated data collection in manufacturing. Companies are currently exploring and implementing 2-D symbols for item identification, lot/batch tracking, production history, safety information, and even machine programming.

For manufacturing-data collection, the two leading symbologies are Data Matrix (developed by International Data Matrix) and PDF417 (developed by Symbol Technologies). Both symbologies are already in use, are in the public domain, and have recommendations from draft-industry or national standards.

SmithKlein Beecham is using Data Matrix to comply with new FDA regulations that require verification of label content for all pharmaceuticals, including over-the-counter medications. The UPC bar code on such a product identifies the product but does not indicate the label content. The Data Matrix symbol, meanwhile, has both.

The semiconductor industry has selected Data Matrix for wafer tracking during production. In addition, a draft Electronics Industry Association (EIA) standard recommends it for component marking and Automotive Industry Action Group (AIAG) production history. Data Matrix may become the symbology of choice for all small-parts identification.

Despite obvious damage, this PDF417 symbol is still readable.

The automotive industry is also interested in PDF417 for production-history documentation. A single PDF417 symbol can contain up to 2000 data characters and still take up no more than a few square inches (the actual size depends on the options selected). Volvo is using this symbology in Sweden to program manufacturing-testing equipment, and Casappa S.p.A. in Italy uses it to enter data into automatic engraving equipment. In addition, the U.S. Department of Energy uses PDF417 for Material Safety Data Sheet information on drums of hazardous waste.

Data Matrix is an example of a matrix symbology (see the photo at right), which uses fixed-size light and dark elements (typically squares) to represent data characters in a predetermined arrangement. Matrix symbols require special imaging readers (typically linear or 2-D charge-coupled devices [CCDs]) but need less contrast, which makes them ideal for molding, etching, or casting into an item.

PDF417 is an example of a stacked bar code, which is just that: short bar codes stacked on top of each other, with special bar code characters in each row to indicate its sequence within the symbol. As with regular bar codes, symbols can vary in length and height. Stacked bar codes offer the advantage of being readable with many existing bar code readers and CCD imagers.

The major 2-D symbologies all provide special features, such as full ASCII encoding, multiple ISO code page selection, the ability to append data from multiple symbols in the correct order, and user-selectable levels of Reed-Solomon or convolution codes for error detection and erasure correction to read even badly damaged symbols (see the photo at left).

The Data Matrix symbol on SmithKlein Beecham's Tums label, for FDA compliance.

It's true that 2-D symbologies won't replace UPC symbols in the supermarket or in many other existing applications. Yet for manufacturing-data collection, they offer tremendous opportunities for marking small items or conveying large amounts of data efficiently.

Bert Moore is director of IDAT Consulting & Education, a Pittsburgh-based firm specializing in automatic data-collection technologies. You can reach him at 72620.1677@compuserve.com or IDATconslt@aol.com, or on BIX c/o "editors."

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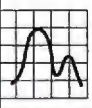

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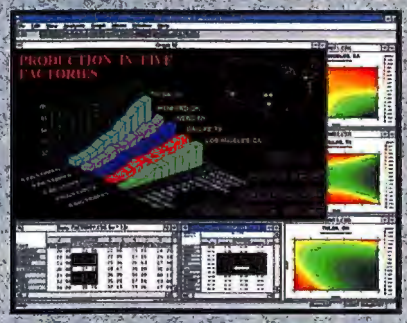
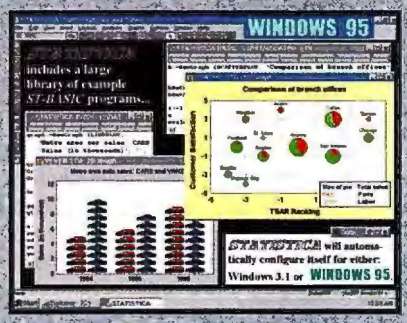
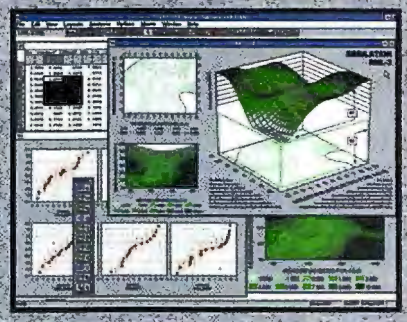
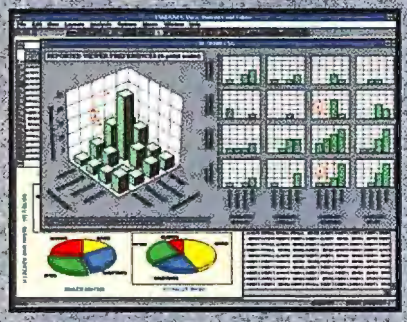
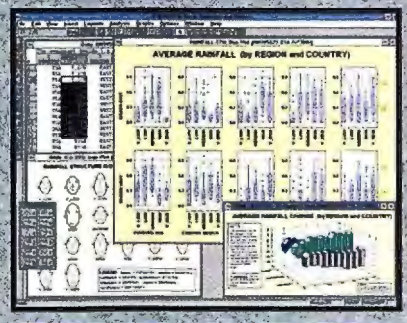
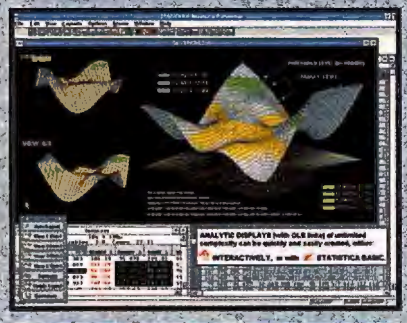


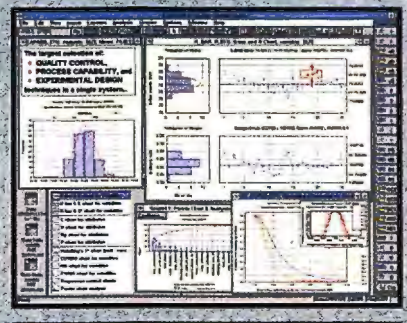


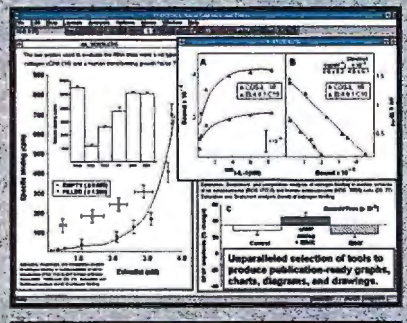


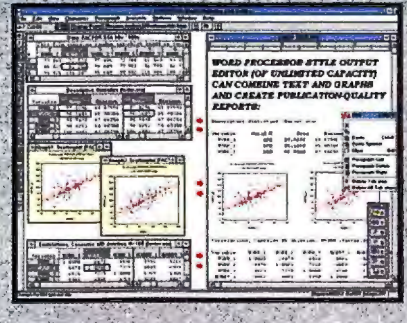


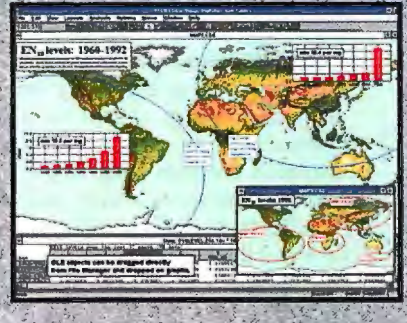












Circle 98 on Inquiry Card.

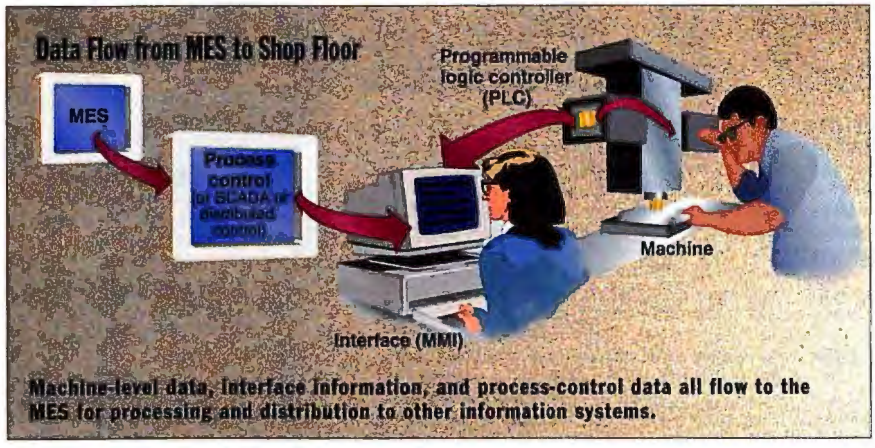
materials, and equipment; the MES then feeds data to the planning system regarding job completion, inventory, regulatory/quality compliance, and operating performance.

Here's a look at the flow of data as it travels through an MES system. For starters, the MES receives its demands from the planning system—a customer orders something or the MRP expresses the need to make more of a certain part, for example. The MES transmits the work order to the shop floor immediately.

At a work center on the shop floor, a terminal instructs a worker to begin the task. The worker logs the start by scanning in a work order's bar code (called *wanding*—see the text box "A New Dimension in Bar Codes" on page 68) or by selecting on-screen the job that is starting. Some MESes include process-control software, while others sit on top of the process-control system. When the task completes, the worker wands-off a bar-coded work order (or selects it on-screen) to indicate that the operation is completed and to report how many units were completed, scrapped, or sent back for rework.

As the worker inputs this information at the terminal, the MES database updates automatically. That information is then available across the plant, and the MES can direct production to continue on the next operation. At some point, data must cross over to the higher-level planning systems. To do this, the MES employs a *gateway*—software that allows data to cross the interface, ensures consistent data flow, and backs up data in case of failure.

At the operator level—which is closest to the factory equipment—there may be a man-machine interface. This MMI integrates the functions of DCSes and programmable logic controllers (PLCs). Opto 22's Mistic Automation system, for example, gives process engineers an object-oriented, fourth-generation language (4GL), flowchart-based control tool called Cyrano. Linked to Cyrano are Mistic's I/O bricks, which perform control functions such as high-speed counting, temperature linearization, and analog alarming.



Machine-level data, interface information, and process-control data all flow to the MES for processing and distribution to other information systems.

The Case for Object Orientation: TI+OO=MES

More and more MES vendors are positioning their products under the object-oriented rubric. This definition includes a host of capabilities: distributed systems, standardized applications tools for user interfaces and database connections, C++ objects that are transportable across architectures, and the use of third-party development tools that are easily extensible rather than proprietary user interfaces.

Take Texas Instruments, for instance. As part of a federally funded research program, the company experimented with object-oriented manufacturing applications. It was so encouraged by the results of the experiments that it applied the ideas to its larger semiconductor facilities in Dallas, Sherman, North Texas, Houston, and Lubbock. The result: an in-house MES called Works MES, comprising seven distinct systems that manage process, planning, scheduling, specifications, materials, equipment, and tracking.

According to Jack Mahaffey, Works product development manager at TI in Plano, Texas, it comes down to one issue: If you're really committed to using the object paradigm to the greatest extent, then "you don't want to distort the designs by forcing a separation of data and methods on your objects," he explains.

Staying true to form, TI selected the GemStone applications server from GemStone Systems to handle the object base. GemStone transparently stores complete Smalltalk objects in the database. "Most of the other object-oriented databases offer some level, some variant to that approach, but none of them is as pure as GemStone," explains Mahaffey. One way to look at it is obvious: In a manufacturing environment, where you're moving products through the factory, the products themselves are the objects.

In a semiconductor-fabrication facility, for instance, the wafer objects, lot objects, and carrier objects contain the complete history of the processing that occurred on each wafer from every manufacturing step. To build a semiconductor device, a wafer will travel through 250 to 400 individual operations or steps where something on that wafer is transformed. "That gives you 400 opportunities to scrap the wafer," says Mahaffey. "It's worth it to maintain a very accurate history of what happened during the manufacturing process."

As the actual wafers move through production, there's a virtual wafer moving through the MES. So, there's a one-to-one mapping between objects in the real world and the objects that your system comprehends.

Integrating the MES

Many companies, especially those in the chemical industry, already have SCADA systems in place, because the processing of chemicals demands a high degree of recipe management and machine-control precision. In such cases, an MES system sits on top of the SCADA system, and the two interoperate. The SCADA system initiates automation and controls the equipment, and it passes process-control data up to the MES system, which maps the data against the current batch.

Some products blend process control, MMI, and SCADA. For instance, Lookout, from Georgetown Systems, offers an object-oriented, event-driven package for PCs that employs a distributed database. Each object monitors incoming signals and sends out signals according to an object's definition, much like the physical controls that it models—switches, push buttons, sliders, and drivers. It logs historical data via SQL to Lookout's Citadel historical database.

Intellution's Fix family of automation software also attempts to cover all bases. After starting with the baseline Fix MMI package, you move up to a networked SCADA product—Fix DMACS (Distributed Manufacturing Automation and Control Software). From there, you migrate up to Fix BOS, a plantwide integration of SCADA and MES. From there, you channel data via SQL interfaces up to the corporate-planning-system layer using ODBC.

The Real-Time Data Challenge

Without reliable, real-time data to work with, however, an MES is useless. The ideal real-time application gathers data from physical sensors, not manual input. It's able to handle data at variable rates. It has many inputs and outputs, which operate independently. And, finally, the

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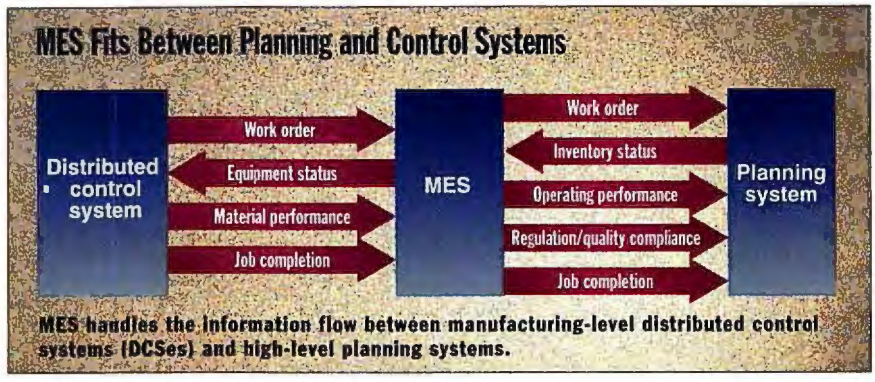
system must perform both responsively and reliably.

Workstream MES, from Consilium, bases its real-time data transfer on a publish/subscribe mechanism: One server publishes a transaction to the message bus, and any other server that subscribes to this message picks it up. This type of system is more efficient than having multiple transactions with the same information submitted to multiple nodes.

What if one of the nodes goes down? A "guaranteed execution" feature ensures that the message is delivered to the target location. "In most manufacturing systems, this is critical. Unfortunately, most manufacturing systems do not have it," says Doug Christensen, technical marketing manager at Consilium.



MES Messages

With so many real-time messages flying around, MES needs a traffic cop. There are several to choose from. Workstream MES's real-time data transfer uses an Equipment Communications server, which exchanges messages between the equipment and Workstream's Script Controller. This, in turn, defines the flow, control, and interaction among host systems, such as the Recipe Management Server and the Quality Server. This is all based on business rules defined by Sematech, which is the government-funded consortium that supports semiconductor-manufacturing research.

You can find another contribution to interoperability in USData's FactoryLink IV software. With FactoryLink, you build multiplatform applications that pull data from all layers of an enterprise through its Open Software Bus architecture. This architecture, analogous to IBM's Open PC Bus, enables you to group application functions into modules.

Hilco Technologies, which sells an MES called real-time Production Management, or rtPM, is addressing the problem of redundant communications between device handlers and MES applications with updated device communications handlers that poll data themselves. The handlers return data that has changed to the applications only. The effect is enhanced communications throughput.

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Benefits of MES

When it works properly, MES directly improves yields, equipment utilization, and schedule performance. Customers talk about shortened lead times, higher returns on investments, and reduction of work-in-process inventories. Manufacturers that are adopting make-to-order, just-in-time, and ISO 9000 methods need to have all the needed information at hand. MES can help.

Still, despite its benefits, MES remains a rather small market. According to Advanced Manufacturing Research (AMR), the integrated MES market was $150 million in 1993, with a projected 40 percent growth in 1995.

One explanation for this might be the fear of complexity on the part of adopters. If you're using scheduling modules on top of an MES, the number of calculations increases as it analyzes cycle times, process times, setup times, equipment-throughput times, product yields, and quantities. Still, the greatest complexity you're likely to encounter is the daunting task of analyzing how your manufacturing process actually works. That's the model on which you build your MES.

In addition, implementation of an MES can be expensive. It's not unusual to encounter costs of $200,000 for a department and $5 million to $6 million for several plants, including hardware, software, maintenance, and training.

Still, maybe it isn't that MES systems are complex or expensive, but only that they're new. These systems are currently where MRP systems were about 10 to 15 years ago. And although MES has officially been around for five years, people are just beginning to accept the term.

Nonetheless, you can be sure that the demand for savings and higher profits, combined with the emerging standards in object-oriented programming and interoperability, will drive future growth in this market. Whether we'll be calling it MES or something else, it's certain that *something* will be performing these functions. ■

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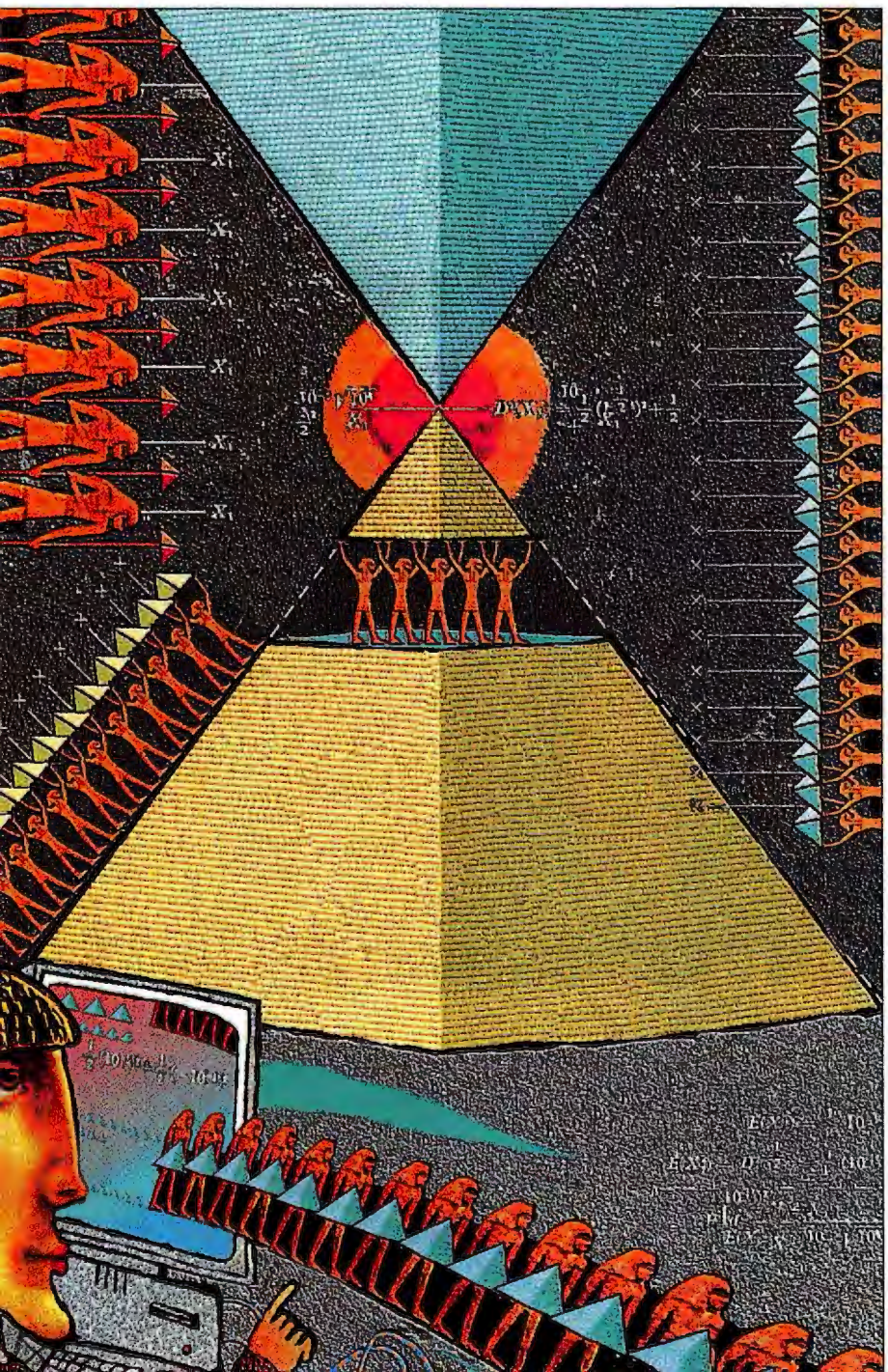
IF AI RAN THE ZOO

Hybrid systems with neural nets and fuzzy logic are controlling complex manufacturing processes

LAWRENCE GOULD



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Machines break. Chemicals react. Devices get stuck. Feed stocks change. Face it: Manufacturing is nonlinear. Interruptions occur randomly.

Controlling—let alone scheduling—processes in the face of such nonlinearities taxes conventional manufacturing control systems. At the same time, products and processes are becoming increasingly complex, cycle times and time-to-market are contracting, and product quality requirements get more demanding every day.

"Using classic linear-control techniques does not yield adequate results, especially in this era of extreme competition," says Mohamad Ali, director of new business development at Neural Applications Corp. "This justifies moving away from traditional linear algorithms and looking toward novel, intelligent strategies capable of coping with such nonlinearities."

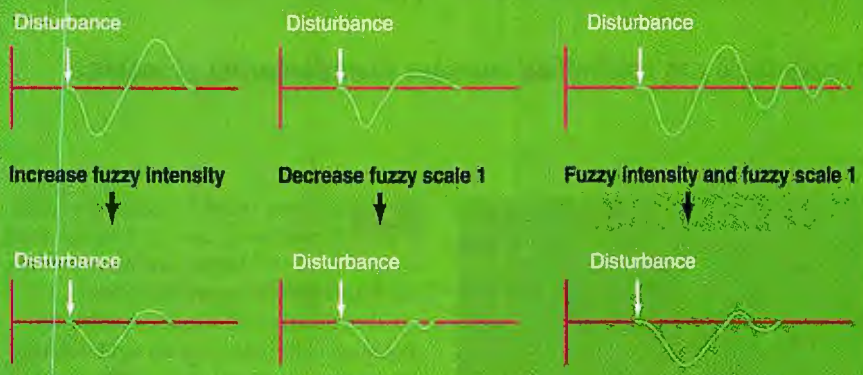
Enter artificial intelligence. Vendors of process-control equipment are developing hybrid AI systems that bundle a variety of AI techniques, including fuzzy logic, neural networks, genetic algorithms, and expert systems. AI is being applied to situations that have resisted control by conventional approaches that use binary logic or proportional, integral, derivative (PID) control, or both.

AI Meets Traditional Systems

The conventional approach to process control uses PID components. These components compare measurement and set-point (desired) values. The difference between measured and desired—error—is the input to the controller. The proportional or integral components respond to the error, while the derivative component usually responds directly to the measurement. The proportional component varies the output percentage, depending on the amount of deviation from a set point. The integral component checks for these offsets and then compensates for them by shifting the

Combined Effects of Fuzzy Adjustments

Omron's E5AF temperature controllers combine advanced PID (proportional, integral, derivative) control with fuzzy-logic control. User-controlled fuzzy parameters improve the response to external process disturbances. Fuzzy intensity governs the magnitude of the fuzzy-logic effects on the final output. *Fuzzy scale 1* governs how big the "error" range is.



Increasing the fuzzy intensity can rapidly correct for large overshoots while minimizing oscillations.

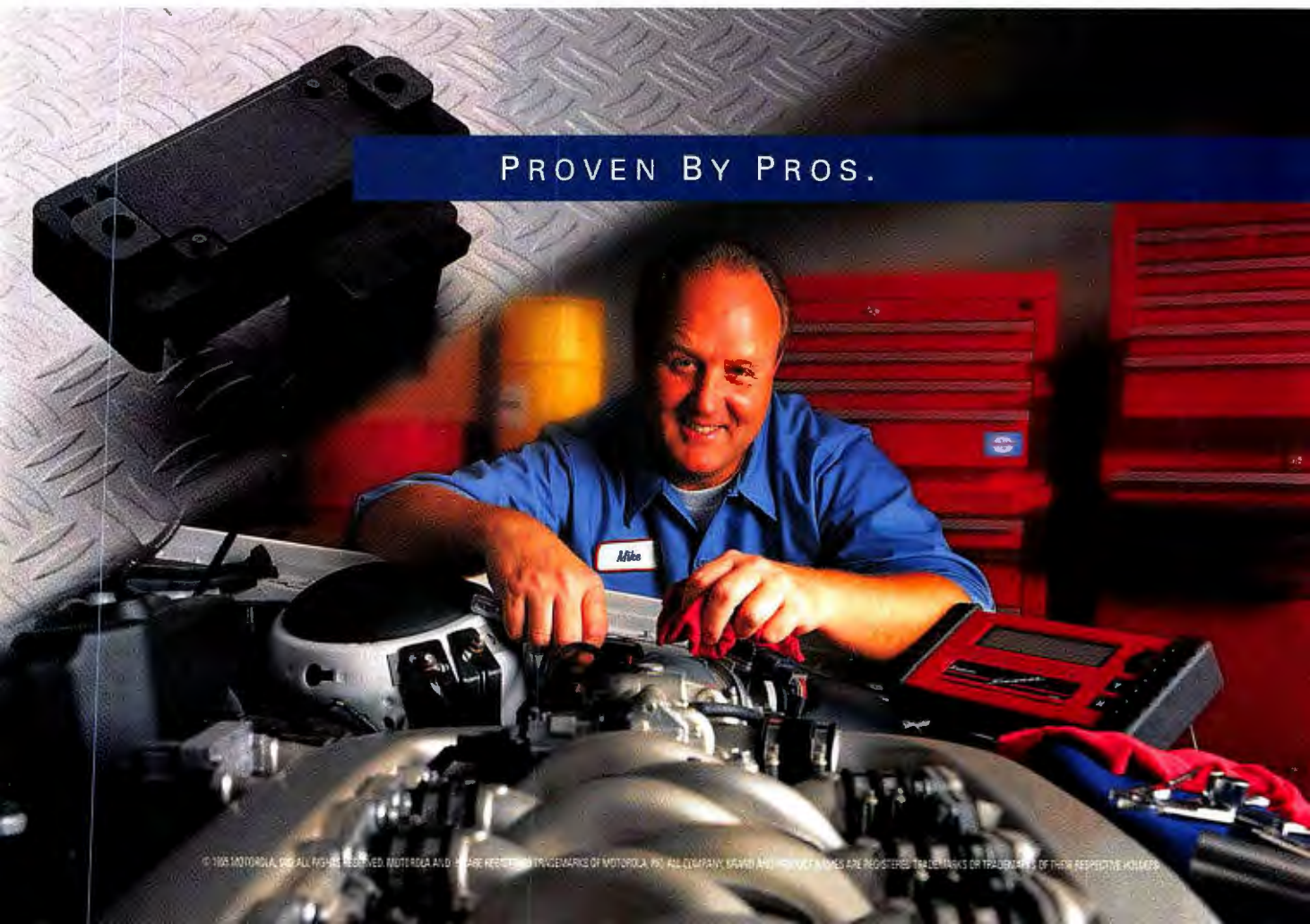
Decreasing fuzzy scale 1 makes the controller more sensitive to error, correcting small disturbances and decreasing time to stabilize.

Combining both parameters corrects large overshoots and quickly stabilizes disturbances.

proportional band up or down. The derivative component increases or decreases the output based on the rate of change of the controlled variables. The sum of the individual P, I, and D coefficients yields the control output.

Now, AI is complementing, and sometimes replacing, PID control. According to Howard Rosenof, manager of process and utilities marketing for Gensym Corp., there are two broad uses of AI in manufacturing. In control and optimization, the plant is working correctly, but the process-control engineer is looking to increase production, speed up operations, and cut costs. In diagnostics, the process-control engineer wants to know, at the earliest instant, when the plant is not operating correctly and how to resolve the problem quickly.

The right AI approach depends on the specific application. Diagnostics typically make use of backward chaining searches (reasoning from the conclusion backward, using subgoals) in expert systems. Prediction uses forward chaining (reasoning from the known toward a solution). Rule-



and case-based logic (expert systems) are usually not suitable to combinatorial problems, such as planning and scheduling problems. Human knowledge is not broad enough for such huge problems, so the resulting expert systems are too slow.

Fuzzy logic mathematically models the world in the vague, subjective way popularized by human beings: It can handle "hot," "cold," "early," "late," and shades of gray, then convert them into numbers supporting conclusions. According to Glenn Anderson, engineering services manager for Omron Electronics Inc., fuzzy logic is well-suited for applications requiring tracking (e.g., set-point control in noisy, nonlinear, and time-variant systems), tuning (handling conflicting constraints), and interpolating (dealing with multiple-input, multiple-processing levels).

Neural networks are a step up from fuzzy logic systems. Neural nets are based on mathematical models that not only collect information but "learn" (adapt to changes) from actual system operations. Neural networks help to identify patterns: If a process engineer knows *what* works but not necessarily *why* it works, neural networks can help. Neural network applications include forecasting, quality control, and production control.

Then there are genetic algorithms. They not only adapt, they optimize. Genetic algorithms are good "for tasks where training data is not available at each step and where it is not feasible to analytically derive a control rule, such as in an unstable system," says Casey Klimasauskas, product manager for NeuralWare Inc. "It is valuable for back-propagation when gradient information is not available at each feed-forward pass, and it is applicable to networks with unorthodox architectures, for example, cascaded connections."

Fuzzy Chips

Silicon AI comes as dedicated microprocessors (custom ASICs) with, typically, fuzzy logic in firmware. These chips are fast. For example, Omron Electronics used to sell a fuzzy processor with reasoning speeds of about 10 megaflips (10 million fuzzy logic processes per second)—10,000 times faster than a conventional 8-bit microprocessor. (Omron Electronics no longer markets circuit-level components in the U.S.)

The NLX22x family of fuzzy logic controllers from NeuroLogix covers all the bases in manufacturing control. The NLX220, for example, has four 8-bit analog inputs and four 8-bit analog outputs. It also has six types of membership functions, 111 fuzzy variables, and up to 50 rules. These customizable microprocessors can directly perform such calculations as derivatives and integrals.

Embedded fuzzy systems can enhance PID control. Omron's E5AF temperature controller, for example, is a hybrid device containing two modules: a conventional, feed-forward PID controller and an Omron fuzzy processor. The output of the E5AF is the sum of the PID and fuzzy outputs.

The controller's response is based on size-of-error information and the error's rate of change, which can be altered by adjusting three fuzzy parameters (see the

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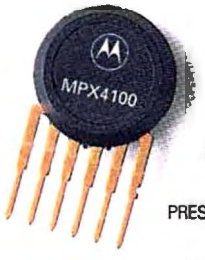

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figure "Combined Effects of Fuzzy Adjustments" on page 80).

Soft AI

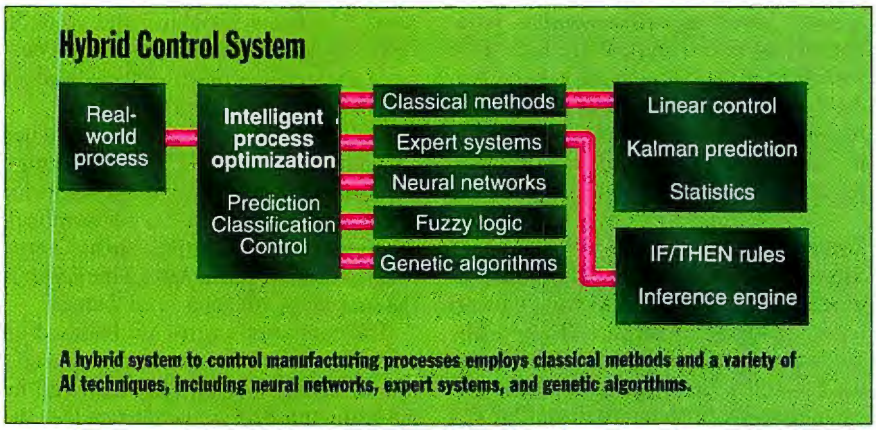
The more common form of AI is in manufacturing software running on general-purpose computers, especially for the many production processes involving low-level dynamics that are not well understood, such as catalytic reactions in distillation columns. These multivariable, nonlinear processes run continuously, but no analytic model fully describes their underlying dynamics. Neural nets can formulate the underlying connections needed to create a robust model of these production processes. With such models, users can intelligently change an operating variable in order to reach some process objective.

Neural-based control systems are available for specific manufacturing applications. For example, Texaco uses the Neural Control and Optimization Package (NeuCOP) it developed with NeuralWare to generate petrochemical products, cut costs, and meet environmental standards.

NeuCOP's identification subsystem captures and stores "interesting" process events while on-line. These events go into a database that becomes the training file for the secondary neural-network model.

The control subsystem has three modules: *target optimization* computes optimal steady-state set-points (targets) based on economic and time factors; *path optimization* drives the process from its current state toward the target, while rejecting disturbances; and *error feedback* manages prediction errors during sampling.

NeuCOP uses the G2 Real-Time Expert System from Gensym as the controller's operator interface to provide dynamic testing and on-line monitoring. G2 also acts as a diagnostic tool for when NeuCOP can't solve a problem effectively—because the limits predefined in NeuCOP are too tight



A hybrid system to control manufacturing processes employs classical methods and a variety of AI techniques, including neural networks, expert systems, and genetic algorithms.

or because the problem is impossible for NeuCOP to solve.

G2 models heuristic and neural-network reasoning in the form of rules, procedures, objects, and relationships between objects. You write G2 rules in a structured natural-language syntax. The rules can be specific or generic, applying either to a particular object or to an entire range of objects within an object class. Moreover, G2 rules can be event-driven (through forward chaining) to automatically respond whenever new data arrives. They can also be data-seeking (through backward chaining) to automatically invoke other rules, procedures, or formulas. Rules can determine the values of referenced variables, or values checked at regular user-specified time intervals can trigger rules.

G2 uses object-oriented technology: Graphical objects representing production components can inherit properties and behaviors from multiple classes. Object libraries help quickly generate graphs, charts, dials, and tables of real-time data. Generic rules and heuristic procedures represent knowledge (e.g., the "Acidity Rule") that applies to all objects of the same class. New instances of these objects automatically inherit the specified behavior. The AI system is built on top of a client/server architecture that can invoke access privileges to the application for various levels of developers and users.

Interprocess communications between NeuCOP, G2, and other plant-wide information, data-collection, and control systems is through the G2 Standard Interface (GSI), a separate process from G2. The resulting API manages protocol handling, data buffering, initial communications handshaking, and restoring after break.

Where to Find

Gensym Corp.
Cambridge, MA
(617) 547-2500 ext. 241

Neural Applications Corp.
Coralville, IA
(319) 626-5000

NeuralWare Inc.
Pittsburgh, PA
(412) 787-8222

NeuroLogix
San Jose, CA
(408) 383-7200

Omron Electronics Inc.
Schaumburg, IL
(708) 843-7900

AI Can Do It

Besides all the benefits to the manufacturing application itself, such as increased throughput, optimized production, reduced waste, and faster response, advances in AI benefit overall system implementation. At one steel plant, the engineers wanted their Intelligent Arc Furnace (IAF) controller, from Neural Applications, to adapt to an incremental change by adding new hydraulic back-pressure inputs. "The inputs were simply wired in, and the system adapted quickly on-line to the new inputs," says Neural Applications' Ali. "No changes were necessary in the system hardware or software configurations."

So, are you ready to hand over control of your factory to a bunch of algorithms? With manufacturing processes getting more complex, you might have no choice. But don't worry. AI is proving it can handle the job. ■

Lawrence Gould specializes in advanced manufacturing technologies. You can reach him at 2541345@mcimail.com.

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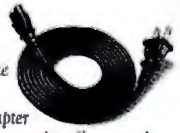

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KEEP THE DATA MOVING

Hand-held computers and PC cards make mobile data acquisition in the factory or field possible—but be aware of the trade-offs and pitfalls

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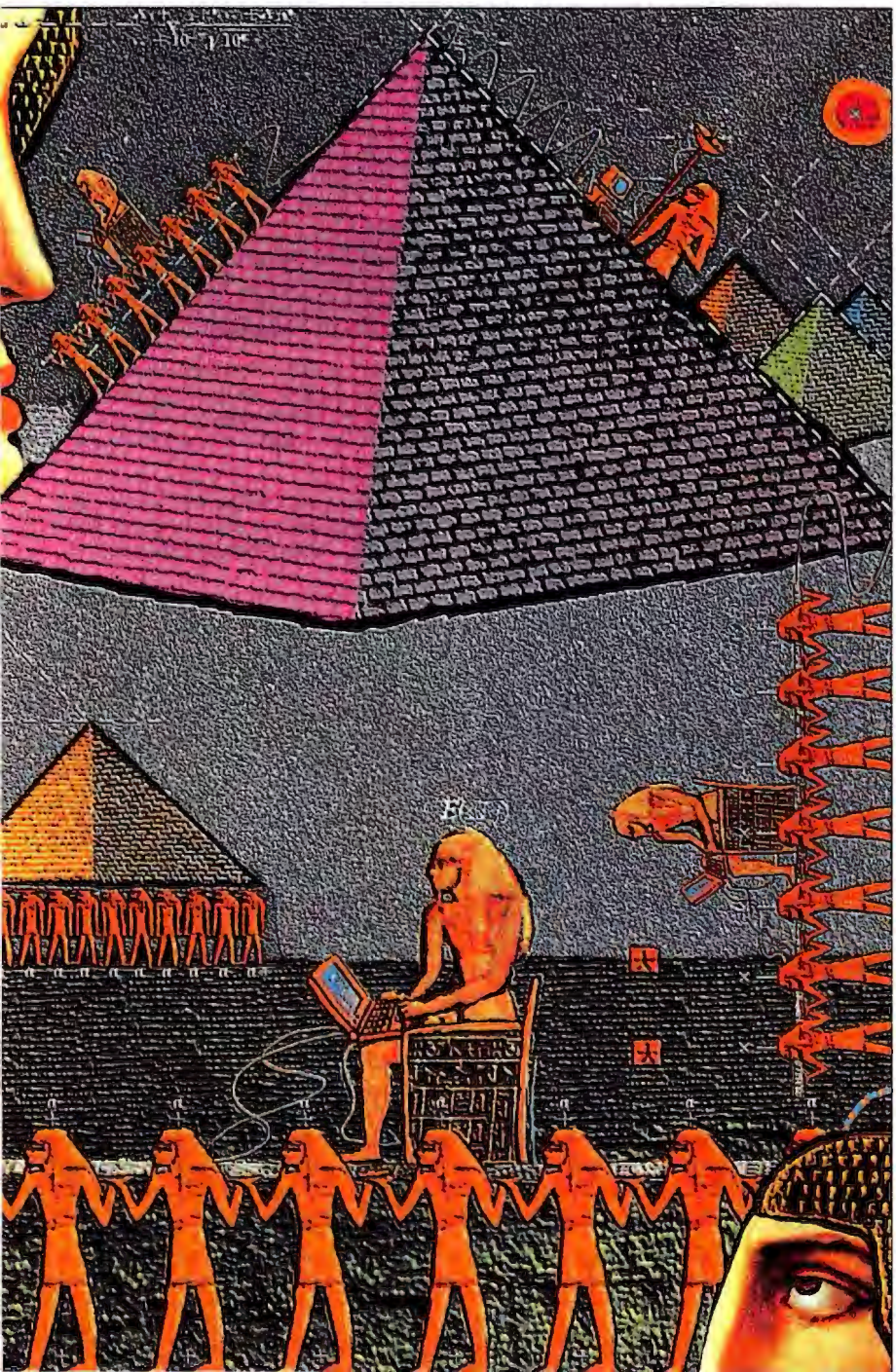

VICTOR GAD © 1995

Niels Anderson regularly drives into the heart of the Mojave Desert over unpaved, washboarded tracks that barely count as roads. He travels to the Reaction Research Society rocket-launch site, where he tests rocket engines in temperatures that frequently top 120°F.

Until only a few months ago, Anderson carefully loaded his car with bulky, expensive, and hard-to-transport test equipment before he drove to the site. He just hoped the equipment would survive the trip. But now, thanks to the development of ruggedized mobile computers and PC cards for data acquisition, he merely throws his laptop in the backseat before he heads off.

"I tried everything else, but I still ended up with huge, heavy, problematic equipment that wasn't meant to go over these kinds of roads," says Anderson. "The boards would get unseated on the way, or something would fail when I got there because of the heat. Now I slide a PC card into my notebook. I take a little black bag with me that's smaller than my briefcase. The convenience is incomparable." Still, not just any notebook will survive the demands of field and factory, not every OS provides the no-fail stability required for data acquisition, and matching specialized sensors with the right PC cards can be a job in itself.

All the trends that are revolutionizing desktop computing—smaller form factors, cheaper components, faster processing, and sturdier designs—are also making data collection in factory or field environments much easier than ever before. But there are still plenty of chances to stumble when you're putting together a mobile data acquisition plan for your business.

There are, for instance, "standards" that are less than standard and inflated vendor claims on just how rugged their systems are. You should also watch out for the costs of specialized software development

and for peripherals that are available from only one vendor. In fact, for most data acquisition needs, PC-based mobile solutions should still be marked with a big sign that says, "Warning—Still Under Construction."

The Mobile Revolution

Data acquisition systems—ways to measure pressure, temperature, or vibration in factory or field settings, or ways to keep track of the movement of inventory or physical assets—are as old as the industrial revolution. Many companies are still getting by with the same old technologies—programmable logic controllers embedded into on-site equipment or inspectors armed with a clipboard. Getting factory or field managers to move from embedded, proprietary systems that have worked fine for years to mobile, PC-based solutions that are just coming into their own is sometimes a tough sale.

But once managers get used to the idea of mobile data acquisition systems, the advantages of moving are many. Intel-based hardware running DOS or Windows allows for cheaper software development than embedded, proprietary systems. Hand-held or laptop devices are far more flexible, lighter in weight, and easier to move than alternatives, allowing for less equipment redundancy. GUIs boost the ability of field workers to interpret data on-site and to make corrections as needed.

The ability to aggregate data across a shop floor or from multiple geographic locations, sometimes by wireless connections, lets companies improve productivity and lower their costs. "We're hearing from our clients that mobile data collection has improved productivity by as much as 25 percent and has reduced costs by about 25 percent, as well," says Jeff Lohrmann, analyst for the San Francisco office of the research firm World Market Strategies.

Standard PC technology just doesn't cut it in the mobile data acquisition field, however. General-use laptop designs are not up to the rigors of a shop floor or field environment. Latest-issue CPUs and OSes are also problematic. While ordinary business users can get by with just rebooting when their laptops freeze, that won't wash in a data acquisition system, where the loss of even a few minutes' worth of data can be critical and costly.

Most mobile data acquisition systems, therefore, are based on older CPUs and OSes that are more stable. They use hardware engineered to withstand far more abuse than any general-use laptop and are loaded with applications that are fail-safe.

Desperately Seeking Input

The first link in any mobile data acquisition system is between what's being measured—be it the number of tablecloths in a storage room or the temperature at the center of a volcano—and a data acquisition device that can read and interpret the measurement.

Data collection for inventory and asset management technology gives you a range of well-understood choices. Physical assets can be tracked with bar code inputs, RF identification tags, keyboard inputs, or pen-based inputs. The choice you make will depend on how you balance your need for accuracy with your need for flexible input systems.

Bar code and RF identification are close to fail-safe in accuracy, but they require specialized detectors; keyboards and pen-based systems are far more flexible but are also more prone to error. Although none of these technologies offer the ideal solution, each one is appropriate for given applications. All of them have well-understood standards that allow you to mix and match vendor products with a fair degree of ease.

Badger's GT-110 weighs 30 ounces, uses several battery types, has a PC Card Type I slot, is PC-compatible, and satisfies military specifications for temperature, rain, vibration, and other challenging environments.

Computer Boards has a full line of PC cards for data acquisition, including a 16-channel analog-to-digital interface with software-selectable signal gains.

This is not so with the measurement of physical systems, such as temperature, pressure, or vibration, where older sensor technologies such as thermocouples are being wedded to PC acquisition devices, and standards are still far in the future. "Except for basic temperature, pressure, and strain sensors, there are massive compatibility issues," says Kevin Sharp, president of the consulting firm Accurate Information. "There are 2200 or more sensor manufacturers, and who knows how many different signal-conditioning circuits. To get a standard output, one that a normal PC card will recognize every time, is still a large, unresolved problem."

Thus, if you plan to use a mobile data acquisition system for collecting physical

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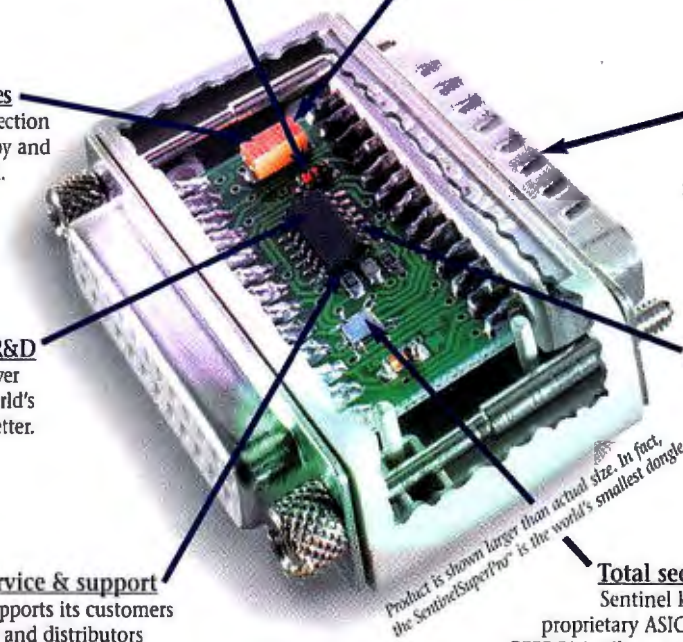

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Circle 237 on Inquiry Card.

Buying Rugged Hand-Held Computers

"Just don't call our computers PDAs," begs Mike Colwell, director of product marketing for Norand. While his company has been manufacturing rugged hand-held computers for very specific industrial applications since 1968, personal digital assistants (PDAs) as a concept are only a few years old, are typically classified as general-use computers for personal-productivity applications, and just as typically don't hold up well in the harsh computing environments that Norand sells to. They've given the whole hand-held-computer industry something of a bad name, one that's not necessarily deserved.

Because hand-held computers in industrial markets are constantly in operation during a workday as an employee moves through a factory floor or from one field location to another, their durability requirements are very different from a typical laptop or even a PDA. Hand-held computers get bumped. They constantly have their circuitry under much more stress than usual.

There aren't any industry-wide certification processes for ruggedized computers, making it hard to compare systems. But all vendors will have test results from either their own labs or third-party test facilities. To make meaningful evaluations, ask for hard copies of the drop tests. Maybe your equipment will never be subjected to 200 drops from 6 feet, but you'll have a margin of safety if you choose a system that has. Vendors should also make available what the industry calls "shake-and-bake" tests—high- and low-temperature variations, plus vibration-test results. All this durability comes at a price, but it will be worth it if your application requires computers to work in harsh environments.

"A lot of companies look at a rugged platform and then decide that they don't want to spend 10 percent or 15 percent more for it," says Tim Schmidt, principal for Encore Consulting Group. "But what's the return on the $150 to $300 you saved on the computer if you're down for the day because the system you bought failed?"

If the system has external PC Card slots, ask the vendor if the connectors are truly waterproof or only have rubber caps that your users will lose the first day out in the field. Just as critical is having enough expansion slots, so that users don't need to change cards (from loss or damage) in the field.

Extra batteries are another point of failure for rugged systems—look for lithium-ion units, and make sure the vendor provides simple charging units for multiple batteries.

Be prepared to trade durability for weight. Schmidt puts the weight limit on a hand-held device at 4 pounds. "Telxon has just released a new rugged unit that weighs in at 4.8 pounds without mass storage," he notes. "I'm sorry, but people will complain."

Other systems will compromise usability for increased ruggedness. Make sure that the hand-held device you select offers access to the peripherals you need—for example, a standard keyboard at a decent price for diagnostics or standard floppy drives for downloading information.

Schmidt notes that just three manufacturers of rugged hand-held computers (Norand, Symbol, and Kalidor) have provided their customers with a convenient way to download information from a hand-held computer to a back-end database. All three companies provide what Schmidt calls *depot docking stations*, which let users dock hand-held computers overnight and have the data collected during the day be automatically transferred to a server. "The other companies still don't seem to realize that customers are crying for this capability," says Schmidt.

Some systems might be more rugged than you need, forcing you to make choices that don't make sense for your business. "Some manufacturers make a totally enclosed case," says Schmidt. "But you need to ship the computer back to the manufacturer to add new PC cards. Do you really need that level of reliability?"

"My advice is to really put your specs together on what you want the equipment to do," says Schmidt. "All vendors will tell you that their systems are rugged. But is it easy to upload and download information? Do you have access to a keyboard when you need it? Can you connect easily with the network and with PC cards? Does the device give you enough expansion slots for the next two to three years? And can it do everything you need it to and still hold up to what your users will put it through? Act like you're from Missouri and say, 'Show me.'"

Shopping List

- Lithium-ion batteries
- Simple recharging units for extra batteries
- Acceptable weight
- Waterproof external PC Card slots
- Extra expansion slots
- Optional peripherals: keyboard, floppy drives, docking stations
- Ease of upgrade/maintenance
- Easy mounting on vehicle
- Written proof of ruggedness, temperature, and vibration testing

data, you can't use a standard solution yet. Instead, you will need to work through a reseller or do a lot of homework to find out which sensors work with which boards. "You don't go down to Egghead and buy these solutions," says Sharp. "You'll end up working with a reseller that specializes in a particular vertical market. Before you buy, get a demonstration that proves to you it will work."

The Right Hardware Platform

Once you choose the input technology that's appropriate for your data acquisition application, you then need to find the mobile computing device that will support that input technology. It must be able to withstand the rigors of your environment.

"If you're dealing with multiple sensor input, by the time you're set up, you're not mobile anymore anyway," notes Sharp. "You'll have 18 to 20 sensors hard-wired to your data acquisition device. In that kind of application, you only need to have a system that's tough enough to survive the rigors of transport while *off*. It's a completely different problem if you need a computer to survive the rigors of a workday while *operating*."

If you're running a typical notebook system and drop it, for example, the disk

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will tend to twist directly into the read head and destroy your data. Vendors have developed solutions that let you drop your computer with impunity (see the text box "Buying Rugged Hand-Held Computers"). However, because increased ruggedness often means compromising on weight, flexibility, or cost, be sure you know your needs before you select your hardware.

Some systems, for example, come with shockproof cases, but those systems are so specialized that you need to send them back to the manufacturer if you want to add a board. Other vendors might require that you buy all your peripherals from the same vendor to keep the warranty protection active.

Norand's rugged Pen*Key 6600 wireless mobile computer is powerful enough to support advanced graphics displays, runs DOS/Windows, and has two PC Card Type II slots and one Type III slot.

PC cards, such as the DaqCard line from National Instruments, provide data acquisition options in form factors to fit notebook slots. The DaqCard line has a power-down mode to draw less power.

Incredible Shrinking Data Acquisition Cards

Much of the excitement surrounding mobile data acquisition relates to the introduction of PC cards based on PC Card Type II standards, which make the form factor for collecting data smaller than ever. "We're extremely excited about PC Card," says Ed McConnell, marketing manager for National Instruments. "Our company has always leveraged off of the PC, where customers can create their own industrial monitoring devices with our tools. But with PC cards, engineers can walk up to a unit anywhere, hook up a couple of probes, and immediately make their tests."

Like everything else in mobile data acquisition, however, the use of PC cards demands a trade-off. Even the most expensive cards top out at a sampling rate of 100 kHz, while a plug-in board can easily provide sampling rates of 1 MHz. The PC Card standard in current use also has yet to provide DMA, and CardBus, PC Card's 32-bit standard, is still part of an unscheduled future plan.

Then there are more mundane issues—like power. "Some PC cards require more power than portables put out," notes Tim Schmidt, principal for Orlando-based Encore Consulting Group and a specialist in hand-held-computing technologies. "You may have a system that's designed for 7 hours continual use and suddenly find you're getting only half an hour."

Although PC cards themselves are hard to break, add them to a rugged computer and what you get is less rugged than what you had before. "Take a look at the PC cards you're buying," says Schmidt. "Some need antennas or other devices to operate. What happens if these get dropped? Keep in mind, also, that you've got 64 little pins on each card. What happens if you need to use three cards in two slots, and you're constantly inserting and removing these cards? Those pins can bend off."

External PC Card slots also add more points of failure to a rugged computer. This requires designers to add waterproof connections (and higher costs) to their mobile devices.

Solutions to these problems are being devised. CardBus will give PC Card the same performance levels as Peripheral Component Interconnect (PCI). The move from a 5.5-V to a 3.3-V standard will ease the power drain (as will the use of lithium-ion batteries.) Until these technologies are standard issue on the mobile computer you choose, however, you'll need to make sure that the current PC Card bus can handle your performance requirements before you commit to a mobile data acquisition solution. And you'll need a backup power supply for even the most simple data collection applications.

You can move acquired data off the hand-held unit in a number of ways. For example, Norand offers 10Base-T connectivity directly to the network. Wireless units can make wireless network connections, also. One important consideration is the ability to efficiently handle multiple simultaneous downloads from different users (e.g., reporting delivery information). There are many software solutions to the data transfer problem. They range from proprietary software to off-the-shelf software to Oracle or Sybase applications.

Keep Software Simple

Some design engineers looking for mobile data acquisition solutions may wonder why they should spend extra money on ruggedized hardware, only to operate that hardware with DOS or Windows 3.1, OSes not known for their crashproof qualities. But there are ways to design your system software so that you get the advantages of easy-to-use development environments, while minimizing the risk.

"To be honest, we don't have too much of a problem with our systems being DOS- or Windows-based," says Mike Colwell, director of product marketing at Norand, a leading manufacturer of hand-held devices. "Most crashes are associated with task

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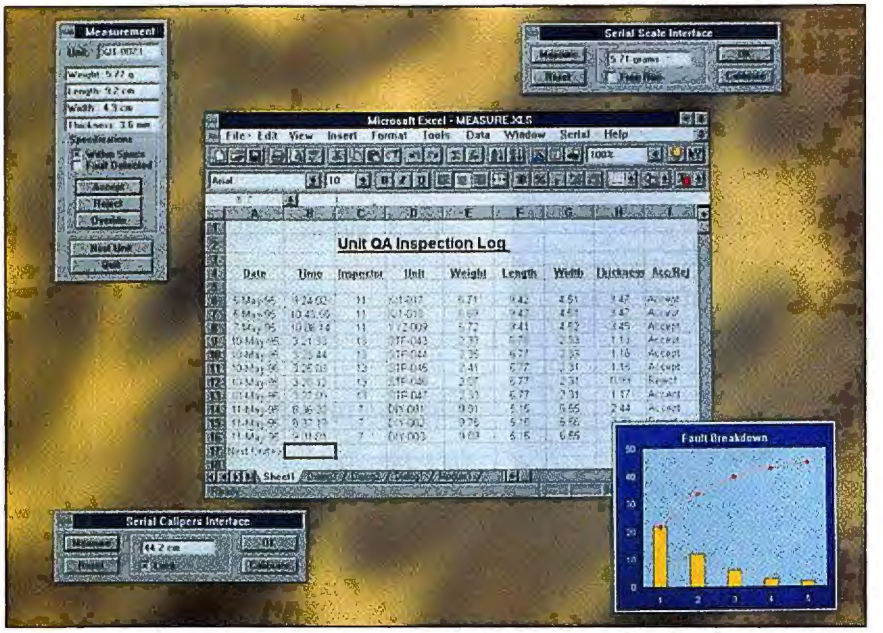

Measure for Windows, from National Instruments, is a spreadsheet add-in for direct data acquisition and serial control from Excel. Using Measure, scientists and engineers can take single-point, low-speed readings for temperature and pressure or process monitoring applications using a PC card.

switching, and our systems aren't being used in a multiapplication environment. All we're doing is using basic Windows to run a specific data collection application. We find Windows to be quite good in our environment, even though rule number 1 for us is, 'don't lose the data.'" Many people choose Windows simply for the ease of using off-the-shelf applications and already-written device drivers.

"In a specific application, it [DOS] can be a stable environment," concurs Schmidt. "The key is to keep users as focused as possible in the specific application they need to do their job. Any time you let users go off and use other pieces of the OS, even to play solitaire, you're creating a lot more support calls."

Choosing DOS or Windows as your OS can help deflate the costs of developing your application, the most expensive factor in putting a data acquisition system in place. "With desktop systems, there's not much custom development," says Sharp. "But with data acquisition running on remote devices, custom development of software dominates the equation. Remote analysis of geological information isn't going to be available in a $200 software package. You'll need to write it yourself or have someone else write it. Your costs are strongly affected by the availability of standard development tools."

Do You Need It?

Despite plenty of progress, designing a mobile data acquisition system still requires you to test input devices for compatibility, to work with hardware that may spend more time in the shop than in the field, to put up with inadequate power, and to write custom software. In other words, the state of the art in mobile data acquisition systems still leaves a lot to be desired, so much so that some analysts and resellers are advising their clients to forget it and move straight to emerging wireless technologies to solve the same problems.

"It's not a good business case to go out on-site if you can perform the same function through an automatic process," says Steve Gurley, national director for wireless data at Electronic Data Systems. "In general terms, data collection will be much more cost-effective if done on an automated basis instead of physical inspection. There are wireless alternatives for most applications that lower costs and improve efficiency. I see the trend away from people having to go out on-site as much as possible."

Others dismiss this wireless argument as more infohighway hype and insist that, although there are still problems with handheld mobile data acquisition systems, none of these problems are insurmountable.

"Why should you run your data acquisition systems on PCs? Because everyone decided that was what a computer looks like," says Ben Bailey, cofounder of Computer Boards, which makes PC-based data acquisition boards and PC cards. "Other solutions, including wireless solutions, get expensive very quickly." *continued*

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STATE OF THE ART

The reality of mobile data acquisition in the next several years is probably evolving to a hybrid system, where companies gain the advantages of on-site mobile data acquisition and use hand-held computers as wireless terminals to relay information to central locations. All vendors of hand-held computers are busy forging deals with wireless LAN and WAN providers.

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Their sales pitches to you will no doubt stress the advantages of spread-spectrum technology over infrared, or Cellular Digital Packet Data (CDPD) over cellular circuit-switched data (CCSD)—or they will tell you the opposite, depending on the alliances they have forged. With such a range of partial answers available to you, it's easy to forget which problem it is you're trying to solve. Don't do that.

"In data collection, stay focused on the process that you're trying to automate," says Sharp. "Don't specify the platform. Specify the result. Then look at strategies to accomplish that result. Only then should you decide what technology will give you the results you need." ■

Claire Tristram is a contributing editor at McGraw-Hill's Open Computing *and also writes for* Wired, New Media, *and other technology publications. You can reach her at claire@netcom.com.*

Untangling Wireless

SALVATORE SALAMONE

Tips on picking the right service for your unplugged applications

Star Trek TV shows and Dick Tracy comics have given us high expectations about wireless connectivity. Unfortunately, widespread wireless connectivity is, like the voyages of the Starship Enterprise, still off in the future.

While cellular phones seem to be everywhere, wireless data connections for laptops and personal digital assistants are not nearly as common. The stumbling blocks to widespread adoption include the lack of ubiquitous service, the lack of compatibility between different services, the cost of the services, and the size and price of wireless modems.

Although some early adopters—long-distance haulers and repair services, for example—report productivity gains from going unplugged, wireless faces a fundamental problem: None of the major wireless data services is ideal for all applications. Instead, wireless services, such as circuit-switched cellular, private packet radio, and Cellular Digital Packet Data (CDPD), are all uniquely qualified for different types of applications (see the chart on page 96NA 2).

Choosing a service will not get any easier. New alternatives, such as Personal Communications Services (PCS), bidirectional satellite, and enhanced specialized mobile radio (ESMR), will start becoming available.

Minutes or Bits?

Selecting a wireless service will depend on the application you want to run. Consider two simple examples:

- If your application primarily relies on the exchange of short, bursty messages (for example, a "trouble ticket" system where technicians in the field send messages confirming that jobs have been completed), CDPD and private packet radio services such as Ardis and RAM Mobile Data would be your best bet. They are economical for this type of data transfer because they charge by the kilobyte of data transmitted.
- On the other hand, if your application requires the exchange of long text messages, large files, or faxes, circuit-switched cellular is a better choice since it typically charges by the minute of connect time and not by the number of bytes transferred.

Circuit-Switched Cellular

Circuit-switched cellular is the same network that cellular phones use. For transferring data, you simply connect a laptop with a cellular modem to a cellular phone and you're in business.

One of circuit-switched cellular's biggest advantages is its nationwide availability. Another advantage is that you have both voice and data capabilities over the cellular phone network.

The initial cost to outfit a laptop to connect to a circuit-switched cellular network is about $500. That includes buying a cellular modem, typically $300 to $350, and a cellular phone (about $150) with an adapter to connect the modem.

The cost to send data varies from provider to provider. These costs are the same as your cellular-phone connectivity charges. Rates for circuit-switched cellular service typically range from 25 to 40 cents per minute (although volume discounts and long-term plans can drop this rate substantially).

The throughput rate for circuit-switched cellular, which depends on the speed of the modem, varies from 1.2 Kbps to 14.4 Kbps. Since you'll be billed by the minute and not by the number of bytes of data transmitted, it makes sense for you to invest in a high-speed cellular modem.

When selecting a cellular modem, look for one that supports one of the common error-correcting technologies, such as MNP-10 (developed by Microcom) or the Enhanced Throughput Cellular protocol (from AT&T Paradyne). These protocols make

the cellular link more efficient by doing things like automatically adjusting transmission speeds depending on the cleanness of the link. (One note of caution: Not all cellular service providers have equipment on their end of the link that supports these protocols. Check with your provider before buying a modem.)

Under the best circumstances (14.4-Kbps throughput), it should cost only about 25 cents to 40 cents to send a 10-KB file. Unfortunately, being billed on a per-minute basis can also be a great disadvantage. A 100-byte file will cost about as much to send as that 10-KB file.

Additionally, in some applications, such as database queries or transaction processing, you may not want circuit-switched cellular because of the long set-up time each connection requires: Typically it takes about 30 seconds to establish this kind of a connection.

Motorola's Personal Messenger 100D is a wireless modem with all its components packed into a single PC Card.

CDPD Steps Up, Slowly

A group of cellular service providers—including the Wireless Data Division of AT&T McCaw Cellular Communications Unit, GTE Personal Communications Services, and Pacific Communication Sciences Inc. (PCSI)—originally conceived Cellular Digital Packet Data (CDPD) to address the high cost of sending short messages over cellular networks. It essentially transmits packets over unused portions of existing cellular network channels. If your application requires quick connect times, CDPD may be the answer. It typically takes only about 5 seconds to establish a link. Such quick call setup is important for database querying and transaction processing.

CDPD has several advantages over other wireless data services. Perhaps most significant, it's based on TCP/IP. That means existing network applications that run over TCP/IP should be easy to access over CDPD. However, you have to modify existing TCP/IP applications for them to run economically over CDPD. For example, you'll have to change software to filter the broadcast and acknowledgment packets off the wireless links.

CDPD is relatively new, so modems to connect to CDPD networks have been more expensive than their circuit-switched cellular counterparts. However, CDPD modem prices are dropping; there are several in the $300 to $500 range (making them comparable to the price of a traditional cellular modem).

Charges to use CDPD networks vary from provider to provider, but typically it costs between 15 cents and 55 cents per kilobyte. Typically, you'll subscribe to a plan that allows you to send a set amount of data for a fixed price. The vendor will charge you for any additional data on a per-kilobyte basis.

The way the pricing is structured, CDPD is most economical for sending many short messages. It can cost as little as 1 cent to send an 80-byte file. It would cost about 15 cents to send the same file over circuit-switched cellular because you're being billed by the minute, not by the kilobyte.

On the other hand, a long file, such as a 10-KB spreadsheet, would cost between $1.50 and $5. Just to remind you, sending the same file over circuit-switched cellular would be significantly less: about 25 cents to 40 cents.

CDPD is well-suited for sending E-mail and for interactive database queries—making it a good fit for a large segment of the mobile workforce. The problem with CDPD is the lack of it. By the middle of this year, CDPD was available in only 19 cities in the U.S. (with plans to roll out in another 22 cities soon).

Your Own Private Radio

For businesses that need widespread connectivity today, there's another type of wireless packetized data service that might be a good match: private packet radio.

There are two major private packet radio providers in the U.S.: Ardis and RAM Mobile Data. You can connect to these services from virtually anywhere in the country. RAM Mobile Data is available in about 260 metropolitan areas, while Ardis is available in about 400 cities and towns.

Private packet radio offers quick call-setup time and is well-suited to communications that generate short, bursty traffic—E-mail, database queries, and point-of-sales applications, for example.

Because private packet radio has been around for several years, many vertical applications now ride over the network. For example, there are programs for Ardis and RAM that handle messaging, scheduling, and electronic filing of expense reports; applications that give real-estate agents access to listing services; and programs that allow insurance agents to process accident claim forms at a customer's house or office.

COMPARING WIRELESS SERVICES

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TYPE OF SERVICE	DATA RATES (Kbps)	PRICING STRUCTURE	BEST APPLICATIONS	ADVANTAGES	DISADVANTAGES
Cellular Digital Packet Data (CDPD)	19.2	Billed per KB (typically 15 to 55 cents per KB)	Transaction processing and database queries	Fast call setup; inexpensive for short messages	Expensive for large file transfers; limited availability
Circuit-switched cellular	1.2 to 14.4	Billed per minute (typically 25 to 40 cents per minute)	Sending large files and faxes	Available nationwide; reasonably priced for sending long messages	Slow call setup; expensive for sending many short messages
Packet radio	4.8 to 19.2	Billed per KB (typically 15 to 25 cents per KB)	E-mail and sending short, bursty messages	Available nationwide; often has links to commercial E-mail services	Expensive for large file transfers

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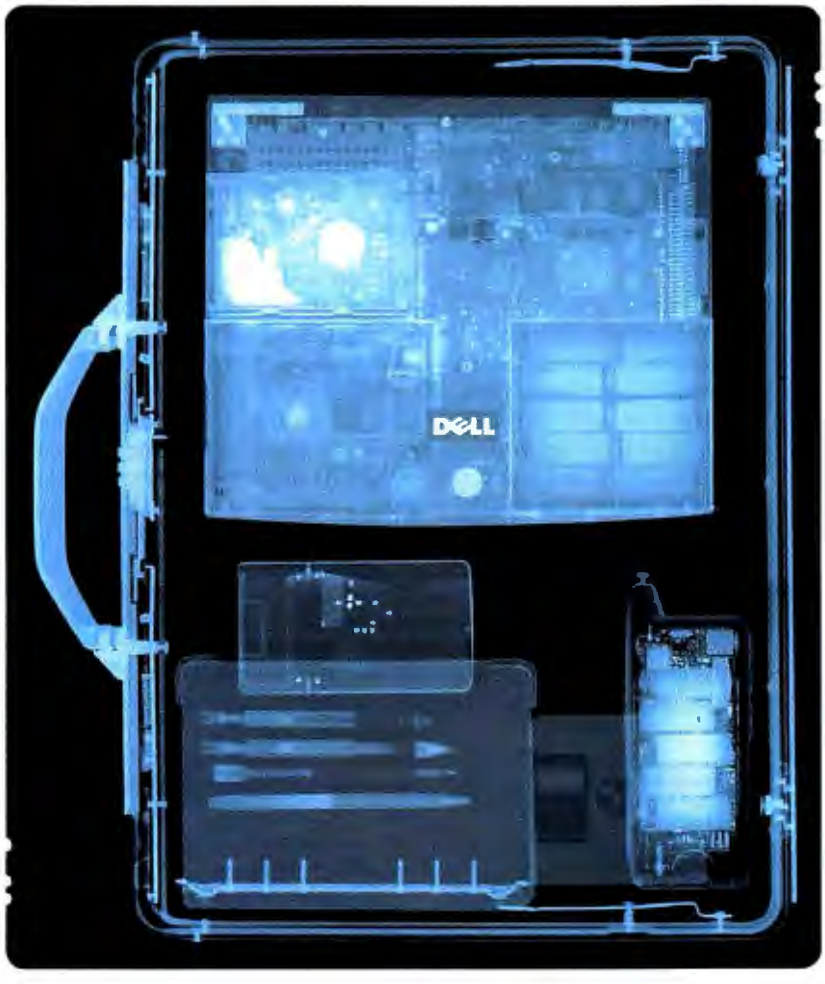

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JUST THE TICKET

Service and repair organizations live and die by "trouble tickets." A field technician goes into the office in the morning and gets a piece of paper listing the first job of the day. Once that job is completed, the technician calls in to the office, and the dispatcher closes out the trouble ticket, then directs the technician to his or her next assignment. Typically, the technician in the field spends 20 to 60 minutes a day calling in, according to Rob Euler, senior vice president at Ardis.

Access into a trouble-ticket system is one area that is ideally suited for wireless technology. And several companies with large service organizations—Sears and Otis Elevators, for example—have made the move to wireless.

Sears will equip 14,000 service technicians nationwide with laptops and wireless modems. Using a wireless connection over the Ardis network, the technicians will be able to peruse a parts database, send questions to other technicians in the field, and send and receive information about service calls

Sears' current paper-based system for handling service orders and dispatching technicians requires the technician to call a dispatcher after each house call. With the wireless laptop, the technician can close a service order once a job is completed and receive his or her next assignment. Sears expects productivity to increase 10 percent by virtue of the better scheduling afforded by using the wireless units.

Organizations rolling out wireless applications that run over Ardis or RAM find the pricing of the service fairly attractive. It typically costs about 25 cents per kilobyte to transmit messages. Both Ardis and RAM offer volume discounts.

Developments in modems for private packet radio are also making the service more attractive. Until recently, one of the biggest drawbacks to using any wireless data service was the size of the modems. These devices typically consumed large quantities of power (compared to your traditional analog modems) and thus were fairly bulky in order to accommodate the power equipment.

Thanks to some semiconductor developments for radio-transmission equipment, wireless modems with much lower power consumption can now be built. Earlier this year, Eiger Labs and IBM Networking Systems introduced PC Card wireless modems for the Ardis network. And Motorola introduced its radio modem for Ardis; the Personal Messenger 100D is a self-contained Type 2 PC Card that runs on a nicad or a 9-V alkaline battery.

The newer modems support faster data rates. Previously, a major disadvantage of using private packet radio was its slow speed—typically 4.8 Kbps but as low as 2.4 Kbps. Now, however, Ardis has started to offer 19.2-Kbps rates in many large urban areas.

Radio, Satellite, and CDMA

Some businesses developing large-scale wireless applications today can't wait for higher-speed services to roll out. They're evaluating new services that might be more rapidly deployed. Among the newer services becoming available are enhanced specialized mobile radio (ESMR), bidirectional satellite, and a wireless spread-spectrum system based on Code Division Multiple Access (CDMA).

Each of these services has strengths that other wireless services lack. However, the main disadvantage of each is, again, limited availability. For example, ESMR is an all-digital voice and data network that operates at 4.8 Kbps. With ESMR, a digital data stream is sent to a radio base station from which it is carried over the public network. But its availability is limited mostly to the West Coast.

Bidirectional satellite systems will work by sending data to low-Earth-orbiting satellites. When the full complement of satellites is deployed (not likely for several years), the great advantage of this technology will be its global accessibility.

And then there's wireless CDMA. It will first be offered as a voice communications service, but it has the potential of very high data rates (up to 76 Kbps under an extended version planned for 1997).

Additionally, many corporations will likely be looking at Personal Communications Services (PCS) in the next year or two. PCS is an all-digital alternative to today's cellular voice and data networks. Many service providers and carriers have bid in government auctions for the bandwidth to deliver PCS. The first of these services should be available around the time this article appears. There will be two flavors of PCS—narrowband, which will carry data only, and broadband, which will carry voice and data.

As these nationwide and regional services start to become available in the next two years, choosing a wireless data service will become even trickier. Since no one service will be the perfect match, your best approach is to match the attributes of a particular wireless data service to your most commonly used applications. ■

Salvatore Salamone is a BYTE news editor and author of Reducing the Cost of LAN Ownership *(Van Nostrand Reinhold, 1995). You can contact him on the Internet by sending E-mail to ssalamone@bix.com.*

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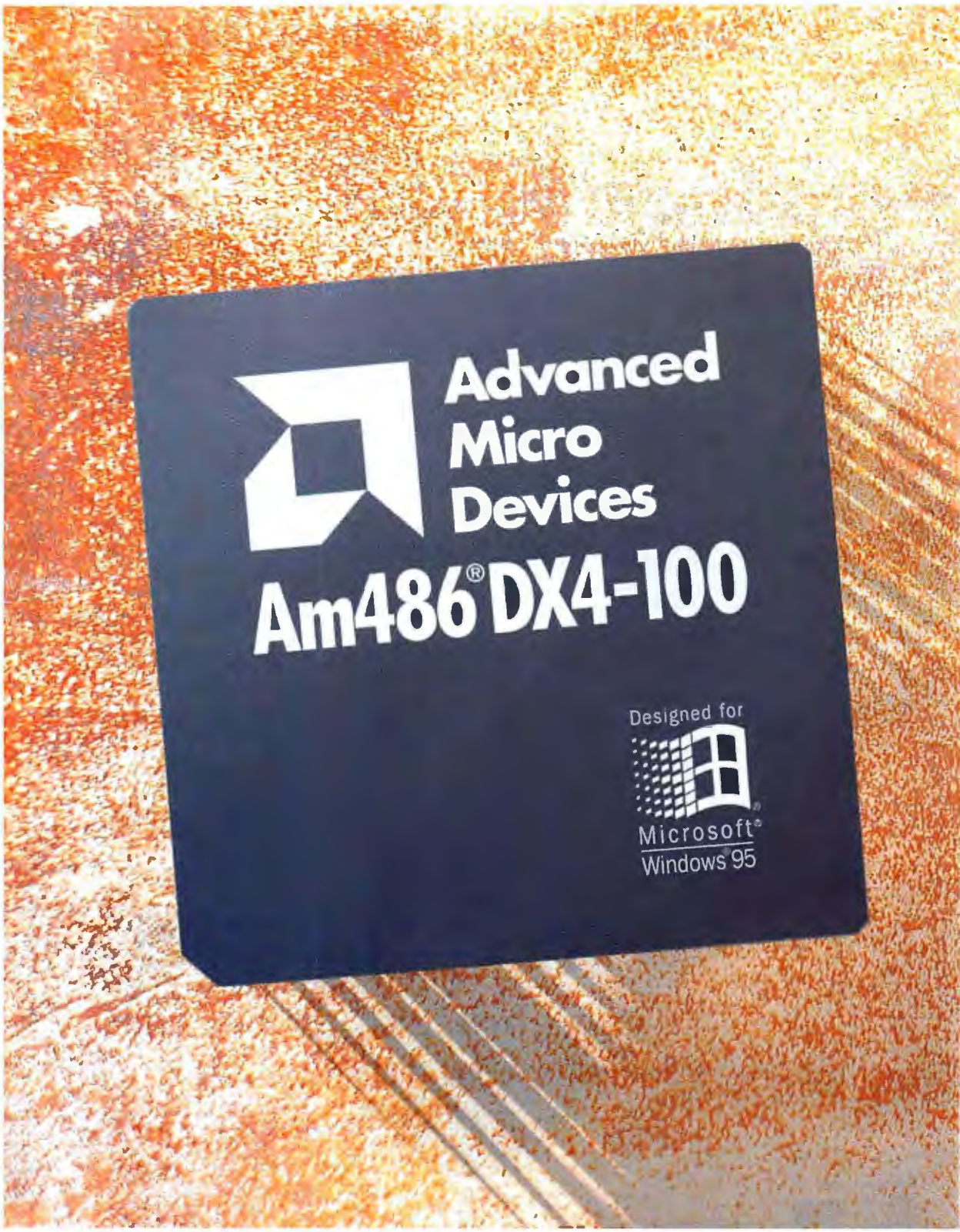
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Talking to Machines

JUDITH MARKOWITZ

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The ultimate computer input device may be right under your nose

You don't see the crew of the *Starship Enterprise* fussing much with keyboards. When someone wants to ask the computer a question, he or she normally just speaks to it. It's fast, efficient, and natural—in *Star Trek*'s twenty-fourth-century universe. In our own time, however, keyboards and mice are a lot more important for computing than our voices are.

But talking to machines is too good an idea to ignore. Speech is such a basic and universal mode of communication that it's natural to want to talk to machines, such as computers and telephones.

What Did You Say?

Whether we use it to dial a telephone, navigate through Windows, dictate a letter, or enter data, speech recognition's basic job remains the same: to identify what a person has said, and to do so quickly, accurately, and seamlessly. It has to identify features from a continuous blast of speech and noise that spans the entire spectrum of audible frequencies.

The task is complicated by regional accents and speech habits (see the text box "Wuzzatdoonear? Idano" on page 102). We rarely notice them because we use nonverbal and situational cues to help us. Speech-recognition systems depend almost exclusively on acoustic data, yet we still expect them to perform as accurately as we do.

Several features influence the accuracy and speed of a speech-recognition system: the recognition algorithms used, the size and nature of the vocabulary, the grammar, whether speech is continuous or discrete, and the speaker model. These are summarized in the table "Speech-Recognition Features" on page 104.

I Recognize that Algorithm

Speech-recognition systems compare stored vocabulary models with spoken input according to specified recognition algorithms. No match will be exact, because slight differences in speed, emphasis, emotion, and other details change a word's acoustic patterns and length, even with just one speaker.

Speech-recognition systems represent words in different ways. Some systems use templates, which encode acoustic patterns from one or more samples and then compare acoustic patterns with spoken input, frame by frame. Most products, however, use hidden Markov models, or HMMs (see the text box "Hidden Markov Models" on page 100). Two recognition algorithms commonly used with HMMs are the Baum-Welch maximum likelihood ("best match") algorithm and the Viterbi ("best path") algorithm. Both process the input through an HMM and produce a probability rating.

HMMs are fast, efficient, and accurate, but the industry and the technology are evolving rapidly, and developers are investigating alternative approaches. One option, *auditory modeling*, attempts to reproduce operations of the inner ear and auditory nerve. Test systems have improved accuracy, speaker modeling, and noise rejection. Unfortunately, human auditory behavior is poorly understood, and full auditory models remain a long-range goal.

Artificial neural networks have begun to appear in commercial speech recognition. Neural nets can extract complex patterns

from large quantities of messy data, which makes them well-suited for speech.

How Many Words Is Enough?

Even dictionaries with 100,000 words can't meet all needs, so some products allow users and developers to add words. The newest tools create new vocabulary items by combining HMMs. A system could construct the word *unbirthday*, for example, by assembling HMMs for each of its sounds. Or it could extract *un* from *unbolt* and attach it to *birthday*.

But large vocabularies can reduce performance or increase complexity. Searching a large vocabulary for every word takes time and increases the likelihood that similar-sounding words will produce errors. Acoustics alone can't prevent a system from recognizing *to* when a user means *two*, or from selecting *write* instead of *right*.

Grammar Knows Best

Position and context can help in picking the right word. Language has an internal structure, which we refer to as grammar. For English, that structure limits word sequencing. Speech-recognition systems also use grammars to reduce or eliminate unacceptable word sequences.

Speech Recognition's Four Main Uses

COMMAND AND CONTROL	DATA ENTRY	DICTATION	DATA ACCESS/ INFORMATION RETRIEVAL
Voice control of machine operations.	Input of data to quality-control systems, databases, or other software.	Creation of letters and other documents using free-form or structured dictation.	Search and retrieval of on-line data.
Voice-activated dialing; navigation of GUIs.	Inspection data; forms completion; order entry.	General dictation; structured report generation.	Banking by phone; directory assistance.

The most common grammar for speech recognition is the *finite-state grammar*, which consists of a set of states connected by transitions, like HMMs without the probabilities. A finite-state grammar defines the paths a user can take through the application and specifies what words are acceptable at each state (known as its *active vocabulary*). Limiting the active vocabulary speeds processing and helps minimize errors. Consider the figure "Who's on First?" on page 100. This finite-state grammar has 14 words or phrases and specifies the active vocabulary.

Finite-state grammars are excellent for highly structured applications, such as inspections in manufacturing and voice control of a GUI, but they don't allow the freedom needed for unstructured dictation. For that application, statistical language models work better. These models contain probabilities about how likely it is that a particular word was uttered, given the identity of the preceding word (bigram model) or two words (trigram model).

Many telephone applications have to deal with unpredictable input. For example, a bank customer looking for a home loan might say something like: "I want to find out about mortgages" or "I wanna buy a home, and I need a loan." Such applications need what's called *keyword spotting*. This procedure doesn't try to identify every word but instead looks for patterns that match specified keywords (e.g., *mortgage* or *loan*). If the system hears one of those words, it takes a programmed action.

Talkus Interruptus

In normal speech, we run words together. This so-called *continuous speech* can be difficult for a speech-recognition system to

SPEECH-RECOGNITION PRODUCTS

Vendor	Product	Target Systems	Price	Primary Functions	Technology Used: Continuous (C) or Discrete (D)	Technology Used: Speaker Dependent (D) Independent (I) Adaptive (A)	Technology Used: Dictionary Size (maximum words per application)	Technology Used: Features	Target Customer	Inquiry No.
BBN Hark Systems Corp. Cambridge, MA (617) 873-4636; fax (617) 873-2473 hark-info@bbn.com http://www.bbn.com	Hark Recognizer	IBM-compatible PCs; Unix workstations	$400 per port	❶, ❷, ❸ (telephony)	C	I	L (100K; 2K active)	FSG, HMM	A, P	991
Dragon Systems, Inc. Newton, MA (800) 825-5897 or (617) 965-5200 fax; (617) 527-0372	DragonDictate	IBM-compatible PCs (486/33 and up)	$395 (5K words), $695 (30K) $1695 (60K)	❶, ❷	D	A	L (60K)	HMM, S	U, OEM	992
IBM Corp. Boca Raton, FL (407) 443-8011; fax (407) 443-6549	VoiceType	IBM-compatible PCs	Starts at $999	❶, ❷	D	A	L (22K)	HMM, S	U	993
Kurzweil Applied Intelligence Waltham, MA (800) 380-1234 or (617) 893-5151 fax: (617) 893-7653	Kurzweil Voice for Windows release 1.5	IBM-compatible PCs (486/33 and up)	$995 (includes sound board and microphone)	❶, ❷	C (for digits), D	A	L (30K or 60K)	Undisclosed; thought to be FSG, HMM, S	U	994
Philips Dictation Systems San Francisco, CA (415) 434-7715 fax: (415) 434-7729	SpeechMagic, SpeechPro (language development tool)	IBM-compatible PCs (486 and up)	Consult vendor	❶	C	A	L (50K and up)	HMM, S	A, P	995
Sensory Circuits San Jose, CA (408) 452-1000; fax (408) 452-1025 http://www.sensoryc.com/	RSC-164 Series	Chip-level	Under $5 per chip in quantity	❶	D	D, I	S	FSG, neural network; (also does speech and music synthesis, voice recording)	P	996
Speech Systems, Inc. Boulder, CO (303) 938-1110 fax: (303) 938-1874	PE500	IBM-compatible PCs (486 and up)	$995	❶, ❷, ❸	C	I	L (40K)	FSG, phoneme model	A, OEM	997

❶ = command and control ❷ = data entry
❸ = data access/querying ❹ = dictation/report generation

S = Small; M = Medium; L = Large

FSG = Finite-state grammar
HMM = Hidden Markov models
S = Statistical language model

A = Applications developer
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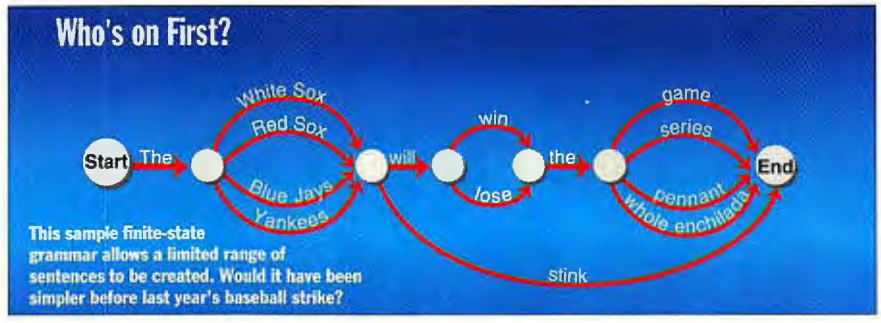
handle. The most common alternative is *discrete-word input*, where users pause between words. Discrete-word input simplifies the identification of word boundaries. With a limited vocabulary and a finite-space grammar, continuous-speech recognition doesn't require too much computation. But for a large vocabulary with a statistical model, great power is required.

Existing laboratory systems for continuous-speech dictation can take from three to 10 times as long to process a speech sample as the person takes to say it. Philips Dictation Systems' SpeechMagic, the first commercial continuous-speech dictation system, avoids this dilemma by beginning its processing after the user has finished dictating. Greater commercial use of continuous-speech dictation awaits more powerful, less expensive CPUs.



Do I Know You?

The simplest approach uses HMMs created from samples spoken by one person and are for use only by that person. These are called *speaker-dependent* systems. Creating the model is called training, or enrollment. Each user must provide at least one spoken sample for each word in the vocabulary. Although this can take considerable up-front time, such systems can recognize users' speech very accurately.

But speaker-dependent systems aren't so good for one-time users or a large vocabulary. These situations call for a speaker-independent system built from samples by many individuals. Although they're less accurate than good speaker-dependent models, such models work surprisingly well. However, speech models created for American English might not work well with British speakers.

When applications demand large vocabularies and are to be used repeatedly by the same people, as for dictation, it's useful to tune the models to each speaker. Because users can't enroll thousands of words, large-vocabulary systems begin with primitive word forms called *baseforms* and modify them using smaller samples of a user's speech. This process is called *speaker adaptation*.

A common form is called "on-the-fly adaptation." Found in Dragon Systems' DragonDictate, it adjusts to the speaker during use. Another approach, known as "rapid enrollment" and used by IBM's VoiceType dictation system, requires a one-time enrollment process that takes anywhere from 45 minutes to 2 hours.

OK, What's It Good for?

Speech-recognition systems are suited to four primary functions: command and control, data entry, data access and querying, and dictation (see the table "Speech Recognition's Four Main Uses" on page 98). Most often, the nature of the application dictates what type of speech-recognition product and technology should be used and determines what features are important.

With command and control, you operate a computer or other device using spoken commands, such as voice-dialing and GUI-navigation systems. The first applications of this type allowed military personnel and factory workers to operate equipment such as map displays in tanks and aircraft.

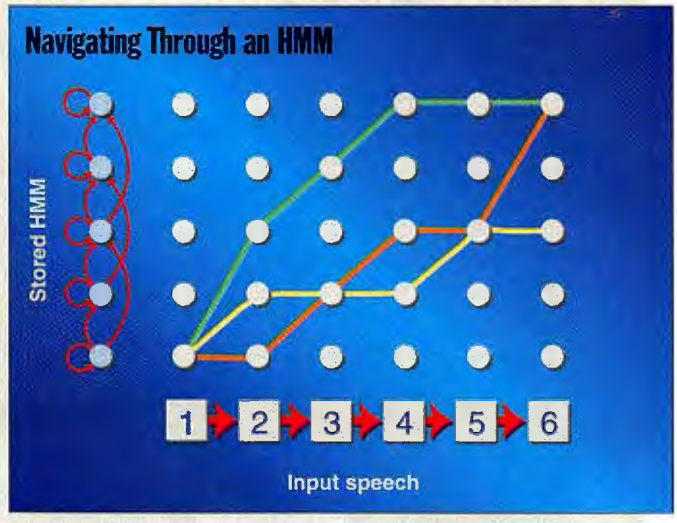
Voice command and control is now being used in consumer products, including

Hidden Markov Models

Hidden Markov models (HMMs) consist of *states* connected by directional arcs or *transitions* containing probability information. A. A. Markov formulated the basic structure in 1913 to describe letter sequences in Russian. Each state in Markov's model corresponded to a single letter, while the transition linking *A* to *B* represented the probability that *B* would follow *A*. James Baker of Carnegie Mellon University first applied HMMs to speech recognition in the 1970s.

In Markov's original model, a state emits its unique letter, making the path easily discernible. What makes an HMM "hidden" is that it's impossible to determine the path taken through the model on the basis of the intermediate outputs. Outputs of HMMs are simply the result of applying probabilities to the input and don't necessarily tell you what state produced them.

Speech recognition constructs the HMM for a word from spoken samples of that word. Each state contains acoustic information about a segment of the word, including acoustic variability. Transitions contain probabilities to determine the likelihood that one state will follow another state. Because they allow a recognition algorithm to move from one state to another based on the input data, HMMs are "nondeterministic" systems.



This diagram illustrates how a speech-recognition algorithm might identify a word by comparing a series of input vectors (i.e., speech samples) with a five-state stored HMM. Here we see three possible paths, all starting at the same state. The orange line indicates the "best path" through this HMM, the one that most closely matches the characteristics of the HMM. For this solution, the first two inputs keep the path in the first state of the HMM. In physical terms, if this HMM represented the word *six*, the orange path might suggest that the speaker lengthened the *s* sound at the start of the word.

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personal digital assistants, VCR programmers, toys, and home appliances. It also gives hands-free control of wheelchairs and other equipment to disabled people.

The telephone is arguably the most popular current platform for speech command and control. Speech also provides a simple, easy-to-use, uniform interface for call management and message-processing operations, and it's an important part of most modern telephony applications. For example, call routing is easier when callers can just say "technical support" or "tech support" to reach the appropriate line.

Most command-and-control systems need small vocabularies in a simple structure. Many systems require the high accuracy offered by good speaker-dependent models and expect superior noise tolerance. In most cases, commands are short enough to allow either discrete-word or continuous-speech recognition.

Data Entry

A data-entry speech-recognition product is an "eyes busy, hands busy" input device that allows an individual to enter data while performing a demanding manual task. Early applications were in manufacturing jobs, such as inspection, receiving, and quality audit.

Newer applications are appearing in other fields. For example, several systems allow physicians and nurses to enter data while examining patients. Visa Interactive recently deployed a speech interface for bill payment over the phone. Using speech-recognition systems, the U.S. Bureau of Labor Statistics has been able to expand its data-collection capabilities despite a shrinking staff.

Data-entry applications are usually highly structured and can support either discrete or continuous input. Vocabularies can range from small to moderately large; speaker-modeling requirements depend on the size and nature of the user population.

Wuzzatdoonear? Idano

If you think speech recognition is a simple problem, consider the following as examples of normal, everyday speech, the kind of thing we hear all the time and never wonder what it means.

hominyuwan? (How many do you want?)

amina (I'm gonna [borrowed from George Carlin])

jeet? (Did you eat?)

wuhjusay? (What did you say?)

ahluv (All of; I love; I'll have; olive [Take your pick!]). This raises the possibility of the following spoken sentence: "Ahluv, ahluv an ahluv, cuz ahluv ahluv 'em lil greentings."

Queries and Data Access

Voice data access is used primarily over the telephone for gathering information from databases and other on-line sources. Banks that wanted to extend their remote services to customers with rotary phones were early users of voice data access. With Touch-Tone technology being rare outside North America, speech recognition permits cost-effective 24-hour support for overseas customers.

The most notable application of voice-activated data access is in information-retrieval systems. For example, both West Publishing and Lexis-Nexis offer speech-recognition interfaces for searching their legal databases. Both companies' products convert spoken queries into SQL statements.

Keyword spotting allows continuous-speech input and speaker-independent modeling for small-vocabulary, telephone-based systems. Database-retrieval systems currently employ discrete-word input and speaker adaptation.

continued

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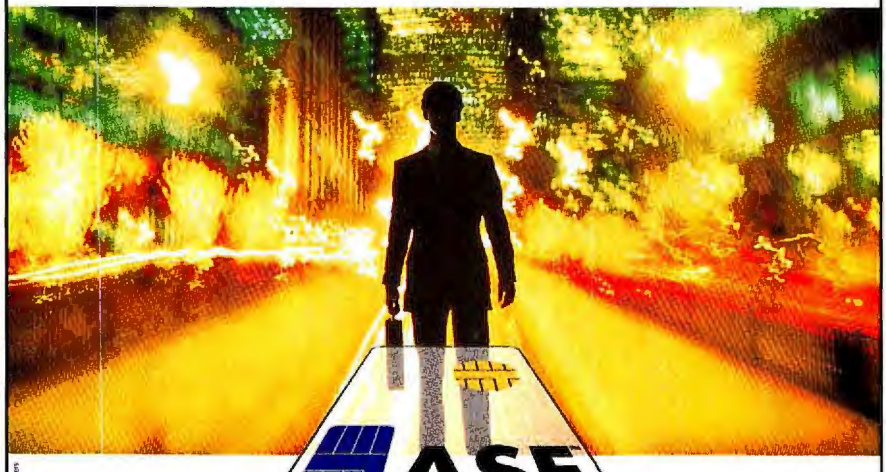

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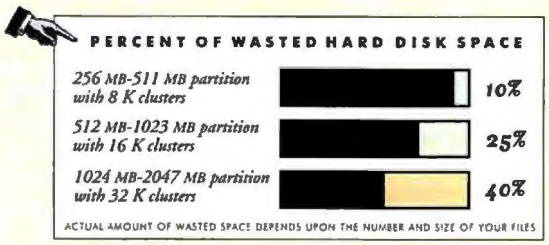

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Dictation: Computer, Take a Letter

Dictation comes in two basic forms: structured report generation and free-form dictation. Reporting systems are widely used in health care and are gaining popularity among attorneys.

Dictation systems need big vocabularies—20,000 words or more. Free-form dictation requires statistical grammars, but structured report generation can be implemented with finite-state grammars. Current technology relies mainly on discrete-word recognition and speaker adaptation.

Do What I Mean, Not What I Say

Speech-recognition technology is a long way from human communication. While figuring out what words are spoken can help automate many operations, it's still only one part of a larger, more difficult puzzle—figuring out what a spoken communication means.

A new field of study, known as spoken language understanding (SLU), aims at improving the verbal communication skills of machines. SLU research is driven primarily by the Defense Department's Advanced Research Projects Agency and by government funding from Japan and Europe. Several organizations are working on speech-to-speech translation, even over transoceanic telephone lines. Researchers and commercial companies are developing systems that can handle limited chunks of meaning that are important for natural conversation. We'll see significant advances in the SLU field in the next few years, but full implementation remains a distant goal.

Neural-net technology is also emerging. Sensory Circuits offers a chip-level product used in toys and other consumer products. Lernout and Hauspie (Woburn, MA) is licensing its neural-net technology. This will be instrumental in improving noise immunity and creating more flexible, speaker-independent models.

Finally, support for speech recognition is being provided by the development of API standards. Proposals covering telecommunications platforms, Windows 3.1, and Windows 95 standards have been formulated and are being adopted. By the end of the century, all these technical advances will make today's speech-recognition technology, as good as it is, look primitive. ■

SPEECH-RECOGNITION FEATURES

Recognition algorithm	Method of representing speech and comparing stored models with user input.
Vocabulary	The number and types of words included in the application. Vocabulary size can range from two words to more than 60,000.
Grammar	Structure imposed on the application that defines what can be said and in what sequence. Possible types include finite-state grammar, statistical language models, keyword spotting, or no grammar.
Speech flow	How a user must speak to the system, either with continuous speech or in discrete words with pauses in between.
Speaker model	How the system gathers information about, and represents, users' acoustic patterns. system can be speaker-dependent, speaker-independent, or speaker-adaptive.

ACKNOWLEDGMENTS

Some information for this article was provided by Martha Lindeman, Ph.D., president of Users First, Inc. (Columbus, OH), and Bruce Armstrong, manager, Novell Speech Technology (Orem, UT), and chairman of the Speech Recognition Application Programming Interface Standards Committee.

Judith Markowitz (Chicago, IL) is author of Using Speech Recognition *(Prentice-Hall, 1995). You can reach her on BIX c/o "editors" or on the Internet at markwitz@steve.iit.edu.*

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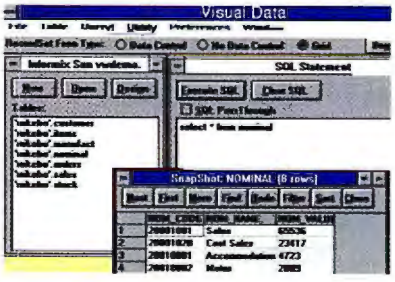

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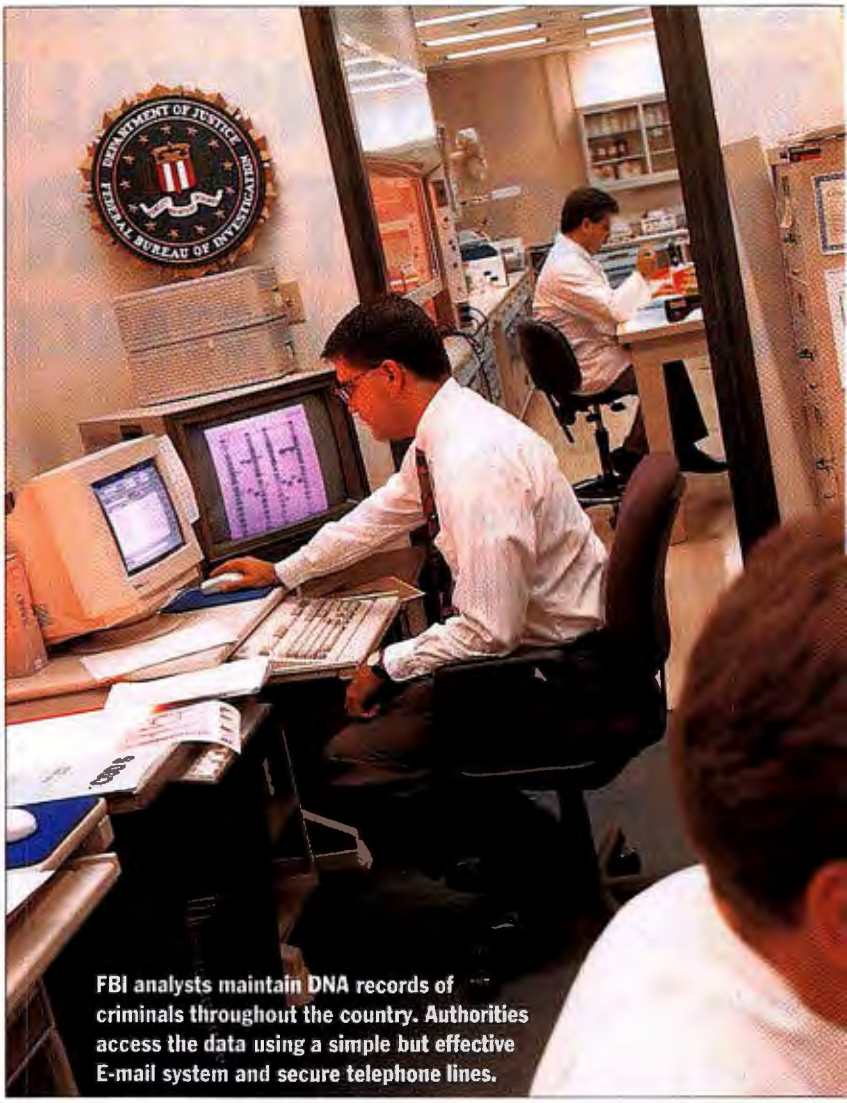
DragNET

G-men launch distributed database; criminals baffled

PETER WAYNER

Criminals beware: Every cell in your body is going to rat on you. With 1 GB of DNA information for each cell, they're as good as fingerprints. Don't believe it? Just ask some police officers in Minnesota. They nabbed a serial rapist. There was blood on his jacket, but at first police couldn't match it to any local victims. They ran the blood profile through the FBI's Combined DNA Index System (CODIS). The profile matched a DNA sample from a rape victim in another part of the state. With additional police work, authorities found enough evidence to make an arrest. In the past, the perpetrator might have walked. This time, he shuffled—to a jail cell.

But the real sleuthing came before this crime ever took place. The technical staff at FBI headquarters in Washington, D.C., first had to figure out how to create a seamless network of databases that would link the DNA labs and law-enforcement agencies throughout the nation. The goal was to make it easy for the police to look for DNA matches and identify criminals who operated in different locations. The solution was a simple store-and-forward mechanism based on a commercial E-mail program that runs over plain old telephone system (POTS) lines and provides all the necessary capabilities without a WAN.



FBI analysts maintain DNA records of criminals throughout the country. Authorities access the data using a simple but effective E-mail system and secure telephone lines.

PHOTO: KATHERINE LAMBERT © 1995

Finding the Right Tool

A high-speed WAN was prohibitively expensive for this application, and it was overkill. There might be 1 GB of data in a cell's DNA, but forensic science had reduced the amount necessary to find accurate matches to about 10 integers (see the text box "DNA by the Numbers" on page 110). As a result, the amount of data traveling over the network was relatively small. Moreover, the lab work to analyze DNA takes several weeks. There was no need for a lightning-quick database response.

However, this doesn't mean the DNA network didn't have a number of design peculiarities. First, the network needed to provide a distributed database so police labs could perform local searches and also access national databases. Second, the network had to be easy to install and maintain by the local DNA labs and police departments. Third, the FBI's division in charge of communications security had to approve the hardware used for encrypting communications links.

The FBI and participating law-enforcement agencies also had some strict requirements for the database itself. Each lab lives under different legal environments, and states treat DNA evidence uniquely. This places different restrictions on how the police can record and analyze DNA information. Some states, for instance, forbid trying to identify a criminal by searching through the records of innocent people. Related to this, the FBI was quite sensitive to the political problems of amassing a large collection of DNA data on citizens for fear that abuse of the database would threaten personal privacy.

Design Complications

In 1990, a technical team from the FBI began working with a contractor, Synetics (Vienna, VA), to develop the E-mail-based system that would bundle DNA queries into electronic messages sent over encrypted lines to central state or national computers.

JUST THE FACTS

The Problems

- Link unconnected PCs throughout the country to a central database.
- Find a solution that is more economical than traditional LANs or WANs.
- Maintain database records according to widely divergent requirements.
- Provide a secure environment that closely controls access to records.

The Solutions

- A store-and-forward system built from standard E-mail software and POTS lines.
- SQL servers with custom front ends for custom queries.
- Government-issue STU-III telephone/modems for security.

The Benefits

- A low-cost, quickly built, and easily maintained network.
- System users can analyze data according to individual needs.

Lesson Learned

- An E-mail/POTS system can be more economical and appropriate than faster networks.

These central servers perform the database search and mail the results back to local labs and police departments.

The E-mail solution was fast enough for the job, and making it secure was easy. The team wrote software for maintaining the local databases and for interacting with the nationwide databases. The FBI provides this software at no cost to 42 local labs in the 21 states (plus the District of Columbia) that participate in the program.

The FBI developed custom source code for the DNA applications while relying on commercial applications (e.g., the Quadbase database, from Quadbase Systems, and Novell's NetWare MHS 1.5 E-mail program) to provide standard services. The approach produced a solution quickly, but it was not without its hassles.

While the programmers didn't have to write E-mail software, they faced problems when knitting together applications from different vendors. Revisions of these applications came throughout the implementation cycle. Incompatibilities such as DLL conflicts would bring the system to a halt. But tracking down bugs was difficult because manufacturers pointed fingers at each other. "Layered architectures are great," says Steve Niezgoda, who is the CODIS program manager. "But you've got to know more than your layer or else the problems will haunt you forever," he adds.

The Network Structure

Each lab in the network maintains a selection of databases that contain DNA records from different sources. One holds records for convicted offenders, another for crime-scene data, and a third database maintains information about the country's population as a whole.

Three layers of computers form the CODIS network. Local labs use 486- and Pentium-class PCs to maintain information about all the cases that each lab processes (the FBI recommends 100-MHz Pentiums with 64 MB of RAM running Windows NT; states are in various stages of upgrading to these machines). Each state keeps a central database, also stored on business-class PCs, with a combined record for all the DNA processed by the local labs. These PCs answer statewide queries.

At the top of the hierarchy is the FBI's central database, which combines records of all the state databases. This database is part of a LAN that includes the database server, a client, and a communications server. All three currently are Pentium-based systems, but Niezgoda says the agency will migrate to RISC-based machines (probably using Alpha or Mips processors) early next year. The FBI's central database runs general searches requested by state and local authorities.

Local-lab databases store tests in Quadbase; Microsoft SQL Server for OS/2 runs the bigger state and nationwide databases. The database software is modular, however, and the team is upgrading to Microsoft SQL for Windows NT. Each state database contains all the local records, and the nationwide database contains all the records that the FBI receives from the participating states.

The FBI built a front end on top of the database to make it easy for lab technicians to make queries (see the screen on page 110). Technicians search for a match by checking the loci (or markers) corresponding to the lab tests that were done. States and labs use different combinations of tests, so the system tries to find the best match it can. Investigators type into data-table cells the integers that roughly represent the lengths of the DNA strands. The program then displays the matching percentage window. The screen shows one successful match for all four loci. A DNA technician performs additional analysis to confirm the quality of the match by examining details in the profile.

Each PC in each DNA lab can search its local database for matches off-line. If someone wants to search statewide or nationwide, the local machine must send its query to the machines responsible for these centralized databases. The links between

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the machines required the most attention from the systems designers. Each local machine needed to forward queries to the larger databases, but the FBI decided it was not feasible to route the queries over the existing FBI WAN because of the volume of traffic already passing through that network. Instead, the CODIS team chose to build an E-mail network to forward the queries as messages.

This E-mail system requires much less overhead, such as expensive leased lines, than a dedicated WAN. Although some people believe that transferring data requires full-time connections among machines, many applications, such as this one, can adequately handle the data flow with a store-and-forward architecture. In this case, the queries and responses are small. Therefore, maintaining dedicated links for small packets is wasteful. The network designers chose MHS because in 1990 it was one of only a few E-mail programs that was able to transfer messages by looking up the phone number and dialing another machine's modem.

The E-mail approach also answered security concerns. The FBI can authorize local labs to use a secure government-controlled telephone known as the STU-III. This phone can encrypt voice and data and perform the functions of an ordinary modem. Programmers can also direct an STU-III to accept calls only from a prearranged list of other STU-IIIs. This lets the FBI lock out access to the DNA database without doing any of the coding or security work itself.

The STU-III, however, is an expensive device. It must be purchased by each lab for about $2000. Also, the hardware makes network maintenance tedious. If a new lab enters the system, its identity must be distributed to the STU-IIIs at the state and national levels so these phones will recognize calls from the new lab. In the future, Niezgoda hopes that software-based encryption will be flexible enough to be useful and strong enough to be acceptable to the FBI's security auditors.

Databases and Access

The FBI is looking at keeping a record of DNA from victims of crimes. If a database of victims is practical, the FBI hopes that samples like the one in Minnesota can help police departments clear up unsolved crimes many years later.

But large databases of innocent people make many people nervous. The FBI's National Crime Information Center (NCIC) computer maintains records of criminals and unconvicted people alike.

continued

DNA by the Numbers

The database for storing the DNA profiles is surprisingly easy to build. Although humans have an immense amount of genetic information encoded in their DNA (about 3 billion amino acids), the FBI's databases need to store only a handful of integers to identify each person. The integers roughly measure the length of a DNA strand containing a particular gene after a special set of enzymes slices up the DNA.

These enzymes cut only the genes where specific genetic patterns occur, and the location of these patterns varies widely from person to person. The result is that the lengths of the strands of DNA left after the enzymatic cutting vary widely from person to person. The lengths of these strands are unique and as personal as fingerprints.

The FBI's DNA database looks for a match between two subjects by comparing the lengths of the strands that contain a particular gene location. If the lengths fall within a fixed percentage of each other—2.5 percent to 6 percent—investigators consider it a match. The locations where the enzymes do their cutting is so variable that the distribution of the lengths of the DNA strands is broad, and the probability of two people matching is extremely low.

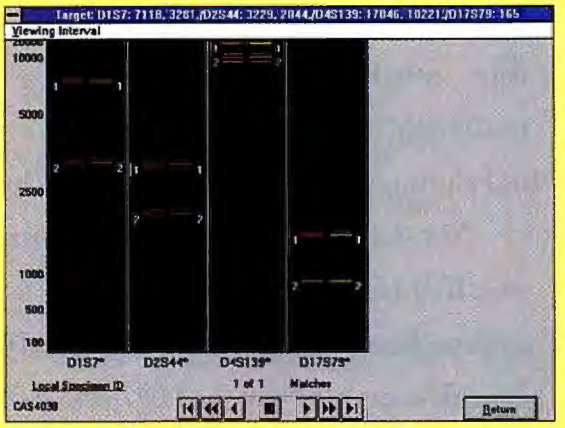
For instance, one lab might choose to slice up the DNA and test the lengths of the strands that contain four common genes (D2S44, D157, D1580, and D17S79 are some popular versions). If the probability that two people produce strands with the same rough length is about 1 in 40, the odds of all strands having the same length is roughly 1 in 2.5 million.

The FBI's database also judges the "strength" of a match to predict the likelihood that two people would have the same mix of genes that turn out to look identical to the test. The FBI's system uses a collection of tables that were developed by genetic scientists. These tables describe the distribution of DNA readings throughout the population.

The database must hold the results from a variety of different genes because many labs use different selections of genes. At least 12 genes are common throughout the country. In general, though, these genes were selected from regions of the DNA that don't seem to have any relationship to physical characteristics. Forensic scientists use these to avoid any future temptation to use the database for purposes beyond identification.

Technicians match DNA samples in the SQL database via a custom front end. After choosing the loci (or markers) used in the DNA sample, technicians input the corresponding data, and any matches appear on the screen.

Each local lab maintains a database of samples it processes. If it can't find a match in this collection, it forwards the query to the state database, which contains a copy of records from all other labs in the state. If there is still no match, the query is passed to Washington, D.C., where the FBI maintains DNA records for the entire country.



The custom front end to the FBI's DNA database lets technicians choose the loci used in the DNA sample, input the corresponding data, and search the SQL database for a match. In this case, the system found only one exact match.

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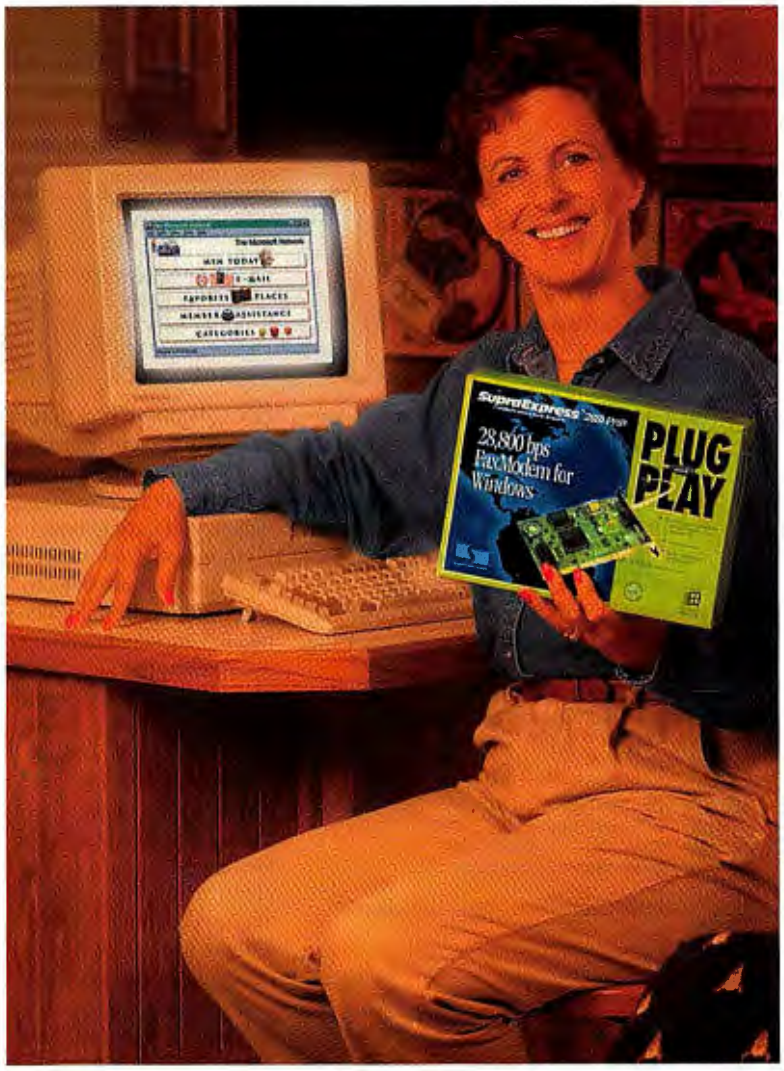

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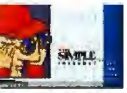

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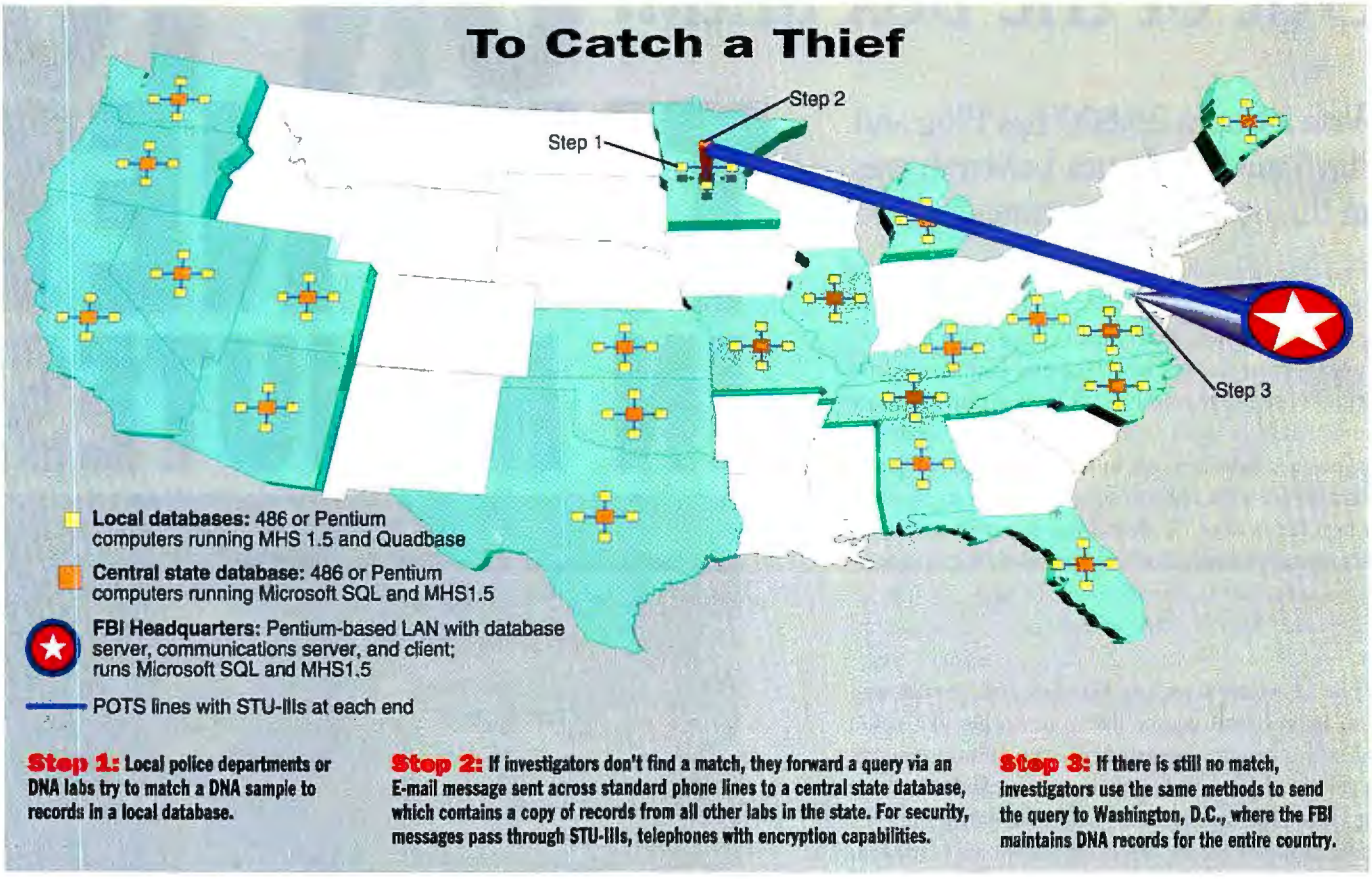

This system has helped with crucial identifications in many investigations. Unfortunately, the system isn't perfect. Some people who have had access to the database misused that privilege. One congressional investigation discovered that a former police officer had used the database to track down a former girlfriend to kill her.

The FBI tries to reduce misuse of the DNA database in a number of ways. The most crucial is to limit access to DNA data. The system stores only specimen and lab ID numbers for each record. If you find a match, you must telephone the lab, identify yourself, and convince the lab that you have a legitimate need to know the actual name behind the sample. The search for a match is fast and computerized. However, discovering the face behind the match requires person-to-person interaction. While this may slow down the investigation process, it also encourages interaction with other investigators.

The limits of database access are controlled by each state's legislature. Some let the police routinely try to match a sample from one crime against all others. Others have strictly limited the matching to narrow classes of records, such as those of convicted felons.

Niezgoda and his team designed the software so that each state can modify it to permit or deny certain types of searches. If a lab technician classifies a sample as coming from a victim, in some states, the technician might find that the software won't allow a search of samples from unsolved crimes. Although the justice might be poetic, people in these states wouldn't incriminate themselves to a crime from their past by falling prey to another criminal.

Future Files

In the future, the FBI hopes to add separate databases for unidentified body parts and DNA samples from the parents of missing people. Parental DNA is crucial for identification because half of our DNA coding comes from our mother, the other half from our father. The database lookup procedure can look for half-matches as easily as whole ones.

The long-term goal for the DNA database is to do more than simply provide confirmation of a crime, says Jay Miller, chief of the FBI's Forensic Science Systems Unit. "We want to generate investigative leads that place someone at the scene of an unsolved crime," he says.

From a technical viewpoint, this may mean building a secure subnetwork that would act as the carrier for the DNA database queries. The FBI's forensic lab might push to have its own secure network developed to carry all the forensic traffic throughout the country and closely link investigations. Then the dragnet around criminals will become even tighter. ■

Peter Wayner is a BYTE consulting editor based in Baltimore, Maryland. His WWW home page is http://access.digex.net/~pcw/pcwpage.html. He can also be contacted by E-mail at pcw@access.digex.com.

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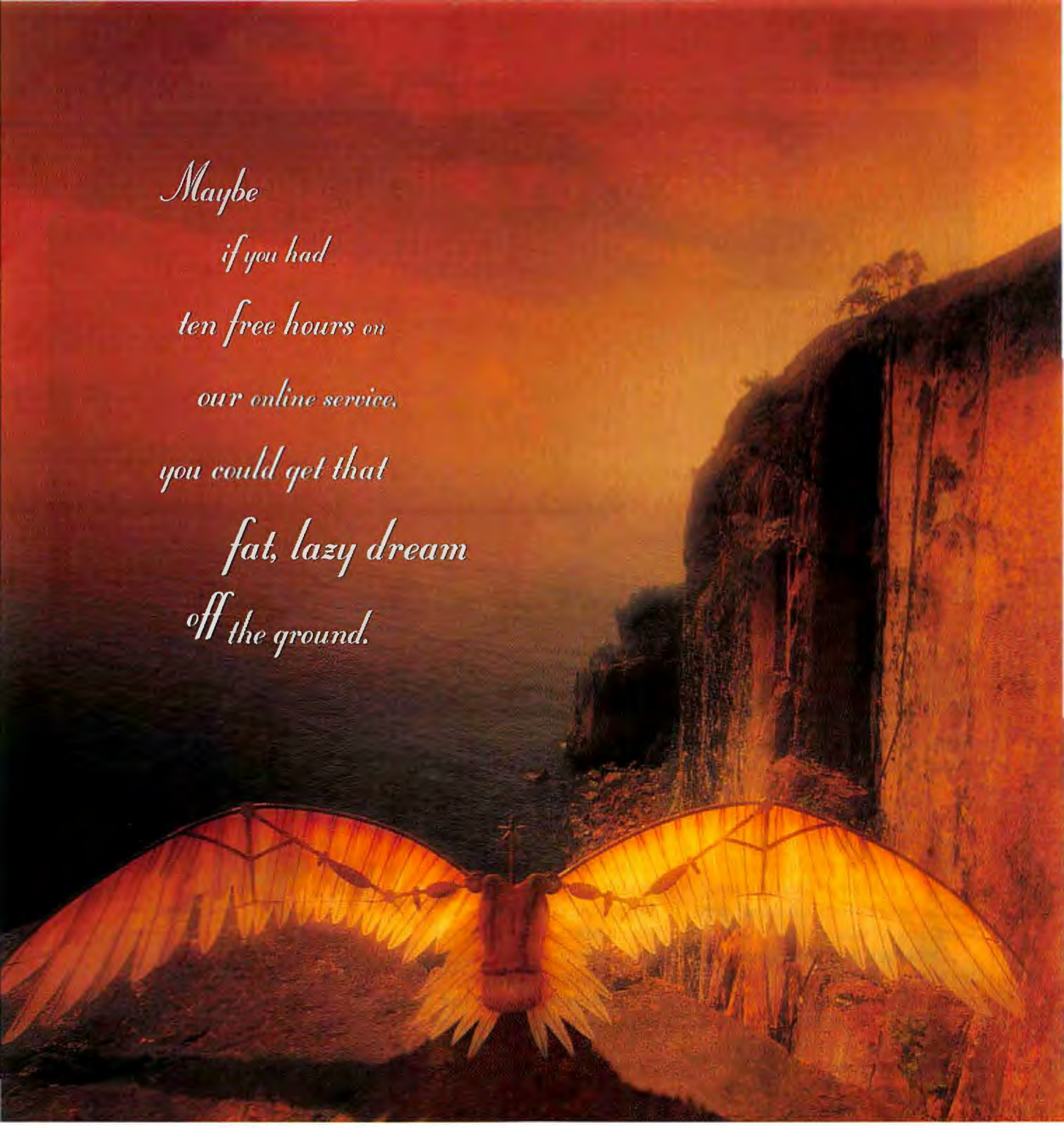

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PERL MAGIC

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How we built the Virtual Press Room using the World Wide Web's two essential development languages, HTML and Perl

Last month we introduced the Virtual Press Room (vpr), a World Wide Web application that organizes the press releases that pile up in BYTE editors' offices. This month we'll look more closely at how vpr works, focusing on two important techniques: using hidden fields to transmit user input through a series of forms, and building Lotus Notes–like views of a Hypertext Markup Language (HTML) archive.

The vpr system (see the figure "Inside the Virtual Press Room" on page 116) comprises three kinds of files: hand-written HTML documents, Perl-generated HTML documents, and Perl scripts. As is typical of Web applications, vpr documents call scripts, which call library routines, which write other documents, which call other scripts and library routines, which write other documents. It's gnarly, but it works.

It's also supremely portable. Browsers on any platform can use vpr. I've also run the vpr back-end scripts on the National Center for Supercomputing Applications (NCSA) Web server under BSD/OS, and on WebSite and the Netscape Commerce Server under Windows NT.

With Perl's parsing and array functions, you can easily build multiple views of an HTML document database.

Gathering the Input

The Submit button on the opening vpr form calls the Common Gateway Interface (CGI) script vpr1.pl, which parses the input and produces one of three kinds of documents: a Required Changes page, an Optional Changes form, or a Preview form.

The Required Changes page lists errors. If there's an empty field, or one that contains more than the maximum amount of text, this page tells you to use your browser's go-back function to return to the input form and try again. Most browsers retain the state of that form, but some annoyingly do not—a defect for

DATA VIEWS IN PERL

The $_ variable is Perl's default string, here containing lines that are read in from each HTML file in the vpr archive.

```
# A. Extract values stored in HTML <meta> tags.
# (See the GetMeta function, part E.)
$metacomp = &GetMeta($_,"name=comp content=");
$metadate = &GetMeta($_,"name=date content=");
$metaprod = &GetMeta($_,"name=prod content=");
```

```
# B. Build a record for each view and add it
# to the array representing that view.
push(@comp,$metacomp . ':' . $metaprod . ':' . $metadate . ':' . $pr );
push(@prod,$metaprod . ':' . $metacomp . ':' . $metadate . ':' . $pr );
push(@date,$metadate . ':' . $metacomp . ':' . $metaprod . ':' . $pr );
```

The push function builds arrays. The . operator concatenates strings.

```
# C. Sort the arrays.
@comp = sort @comp;
@prod = sort @prod;
@date = reverse (sort @date);
```

The reverse function ensures that the date view will appear in reverse chronological order.

The main function passes arrays representing views to the functions that build tables of contents.

```
# D. Walk each array's view, split records
# into fields, and write a table of contents.
# (See the BuildFullToc function, part F.)
&BuildFullToc("comp",@comp);
&BuildFullToc("prod",@prod);
&BuildFullToc("date",@date);
```

```
# E. Extract value stored in a <meta> tag.
sub GetMeta {
    local($line,$meta) = @_;
    if ( index($line,$meta) ne -1 )
        {
        @ret = split(/$meta/);
        ($ret = @ret[1]) =~ s/>//;
        chop $ret;
        }
    else
        {   $ret = ""; }
    return $ret; }
```

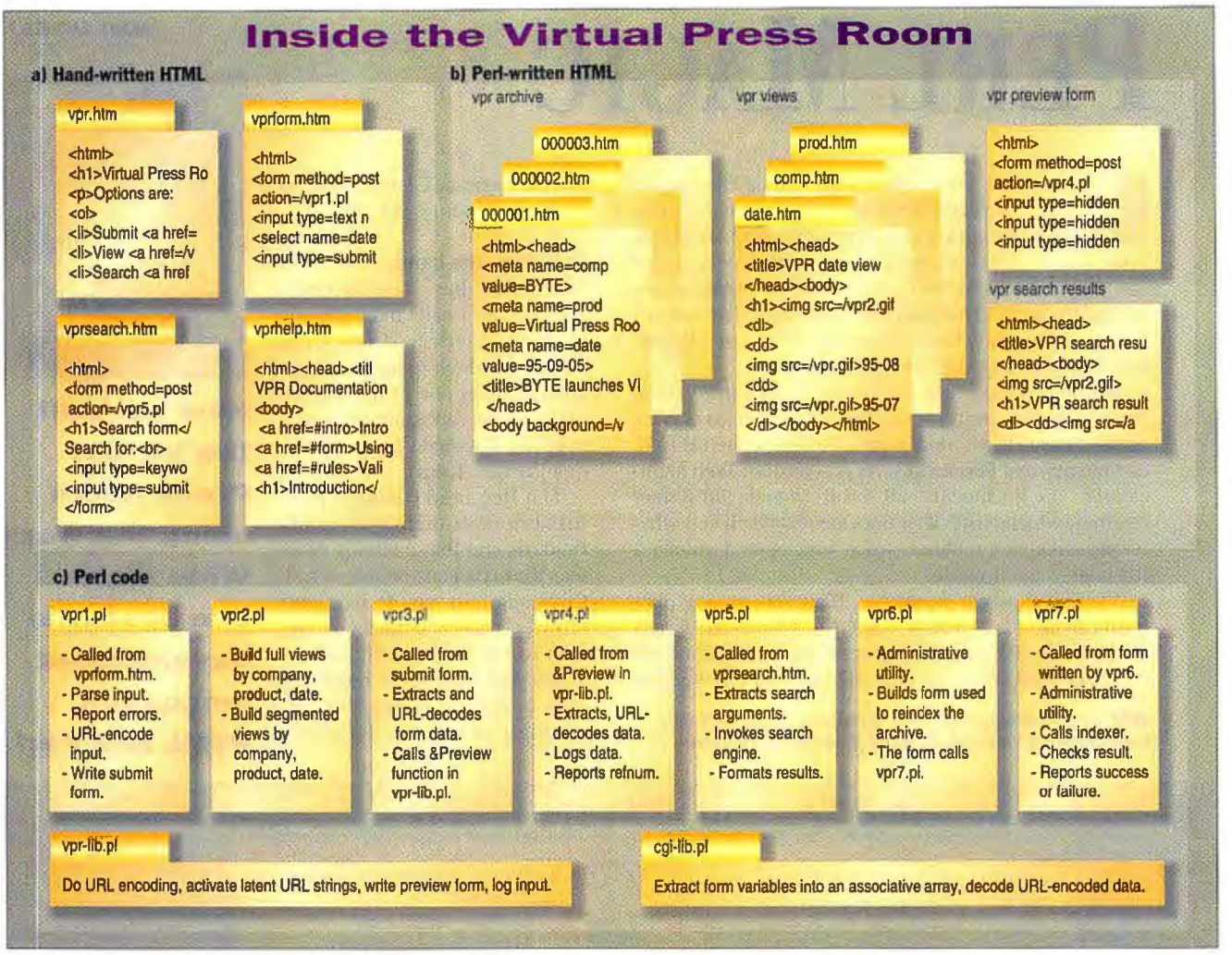
The @_ variable is the default array for arguments passed to functions. The split function uses regular expressions to carve strings into arrays; here, that expression looks like "name=comp value=". The =~ operator binds the search and replace to $ret, the second element of the array split produces. The search and replace trims the trailing > and chop trims the new line.

```
# F. Convert an array representing a view
# into an HTML table of contents.
sub BuildFullToc {
    local($which,@view) = @_;
    $toc = $which . "toc";
    open (TOC, ">$root/$toc.htm");
    print TOC "<html><head><title>List of press releases</title></head>\n";
    print TOC "<body><ul>";

    foreach $item (@view)
        {
        ($first, $second, $third, $file) = split(/:/,$item,4);
        print TOC "<li><a href=pr/$file>$first / $second / $third</a>\n";
        }

    print TOC "</body></ul></html>\n";}
```

The foreach function traverses an array representing a view. Note how split can load all four fields of a record into corresponding variables.



The vpr system rests on the twin pillars of Web programming: HTML and Perl. Some HTML documents are written by hand (a). Most documents (b) are written by Perl scripts (c).

which `vpr` does not yet compensate.

The Optional Changes form lists warnings—for example, that there are HTML tags in the input. Why must there be no HTML? The `vpr` application wants to have control over the HTML formatting of the documents in its archive to ensure consistency of look and feel. Because `vpr` automatically transforms a uniform-resource-locator-signifying (URL) string (http://www.byte.com) into the corresponding HTML link (http://www.byte.com), there's no need for `vpr` users to encode HTML back-links to their own sites.

What if you need to *refer* to HTML-like strings in a document? For example, a Sun Microsystems press release on Java might contain an example of the new `<aɔp>` tag used to invoke Java applets. The `vpr` application will not reject input containing HTML. Instead, its Optional Changes form warns you that it found HTML in the input.

If you intend to use the HTML as text, fine. You can submit the form and go on to the preview. The `vpr` application will neutralize the HTML tag delimiters < and > by converting them into the *entity references* `<` and `>`. If you intend to use the HTML as code, too bad; `vpr` will flatten it anyway, so you might want to go back and remove it.

Finally, the Optional Changes form's action script, `vpr3.pl`, invokes a library function, `&Preview`, and passes in the form's data. The `&Preview` function writes another form that shows how the input will appear with the `vpr`-supplied background, icon, text formatting, and automatic hyperlink activation.

The First Path to the Preview

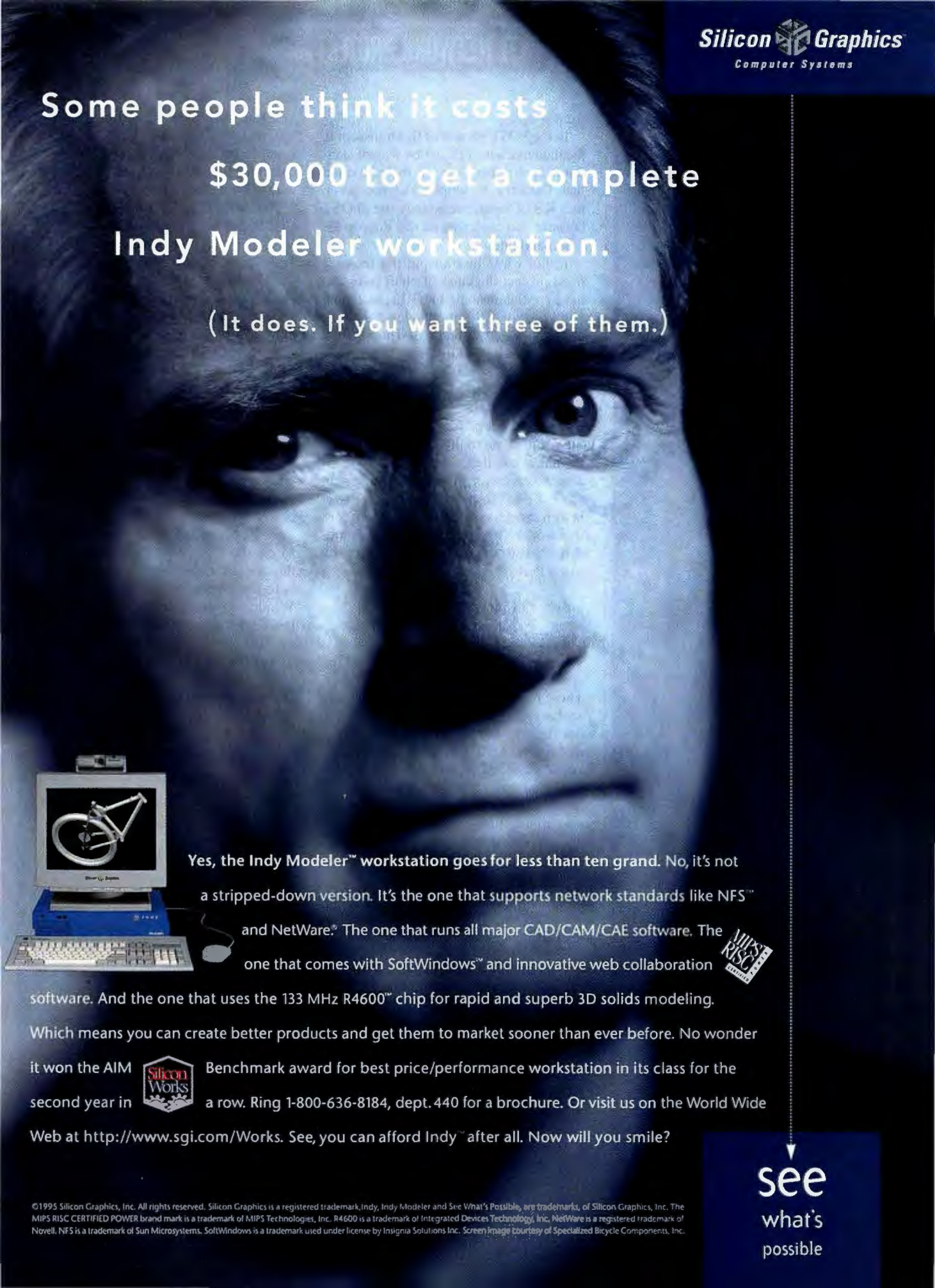
If `vprl.pl` detects no required or optional changes, it calls `&Preview` directly. That means there are two paths to the preview form. One path runs this way: `input form -> vprl.pl -> &Preview`. The other goes like this: `input form -> vprl.pl -> Optional Changes form -> vpr3.pl -> &Preview`.

On the first path, `vprl.pl` can use the standard Perl CGI library that's kicking around on the Internet (ftp://ftp.intergraph.com, ftp://www.process.com) to decode the form's data and transfer it into Perl variables.

But wait. Decode? The two methods that Web clients can use to send form data to servers—GET and POST—encode that data as a URL. GET works like an extended command line, calling the program and the name/value pairs with URL syntax that looks like this:

```
http://cgi-bin/vprl.pl
?comp=byte&prod
=Virtual+Press+Room
```

Here, ? means begin the list of pairs, = connects a name to its value, and + stands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for a space.

In the POST version of this transaction, the data reaches `vpr1.pl` by way of standard input rather than via the command line. The `vpr1.pl` script, which accepts up to 5 KB of input, necessarily uses POST because you can't pass all that data on the command line.

Either way, the transmitting browser must protect the class of characters that have special meaning in URLs, including `?`, `/`, `<`, and `>`. So, it encodes them like this: `%3F`, `%2F`, `%3C`, and `%3E`. The parser in the standard Perl CGI library knows how to decode this syntax.

Hiding Form Data

On the second path, `vpr1.pl` transmits the form's data to the Optional Changes form that it writes and that `vpr3.pl` handles. Users never even see this data, but `vpr1.pl` has to pass it to `vpr3.pl` so it in turn can pass it to `&Preview`. How does this work? The `vpr1.pl` script adds hidden fields to the Optional Changes form using Perl statements like this:

```
print "<input type=hidden
name=company value=$company>";
```

This worked fine for simple fields but fell apart when I fed in whole press releases. These required another layer of encoding so that special characters in the text would not ruin the integrity of the form's hidden fields. And, of course, the new encoder needed a matching decoder.

Sound hairy? It's hard to think about (at least for me it is), but it's easy to do. Here's the encoder:

```
$s =~ s/($RE_SPECIAL)/"%" .
sprintf("%2.2lx",ord($1))/ge;
```

`$s` is a Perl string containing, say, the body of a press release. The `=~` operator binds the search-and-replace operation to that string. The `s/OLD/NEW/ge` function searches for the regular expression between the first and second slashes and then replaces it with what's between the second and third slashes. The `g` modifier at the end of the encoder says, "replace all occurrences."

The `e` operator is truly magical. It says, "evaluate the replace string as a Perl expression and use the result of that evaluation for the replacement." `$RE_SPECIAL` is a string, such as "[\x22|\x25]," that enumerates the special characters to be encoded. The `ord` function gives the ordinal value of `$1`, which stands for each character matched by `$RE_SPECIAL`. Finally, `.` concatenates a `%` with the hexadecimal-formatted output of `sprintf`.

Here's the decoder (lifted from the Perl CGI library):

```
$s =~ s/%(..)/pack("c",hex($1))/ge;
```

Here, `%(..)` matches strings such as `%5C` and `%5E`, and `pack` makes a character out of the corresponding hexadecimal value.

The `vpr` application employs hidden fields along with this coding/decoding scheme twice—once when `vpr1.pl` writes the Optional Changes form, and again when `&Preview` writes the final preview form. To the user, it looks like a sequence of dialogues typical of a normal GUI application. To the programmer, it would be a nightmare without the magic of Perl.

Am I becoming a Perl nut? You bet. Life's short, and what can't get done in a day usually doesn't get done at all. Perl is to the Web what Visual Basic was to Windows programming—a quick-start toolkit that a merely competent programmer (like me) can use to build a really useful application in one day.

Building Notes-Like Views

In the spirit of Lotus Notes, `vpr` offers multiple views of the press-release archive

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it manages—by date, by company, and by product. Perl's powerful string-parsing, array-building, and array-sorting functions made it a snap to create multiple views of the database.

How do you structure an HTML document collection so it can act like a Notes database with multiple views? Here's one approach. Start with an HTML form. When you process the form's data (see "BOMB's Away," October BYTE, for a discussion of basic CGI programming using Perl), store the fields that will serve as sort keys in the header of the HTML document that you create.

The HTML `<meta>` tag, valid within a document's header, is a great place to tuck arbitrary name/value pairs that browsers won't touch but that other utilities can use. Here's an example:

```
<html><head>
<meta name=company value="BYTE">
<meta name=product value="Virtual
    Press Room">
```

Then you parse the document and extract the key values into variables. Perl's `split` function makes this easy (see the figure "Data Views in Perl," parts A and E, on page 115). Combine the keys once for each view and then add each combination to an array representing that view. Again, this is very easily accomplished (see part B). Sort the arrays (part C). Finally, walk through each array, split each item back into its component parts, and then write an ordered HTML table of contents (parts D and F).

As our archive grows from tens to hundreds of documents or more, it will become impractical to list each complete view in a single HTML document. Web browsers can't fetch parts of a document as needed; they have to grab the whole thing. Therefore, `vpr` also builds views that segment alphabetically (e.g., just the companies whose names begin with the letter *M*) as well as by date (e.g., just the announcements for August 1995). You see examples of this kind of segmentation all over the Web.

Eventually, I may need to slide a real database underneath `vpr`. But because Perl can rapidly slurp up and sort arrays of tens and even hundreds of thousands of items on a 32-MB Digital Equipment AXP 150, I'm happy to keep things light, flexible, and portable for now. ■

Jon Udell (judell@bix.com) is BYTE's executive editor for new media.

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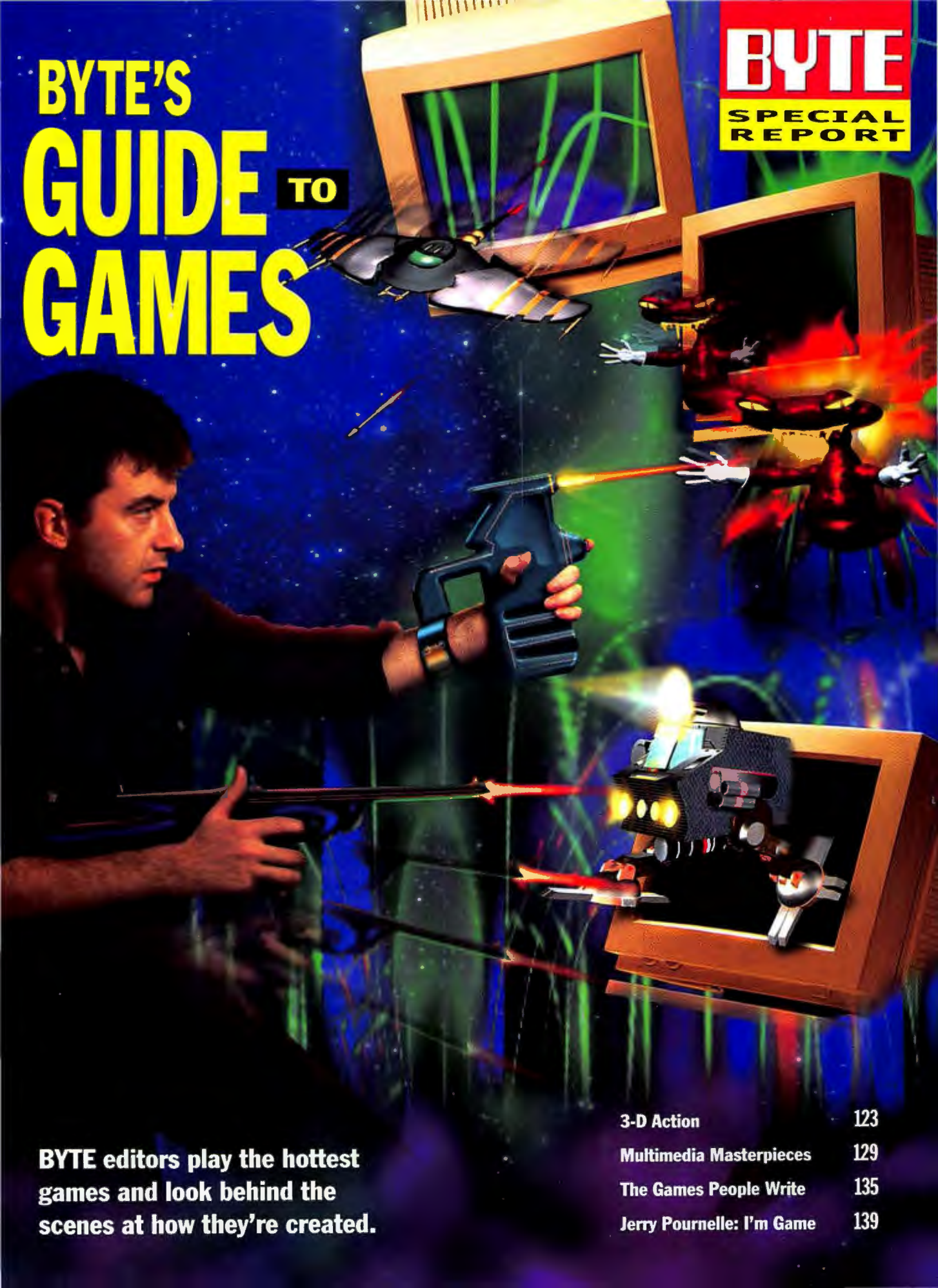

BYTE SPECIAL REPORT

BYTE'S GUIDE TO GAMES

BYTE editors play the hottest games and look behind the scenes at how they're created.

3-D Action 123
Multimedia Masterpieces 129
The Games People Write 135
Jerry Pournelle: I'm Game 139

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3-D Action

REX BALDAZO

It's 1980, and you're playing Atari Battlezone. Looking through your computer's monitor, you track down and destroy enemy tanks and flying saucers. The landscape is a sickly green color, and you keep running into pyramid- and box-shape roadblocks. The little red status bar at the top of the screen doesn't change: It's a clear red strip taped inside the CRT. And those beeps and buzzes are actually the sound track.

Cut to 1995. You're playing LucasArts' Dark Forces or maybe Bungie's Marathon. These are the new breed of games. Like Battlezone, they're first-person 3-D games. But in the 15 years that have elapsed since Atari's venture, things have changed a little. Instead of simple vector graphics, these games employ texture-mapped scenery. They handle thousands of colors with ease. Their professionally scored sound tracks employ up to 16 MIDI instruments, digital explosions, and speech. And instead of requiring a special-purpose arcade machine, these modern marvels run on a home computer costing less than $1500.

The Force Is with You

Dark Forces takes place in the *Star Wars* universe created by George Lucas. The story is straightforward: You are Kyle Katarn, a mercenary hired by the Rebellion to find and help defeat the Empire's newest warriors, the Dark Troopers. Along the way, you must battle your way through 14 levels populated with Imperial forces bent on your destruction.

Games such as id Software's Castle Wolfenstein and Doom were the early masters of this genre, and Dark Forces represents a natural evolution—so natural, in fact, that we were surprised to learn that the LucasArts team that programmed the core game engine had never worked on a 3-D game before—not even such earlier LucasArts games as X-Wing or Rebel Assault.

Under project leader Daron Stinnett, the Dark Forces design team undertook a type of clean-room approach, experimenting with and mastering the techniques required in 3-D action games without taking much from other LucasArts products. They did, however, take key components from previous LucasArts games, such as the iMuse music engine and the Landru cut-scene engine, but the majority of the engine is unique to Dark Forces.

This engine, appropriately code-named Jedi, spends over 50 percent of its time blasting textures onto the wall, floor, and ceiling surfaces of the game's various levels. Some textures are as large as 256 pixels square—thus, the engine must smoothly render a 32-KB block of memory at 30 frames per second as you move around through 64,000 possible angles of rotation.

But to be able to blast these textures at 30 fps, the developers had to make some compromises. Unlike the X-Wing and Rebel Assault engines, Jedi does not allow curved or sloping surfaces.

continued

SCREENS: TAKEN FROM DARK FORCES

And with the exception of Kyle Katarn's spaceship, which appears in only a few scenes, there are no 3-D objects other than the walls, ceilings, and floors. Objects such as enemy soldiers are simply bit maps that the engine rescales as you approach or retreat.

The developers created the objects as 3-D models and then rendered them into bit maps from various angles. They did most of them in 45-degree intervals, which requires eight views to represent an object. The Jedi engine can support up to 32 angles for each object. The additional angles make the object's rotation appear to be smoother but at the cost of requiring more bit maps and thus more room on the CD and in memory.

Objects such as shields and keys don't even bother with the pretense of 3-D. The engine renders them as the same bit map no matter how you move. Clever use of these components—textured surfaces, bit-mapped objects with different angled views, and bit-mapped objects with one view—lets the designers present the marvelously *real* illusion of a 3-D world.

Despite a lack of 3-D-game programming experience, the developers were able to create the core Jedi engine in less than two staff-years of coding. Of course, developing the music, graphics, and general game play took another 30 staff-years.

One of their key concerns during the development of Jedi was portability. The original Dark Forces was targeted to DOS-based machines with a 486 or Pentium microprocessor. The team coded in ANSI C, avoiding any compiler-specific features.

Programmers writing high-performance software generally write the code in C and compile it. They profile the result to look for bottlenecks. The first step to eliminate bottlenecks is to implement the algorithms more efficiently. Developers may be tempted to hand-optimize the code to get additional performance.

The Dark Forces team did that before backing out and returning to the original C in most instances. They found that a Pentium-aware compiler was far more capable than a human at reordering instructions to keep the Pentium busy. And according to Stinnett, these optimizations had no effect on 486 performance. Of course, those who try to run Dark Forces on a 386 will pay a performance penalty. The Pentium-ordered code will be significantly slower than if it had been optimized for the 386.

A REAL OPPONENT

Marathon, a Doom-style game for the Mac, allows up to eight networked users to play with (or against) each other. Why eight? It's nearly arbitrary: The dialog box has room for eight selections. Games such as Marathon 2 may support more.

Bungie wanted its game to run on any Apple network, including AppleTalk. The problem is that on AppleTalk networks, every packet your application sends requires that the microprocessor handle two interrupts—one for the transmission and another for the acknowledgment. With a game running at 30 frames per second, you need to send out 30 messages per second, resulting in 60 interrupts. And that's just to service the outgoing messages. Incoming messages from the other network players bring additional interrupts. Because network services still run in the 68000 emulator on Power Macs, this shortcoming affects even them.

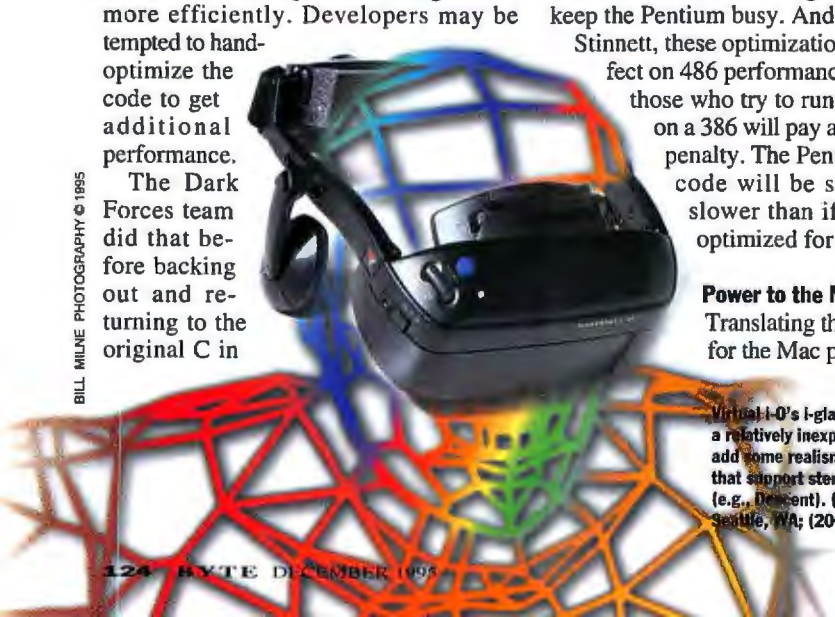
Bungie's answer was to use a 32-bit vector to represent the player's keystroke every 1/30 of a second. The game broadcasts the vector over the network to the other computers in the game. Those computers in turn are broadcasting their own 32-bit keystroke vectors, also 30 times a second. Thus, each computer maintains the correct state of all the players in the game. According to Jason Jones, lead developer on the Marathon project, most network games employ a similar strategy to minimize network traffic.

The physics-model concept in Marathon led to an interesting problem. Because each computer independently computes the players' states, they can quickly get out of synchronization if the different computers have different physics models. That makes the game essentially unplayable, since in one computer the players might be shooting at each other, while in another they aren't even in the same room. Marathon 2 will correct this little glitch by distributing a common physics model when starting a network game.

Power to the Mac

Translating the Jedi engine for the Mac presented several challenges. One of the more difficult was a self-imposed limit. The PC version of Dark Forces requires 8 MB of RAM, and LucasArts wanted the Mac version to have the same requirement. The challenge is that on an 8-MB PC running DOS, an extended-memory application such as Dark Forces has about 7.5 MB to play with. But because the Mac OS has to run a GUI, much less memory is available, depending on what extensions are installed. After examining some Mac setups, the team decided that an 8-MB Mac could reasonably be expected to have 4.5 MB free, so that was their target.

Aaron Giles, the lone Mac developer on the Dark Forces team, says that the temptation for Mac programmers is to "load everything into memory." But that would not work here. Therefore, one of his main programming challenges was to efficiently manage swapping components



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Virtual I-O's i-glasses ($799) are a relatively inexpensive way to add some realism to 3-D games that support stereo headsets (e.g., Descent). (Virtual I-O, Seattle, WA; (206) 382-7410)

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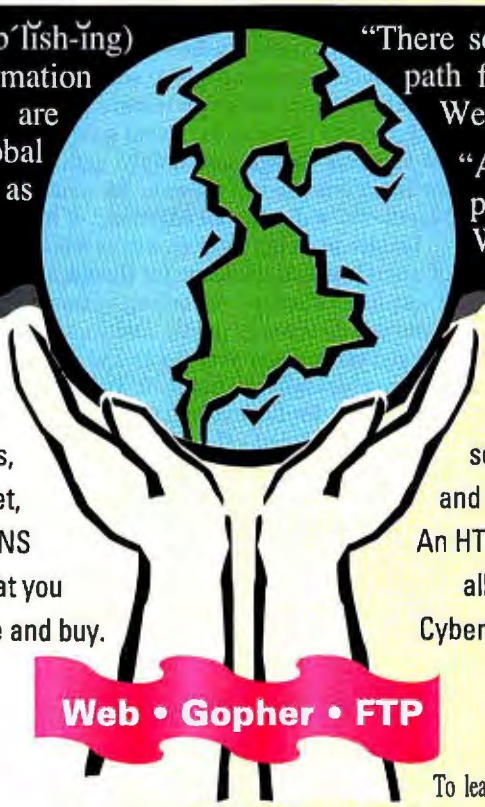

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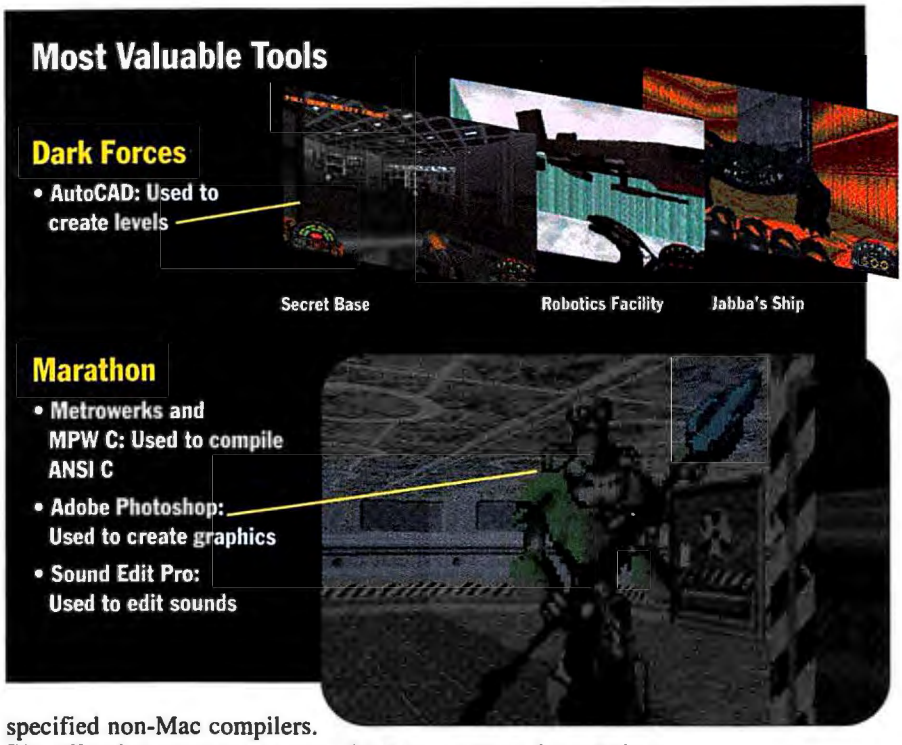
of the game in and out of memory.

Because LucasArts had invested much more effort in the game content than in the game engine, the goal was to bring that content essentially unchanged from the PC. That forced the game to take another memory hit, because the team had to add a MIDI module to the Mac version that could support the same instruments and mixing capabilities as the PC—eating up about 400 KB of the ever-shrinking memory. To keep this memory hit to a minimum, the game loads only the instruments it needs at any particular point in the game.

To satisfy the demanding Mac crowd, the developers implemented Dark Forces in 640- by 480-pixel graphics rather than the PC version's 320 by 200 pixels. In essence, the Power Mac is being asked to move five times as much data through the microprocessor and still play as smoothly as a Pentium. And it can do this.



Running a Marathon

Marathon, from Bungie Software Products, is available only for the Mac. It is a network-playable game that can run on a 68020, though a 68040 is recommended, and a native Power Mac version exists. The scenario is similar to Doom—you are on a space station inhabited by beasts who enjoy shooting at you. Like Doom, and unlike Dark Forces, Marathon provides multiplayer network support (see the text box "A Real Opponent" on page 124).

Even though Marathon is a Mac-only game, Bungie went to the same lengths as LucasArts by writing the game in portable ANSI C. The company has successfully run the code through numerous Mac compilers, such as Metrowerks and MPW C. It has also compiled on a number of unspecified non-Mac compilers. The effort has proven so successful that Bungie is considering licensing its core game engine.

Unlike LucasArts, Bungie chose to use the Mac's native sound support rather than develop its own. Sound effects can play on any Mac, but playing background music requires the use of QuickTime 2.0. Bungie developed software to create what it calls active-panning stereo sound. As the orientation of the player relative to the sound source changes, the sound levels in the speakers change accordingly, getting louder in one ear and softer in the other. Marathon 2 will take full advantage of it.

Texture-mapping surfaces was as much of a performance challenge for Bungie as it was for LucasArts. According to Doug Zartman, director of public relations at Bungie, texture-mapping floors and ceilings is especially difficult. In fact, for 680x0 Macs, the floor/ceiling texture mapping can be turned off in Marathon, resulting in a significant speedup.

Because you can install the game on a hard drive (Dark Forces runs the main executable file from the hard drive but leaves most of the game on the CD-ROM), you can change the way components operate. Just as with Doom, third-party editors allow you to customize every level and creature in the game. But unique to Marathon is the physics model, which lets the characteristics of the game be changed. For example, you can edit the physics model so that the recoil from your weapon will send you flying.

Cheats are common to many games. These let you get weapons and lives without earning them or reach certain levels without having to fight your way through aliens. But the only "cheats" in Marathon involve changing the physics model.

End Game

Game developers are a tight-lipped cabal. At least one company, id Software (the maker of Doom), makes it a policy not to talk to the press. Interplay (Descent) and Apogee (Rise of the Triad) didn't even bother to return repeated fax, voice, and E-mail messages. Nobody wants to give another company a competitive advantage.

The two companies we did talk to were always careful with how far they would go in revealing their secrets. We did manage to get Bungie's Jason Jones to admit there is actually one cheat in Marathon. But we had to promise not to tell.

One thing is clear: The next generation of games will be pushing the envelope harder and further. Bungie's Marathon 2 will feature improved graphics and a more-realistic sound environment. The next major game from LucasArts, Rebel Assault 2, will have cut scenes featuring real actors and will let you fly the fabled Millennium Falcon.

The adventure has only just begun. ■

Rex Baldazo is a technical editor for BYTE. You can contact him on the Internet or BIX at rbaldazo@bix.com.

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Multimedia Masterpieces

TOM R. HALFHILL

Hollywood talent and programmers create today's hot games

Gone are the days when a lone programmer would create a hit game while toiling in a corner of his bedroom. Except for a few shareware authors, the creators of commercial games in the 1990s are teams of writers, artists, musicians, actors, directors, videographers, and programmers who often work with multimillion-dollar budgets and Hollywood production values.

Ironically, programmers rank relatively low in this hierarchy. Creative control rests in the hands of directors, producers, and project managers; hired talent representing numerous artistic disciplines generates content. Hot-shot programmers, once the kings of computer gaming, are indispensable for executing the final product, but they're definitely not in the director's chair.

Where once a game might have been based on a clever programming trick or special effect, today's games are likely to be judged on story lines and artistic content. This is especially true of multimedia adventure games designed for mature players.

Two outstanding examples: Phantasmagoria from Sierra On-Line and Buried in Time from Sanctuary Woods. While both games will entertain you with startling effects, their real strength is the way they blend traditional storytelling with interactivity in a movie-like experience.

Phantasmagoria

Packed onto seven CD-ROMs, Phantasmagoria might seem like the *War and Peace* of adventure games. But it's actually intended for relatively novice players, says project manager Mark Hood. Sierra's goal was to attract a broader audience. So the puzzles are less difficult, and the theme isn't based on science fiction.

Phantasmagoria is a creepy tale of gothic horror, electrified with some truly graphic graphics. (Indeed, despite a "censor button" that tones down the game, Phantasmagoria was recently rejected by CompUSA's chain of computer stores.)

Sierra began developing the game in 1993. Roberta Williams, cofounder of Sierra and author of the popular King's Quest series, wrote the original story. Phantasmagoria eventually ballooned into a $4 million project that involved about 50 people, not counting the California State University (Fresno) orchestra and choir. Most were artists; only eight to 12 were programmers. "I've seen our budgets go from 2 to 1 in favor of programming to 2 to 1 in favor of art," says Hood.

Unlike most companies, Sierra doesn't write its adventure games with standard programming tools or use outside developers. Instead, in-house programmers use a proprietary tool called Sierra's Creative Interpreter (SCI)—an object-oriented language that combines elements of Lisp, Objective C, and Smalltalk.

SCI is based on a procedural language that Sierra produced in-house more than seven years ago. It has two main advantages

SCREENS: TAKEN FROM PHANTASMAGORIA

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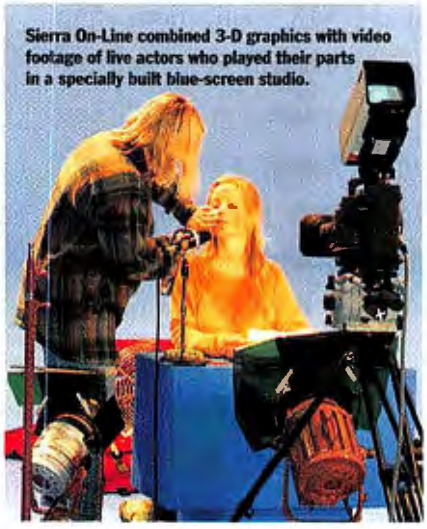
Dedicated game machines such as Sony's superb PlayStation aren't going away anytime soon. But they aren't as different from your PC as you may think—inside this machine are a Mips R3000A and a few custom ASICs. It even runs a lightweight version of Unix.

over standard tools: rapid game development and portability. Sierra programmers use the system's interactive debugger to modify their code while the game is running, which saves enormous development time. And the compiler generates p-code that executes on multiple run-time interpreters. Sierra has interpreters for DOS, Windows, and 680x0-based Macintoshes, plus another in the works for Power Macs.



Sierra On-Line combined 3-D graphics with video footage of live actors who played their parts in a specially built blue-screen studio.

Interpreted code is usually slower than compiled code, but Hood says SCI delivers good performance. "The interpreter has highly optimized routines written in C++ and assembly. When the program does a 'kernel call,' it directly calls those low-level routines and executes as fast as any C++ or assembly language routine. An example of a kernel call is 'Play Movie'—you just make the call and tell it the number of the movie to play."

Sierra's artists created most of the game's dazzling screens on a Silicon Graphics Indigo 2 workstation using SGI's Alias 3-D modeling software. They retouched the images with Adobe PhotoShop to make them appear less artificial.

Videographers shot all the live video in a brand-new blue-screen studio that Sierra constructed in Oakhurst, California. It has blue-screen panels on the floors and walls, with curved surfaces wherever the panels would meet at right angles. Actors play all their parts in this studio; editors later composite their images seamlessly with the computer-generated graphics.

Sierra taped all the action with broadcast-quality Betacam SP cameras. Although this may seem like overkill for video that's going to play back in a 592- by 283-pixel screen window, Hood says the quality difference is readily apparent. The raw video footage, when digitized, filled 29 CD-ROMs. About 2 hours' worth—compressed with Sierra's own proprietary software—made it into the finished game.

Video editors used several tools to combine the live footage with the computer graphics. For example, whenever a person opens a door in the game, the video footage of the actor is composited with a

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computer-generated door. Sierra used Autodesk's Animator Pro and 3-D Studio for this frame-by-frame editing.

The developers also made heavy use of a rack-mount video-compositing device called the Ultimatte. Although there's a software version of the Ultimatte that runs on a Power Mac (VideoFusion 2.0), it takes about 4 seconds to render each frame, and Sierra needed to process 72,000 frames. Hence the rack-mount Ultimatte: It works in real time. They processed additional frames with Parallax Graphics' Matador on the SGI Indigo.

Composers Mark Seibert and Jay Usher wrote the music. About half was performed live by the university orchestra and choir, and the rest was created on MIDI instruments using Voyetra Technology's AudioStation software. Sierra recorded foley effects (footsteps, doors opening, etc.) in a special sound room. Later, sound editors overdubbed these effects onto the music tracks and then synchronized the sound and video using Adobe Premiere and Microsoft VidEdit.

Hood is traveling to Sri Lanka to collaborate with Arthur C. Clarke on Sierra's next major project: an adventure game based on Clarke's science-fiction novel *Rendezvous with Rama*.

Buried in Time

Instead of relying heavily on video footage and composited graphics, Sanctuary Woods' Buried in Time takes a different approach. All the scenes in this science-fiction adventure game are rendered in computer-generated 3-D graphics. The few scenes that do include live-action video are there for a purpose; for example, TV news reports and videophone messages provide important clues to the main character, a time-traveling detective who works for the Temporal Security Agency.

As a result, Buried in Time feels a little more interactive than Phantasmagoria. It's also designed for more-advanced players. Buried in Time is the sequel to the Journeyman Project, a hit based on the same theme. In this installment, your mission is to clear your name of false charges that you traveled back in time to alter history.

Presto Studios, an independent development house in Miramar, California, created Buried in Time for Sanctuary Woods. Most games these days are developed by someone other than the distributor, and even companies like Sierra that do in-house development will often assign some miscellaneous work to outside contractors.

Presto Studios began working on Buried in Time in July 1993. It was supposed to fill only one CD-ROM, but multimedia projects tend to acquire a life of their own; it ended up filling three CDs. The game eventually involved 16 developers (14 artists of various types and two programmers), 17 actors, and six testers. Before the first line of code was written, the game's authors (David Flanagan, Phil Saunders, and company president Michel Kripalani) spent months studying the historical time periods re-created in the game.

Presto did all development on Macs before porting to the PC. A single programmer wrote all the code on each platform. Greg Uhler, Presto's chief financial officer, wrote the Mac version in Lingo, the scripting language in Macromind Director. Uhler also wrote the Journeyman Project, which was ported to the PC with Director. But the PC version of the Journeyman Project ran so poorly, says Kripalani, that they decided to rewrite the PC version of Buried in Time in C++. In the future, he says, they'll write both versions of new

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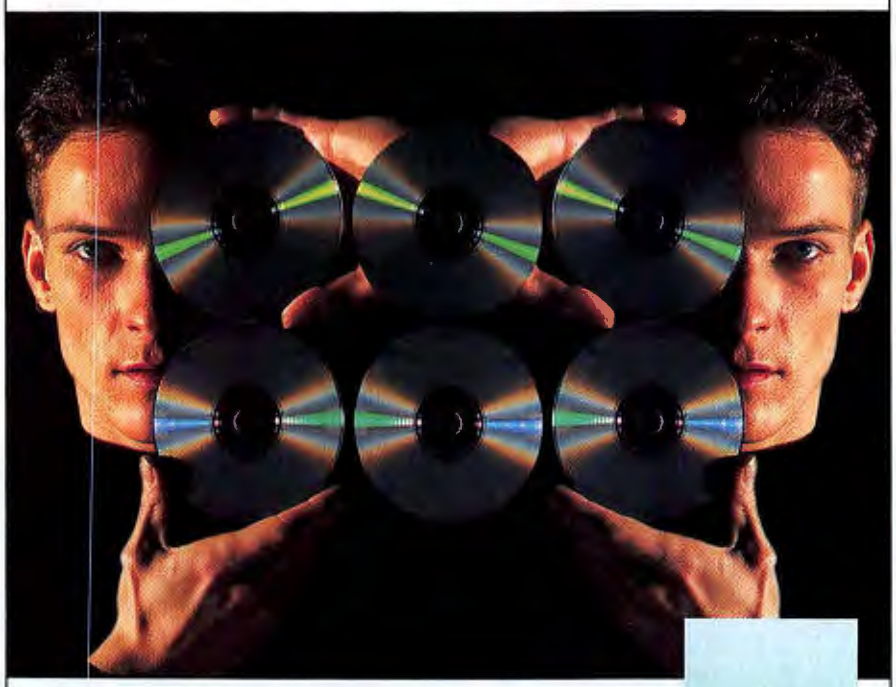

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Generating the graphics was an intensive process. The artists started with a 3-D modeling package—Form-Z from Autodesys—to create the polygon models. Then they used Adobe PhotoShop and Kai's Power Tools to create textures. They used Electric Image, a Macintosh 3-D animation package, to map the textures onto the models and generate the animation.

Buried in Time is so richly detailed—about 300,000 polygons and 30 to 50 light sources per scene—that rendering each frame required 5 to 15 minutes. With 30,000 frames in the entire game, that's a lot of processing. To handle the job, Presto bought six Power Mac 8100/100s, each with 140 MB of RAM and 2-GB drives. They crunched graphics 24 hours a day.

Presto shot the live video with Betacam SP and Hi-8 cameras, then used Aldus AfterEffects and Adobe Premiere for compositing. As was the case at Sierra, Presto noticed that broadcast-quality Betacam makes a big difference. Presto also discovered that some video effects couldn't be achieved even with the latest software. For

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example, computer-generated lightning bolts didn't look convincing, so the artists added them by rotoscoping—drawing them by hand on every video frame.

Bob Stewart, an outside contractor, composed the music and overdubbed the foley effects on a Quadra 950. For sound sampling, digital audio recording, and MIDI sequencing, he used Digidesign's ProTools, OSC Media Products' DECK II, and OSC's Metro.

Now that Buried in Time is finished, Presto is working on an all-new version of the Journeyman Project for the Sony PlayStation and Sega Saturn, and an action game for Apple's Pippin, a Mac-like game machine to be made by Bandai. "We're keeping busy," says Kripalani. ■

Tom R. Halfhill (thalfhill@bix.com) is a BYTE senior editor.

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The Games People Write

JOHN MONTGOMERY

Playful advances in Windows 95 make it easier to develop games for Microsoft's new OS

SCREEN: TAKEN FROM SUPER BUSBY

At last, Windows has been freed from Solitaire confinement. You can now run real games—action games, shoot-'em-up games, network games, games with video. All this, thanks to Microsoft's Win32 game-development tools. The Game SDK can help create games as fast if not faster than the games we got used to under DOS, game designers say. Not only are they faster, they're easier to develop. According to LucasArts programmer Matthew Russell, "Because the Game SDK provides a layer of abstraction between the game developer and the hardware . . . it's actually easier to do in Windows what we do under DOS, especially for high-resolution graphics."

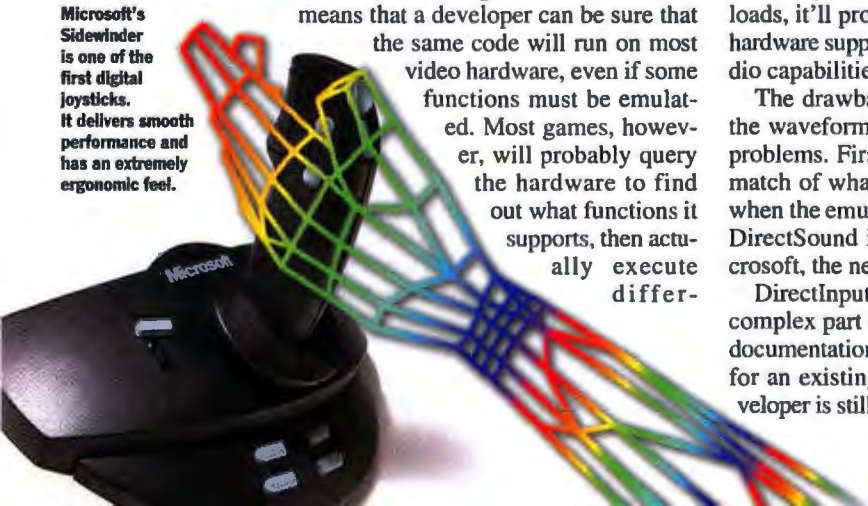
Blowing Up Minesweeper

The Game SDK has four main parts: DirectDraw, DirectSound, DirectInput, and DirectPlay. The first three of these APIs provide interfaces that enable programmers to write directly to video, audio, and joystick hardware. DirectPlay makes writing multiplayer games easier. Let's take a look at each.

The DirectDraw services handle graphics functions typical of games, including overlays, stretching, alpha blending, and Z-buffer-aware block-transfer engines (*blters* for short). It provides services for managing display memory and hardware, as well as some memory-management features (e.g., allocation).

Architecturally, DirectDraw has two main parts: the DirectDraw hardware abstraction layer (HAL) and the DirectDraw services. Hardware developers write the device-dependent code (either as a video driver or as a separate DLL), one end of which talks to the hardware, the other of which exposes the hardware's functions to the HAL. Software developers write to the HAL.

When your graphics hardware doesn't support some feature, DirectDraw uses software emulation. To a game, the emulation looks like part of the HAL, so it doesn't need to know that DirectDraw is emulating some functions. This means that a developer can be sure that the same code will run on most video hardware, even if some functions must be emulated. Most games, however, will probably query the hardware to find out what functions it supports, then actually execute differently to make sure performance is optimal.



Microsoft's Sidewinder is one of the first digital joysticks. It delivers smooth performance and has an extremely ergonomic feel.

BILL MILNE PHOTOGRAPHY © 1995

DirectSound works pretty much the same way: A generic API call passes through a HAL, which turns it into something your audio card can understand. DirectSound exploits accelerated sound hardware, including hardware mixing and sound-buffer memory. Your games don't have to ask specifically for hardware acceleration: DirectSound takes care of it automatically. DirectSound also supports 3-D audio, which is what makes airplanes in games sound like they're flying by from one side to another.

Like DirectDraw, DirectSound allows software emulation of features your hardware doesn't support. However, when a game loads, it'll probably query DirectSound to figure out what your hardware supports and will then alter its functions to match the audio capabilities of your PC.

The drawback with DirectSound's emulation is that it uses the waveform hardware on your sound card, which poses two problems. First, the emulated sound isn't going to be a perfect match of what the DirectSound HAL could generate. Second, when the emulation layer has allocated the waveform hardware, DirectSound is locked out, and vice versa. (According to Microsoft, the next version of DirectSound should fix this.)

DirectInput is mainly for joystick support, and it's the least complex part of the Win32 Game SDK. According to the SDK documentation, DirectInput is in fact currently just another name for an existing Win32 function called JoyGetPosEx. "The developer is still forced to rely on processing the Windows message

queue for keyboard input," says Matthew Russell of LucasArts.

Net Games

Now we come to DirectPlay, the network-enabling part of the SDK. It works with Windows 95 and NT and provides a way for games to talk to each other without worrying about the underlying communication protocols (network or serial).

DirectPlay has two parts: the IDirectPlay interface and the DirectPlay server. IDirectPlay provides methods that enable you to create and destroy players, send messages to players, invite players into games, and so on. DirectPlay servers are basically HALs for networks, on-line services, and modems.

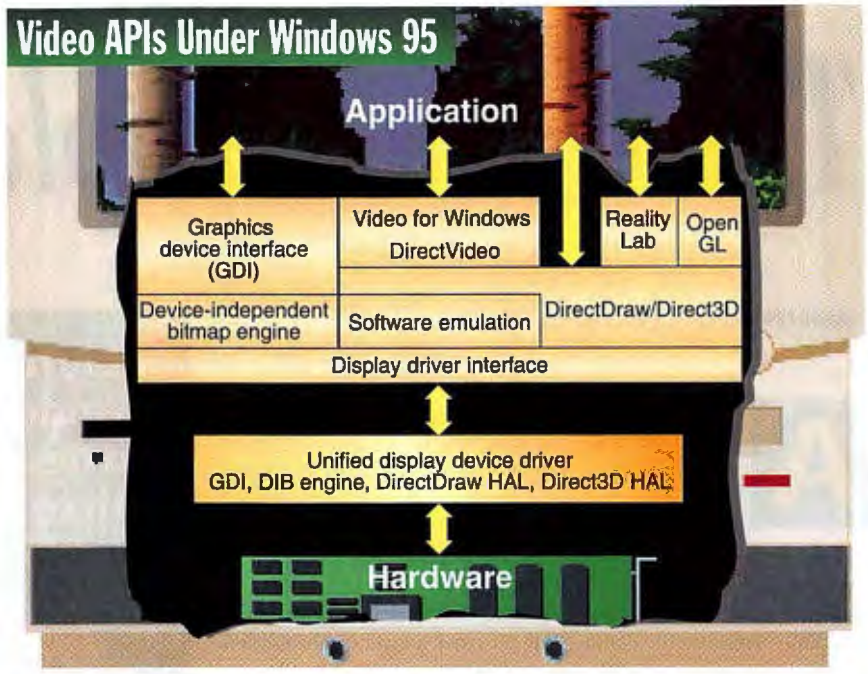
When you run a DirectPlay-enabled game, it talks to the DirectPlay object, which interacts with one of the servers, which talks to the transport. Your game can query the DirectPlay object to find out about the network (e.g., its bandwidth) to adjust the game's requirements.

Once your copy of the game is on the network, it looks for other games that have the same globally unique identifier (GUID, which the developer creates and which is unique to each game). Once your copy has found another copy, the game sets about creating players for each individual. Then the game can begin.

Reversi of Fortune

There are two other APIs you may hear about in relation to Win32 games: WinToon and the 3-D tools.

WinToon is a frame-based animation playback system. Microsoft points out that it's a developer toolkit, not an authoring tool. Basically it enables developers to create the foreground movie and the background. But, says Ken Nicholson, director of ATI Interactive, "WinToon isn't that great for games." Performance, he says, is the main drawback. "WinToon is built on top of the graphical device interface, and GDI is slow. GDI is designed to move graphics across the bus," which is too slow for games. Nicholson says most developers will probably find DirectDraw a better tool.



Windows 95's graphics architecture hinges on the unified display device driver, which the video hardware vendor will typically write. One end of the unified display driver talks to the video hardware; the other end exposes the hardware's capabilities to Win 95's various APIs and graphics engines. Most game developers we talked to indicated they would usually write to DirectDraw and Direct3D, with some other calls to higher-level APIs.

Why? Because DirectDraw lets you get a pointer directly to video memory and page flip (prepare a screen off screen, then tell the hardware to switch to that screen). It enables you to put your own graphics into the video card's video space, which gives you some extra memory to store graphics. Plus, DirectDraw gives you access to the blter. It can also do transparent blts (it knows how to copy irregular shapes), effectively saying "copy all the pixels that aren't a certain color." WinToon can't do any of that.

The Windows 95 game-development tools also include some extensive 3-D features. If you're developing a game that needs a 3-D engine, you could choose to write to the Reality Lab 3-D API. If you already have an engine, you're more likely to port it to support Direct3D (which behaves pretty much like the other Direct SDK subsystems). Basically, the architecture places the Reality Lab API on top of Direct3D, which in turn talks to the 3-D device driver interface, which is basically the 3-D HAL.

But these 3-D tools aren't going to mean great leaps forward for 3-D games. Nicholson explains: "The 3-D hardware that's coming out doesn't do geometry acceleration. Because of that, the types of games are going to be about what you get with Descent, but with better resolution. [The PC is] not going to be a PlayStation. The Pentium just can't do the math to keep them moving."

The Games

So who's creating games? Well, there's id Software, with Doom for Windows 95. Yes, your favorite shoot-'em-up is available for Windows. It runs pretty well, too, if the prerelease version we played is any indicator. Microsoft is also entering the 3-D action genre with Fury3, a game that puts you into the pilot's seat of a fast fighter shooting down enemies left, right, above, and below.

If you prefer both feet firmly on the ground, Accolade's Super Busby for Windows 95 will give you a treat when it becomes available soon. Running at speeds of up to 70 frames per second, Busby gives the DirectDraw architecture a run for its money as this bobcat saves the world from the yarn-craving Woolies. ■

John Montgomery (jmontgomery@bix.com) pilots BYTE's features section.

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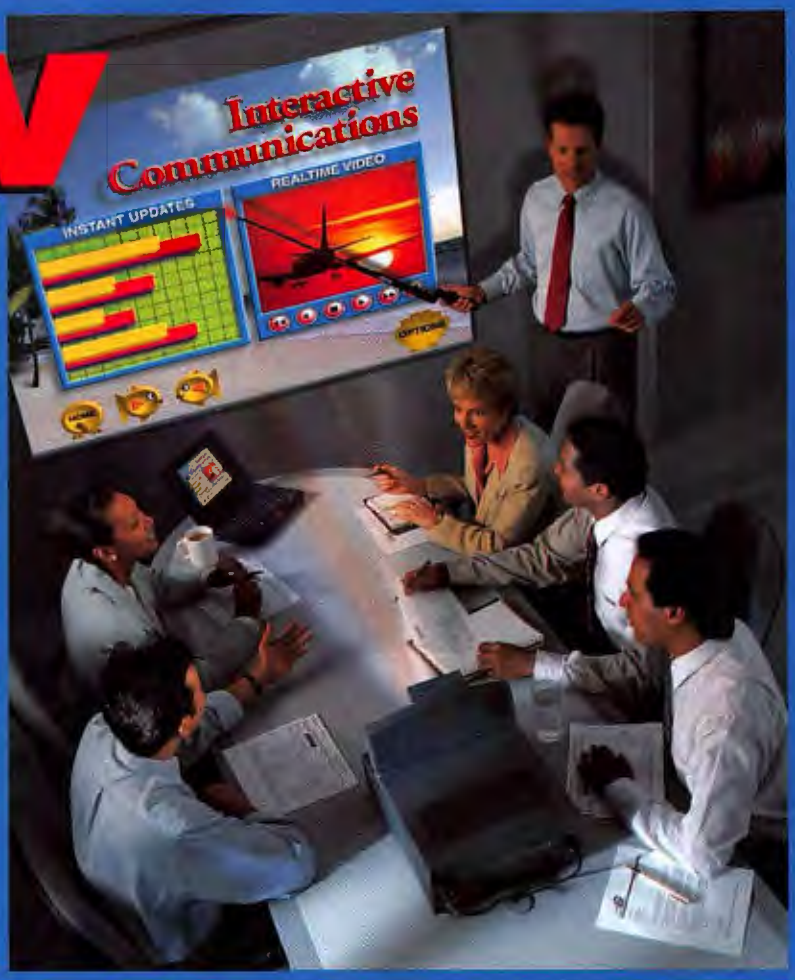

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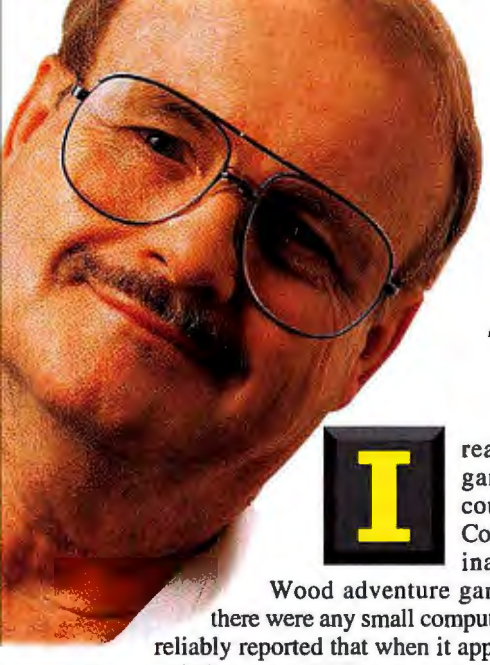

I'm Game

JERRY POURNELLE

I really love computer games. My first encounter was with The Colossal Cave, the original Crowther and Wood adventure game—written before there were any small computers. A text game, it's reliably reported that when it appeared in a minicomputer or mainframe establishment, system administrators lost two weeks per programmer. It got to me. I still remember the creepy feeling when I saw the shadowy figure waving at me.

There are still some pretty good text games, but now we want graphics, and not just "graphics" built out of ASCII characters. For a long time, graphics meant Apple. Then came the Atari and Amiga; but eventually, PCompatibles sported hot graphics capabilities, and now Doom is ubiquitous in glorious 3-D. Doom is the AutoCAD of games. Real Doom fanatics go on-line and download toolkits that let them design new scenarios, new weapons, and new monsters. You haven't lived until you've killed Barney the Dinosaur by firing frozen chickens at him.

Doom is fine action, but I like strategy and simulation games, like Origin Systems' Wing Commander. When I first got Wing Commander, it was so good I had trouble believing it. I felt better when Professor Niklaus Wirth, one of the best-known computer scientists in the world, visited Chaos Manor and stared openmouthed pointing out Wing Commander graphics features to his wife. I gave a copy of it to science fantasy author Terry Pratchett on the theory that because I'd wasted so much time with it, I might as well slow down the competition; but it didn't work. He mastered the game and increased his output.

The latest games include movies and have budgets comparable to small feature films. Wing Commander's latest version is no exception. All the characters in the original Wing Commander were animations, but Wing Commander III features Mark Hamill and a star-studded cast. They act out the role-playing part of the script. Then you go pilot your ship and slaughter aliens.

Favorite Pastimes at Chaos Manor

Wing Commander III is worth getting, but, perversely, I much prefer the combat action of Origin's Privateer—a game that uses the Wing Commander flight-simulator engine but is more free-form. My preference may be due to age slowing my reflexes. Fortunately, there are plenty of games for us elder warriors. Master of Orion, a game of interstellar diplomacy and conquest, is one of my all-time favorites, and I play it about once a month.

For those who like fantasy without violence, there's Pratchett's Discworld, with actor Eric Idle as the voice of Rincewynde. Fair warning: while this is a lot of fun, you are unlikely to solve the puzzles without a lot of help. You can get help from several on-line game conferences; one of the best is Scorpia's on GEnie.

The CD-ROM has enabled the reissue of many wonderful old games at low cost. While simulation fans may prefer the newer SimCity 2000 to the original, many of us think the original Railroad Tycoon is better than the upgraded Deluxe edition. If you don't know about Railroad Tycoon, you have a treat in store. Sid Meier, the genius designer of Railroad Tycoon, also designed Civilization, which remains one of the best games ever.

CD-ROMs have also made possible a really great buy: Strategic Simulations' Definitive Wargame Collection. It contains two wonderful fantasy games, Warlords and Sword of Aragon; a big collection of World War II strategic-level games; Reach for the Stars, a science fiction economics/star-fleet battle game; and a good Napoleonic game kit.

There's a stellar crop of games due this Christmas. Alas, a number of publishers are skimping on in-house tests. There's nothing worse than a Christmas present that won't run. There are so many wonderful old games in reissue that you can let someone else be a paying beta tester.

Now if you'll excuse me, I want to get back to Stone Prophet. I've got a monster to kill.... ■

Among other things, Jerry Pournelle is a science fiction writer, senior contributing editor for BYTE, and an advocate of spaceships. You can reach him on the Internet or BIX at jerryp@bix.com.

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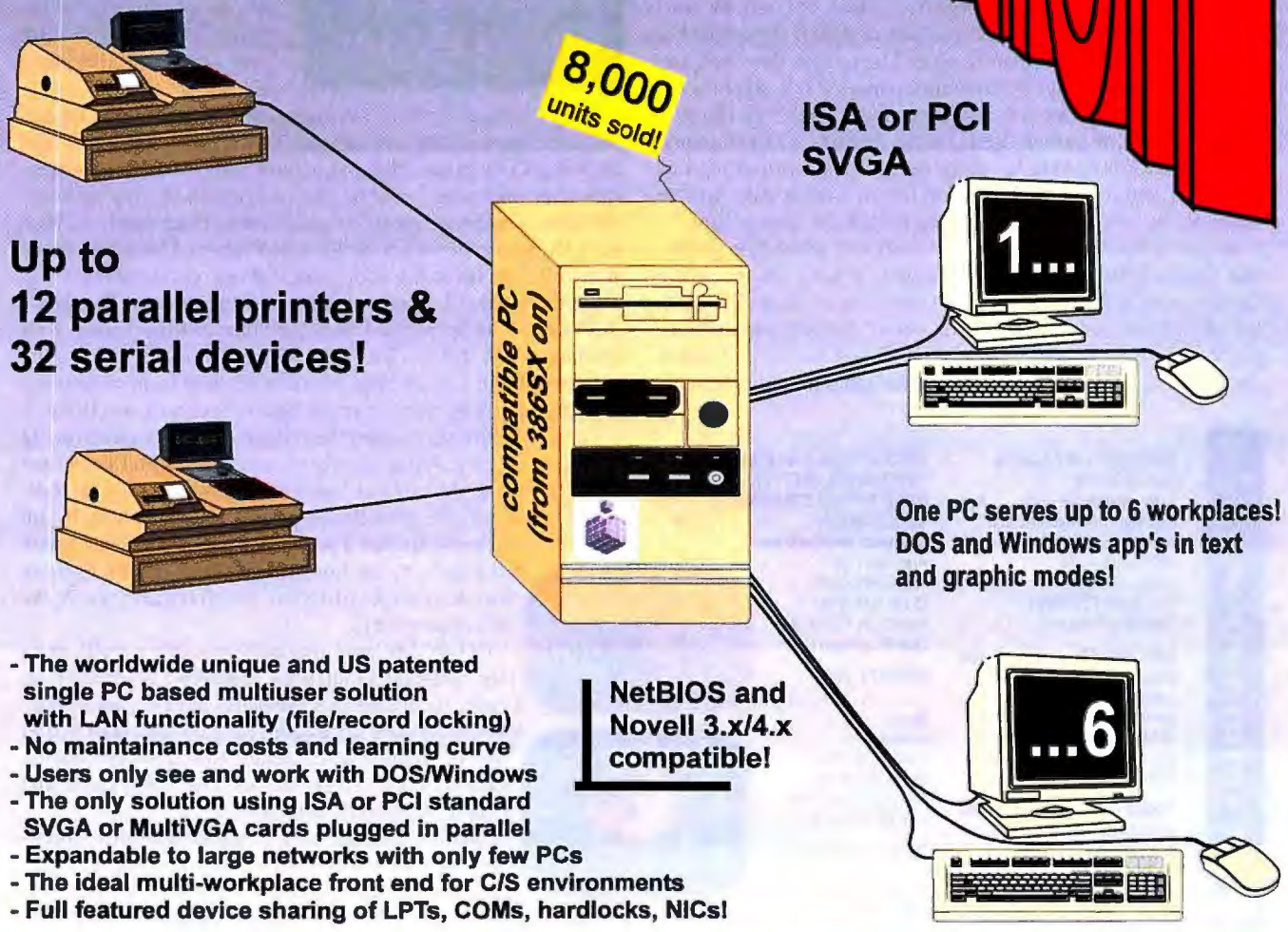

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OMNIPRO675	675/425	4	Yes	17	20	254
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IB6ULTRA	ISOBAR 6 Outlet, 3 Filter Banks	56	
IB8ULTRA	ISOBAR 8 Outlet, 4 Filter Banks	61	
ISOTELULT4	Modem/Fax, 4 Outlet,2 Filter Banks	55	
ISOTELULT6	Modem/Fax, 6 Outlet,3 Filter Banks	61	
ISOTELULT8	Modem/Fax, 8 Outlet, 4 Filter Banks	69	
TERM-6	Super Surge Alert 6 Outlet. 36,000A	$32	
TERM-6FM	6 Outlet, Fax/Modem	38	
SUPER7	7 Outlet, 18,000A diag. LEDS,7' cord	19	
MP	Econo Modem/Fax for One line	14	
LC-1200	1200W, 4 Outlet Conditioner	139	
LC-2400	2400W, 6 Outlet, 110V Conditioner	243	
LS-600	600W, 2 Outlets Low Voltage Stabilizer	77	
LS-604	600W, 4 Outlets Low/High Voltage	98	
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KWP-3	3 Port	1.49	1.34	1.22
KWP-4	4 Port	1.49	1.34	1.22
KWP-6	6 Port	1.49	1.34	1.22

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KP-INW	Blank Insert	0.30	0.25	0.20
KP-BNC	BNC Feed through Insert	3.00	2.73	2.50
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KP-ST	ST Insert	6.50	5.91	5.42

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KEC-6 *Keyboard Cable (6 foot)*	2.99	2.54
PS2-KEC6 *PS2 Keyboard Cable (6 foot)*	3.39	2.99
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PS2-MEC6 *VGA Monitor Cable (6 foot)*	3.39	2.99
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ACPC-04 *Monitor Power Extension (6')*	3.69	2.75

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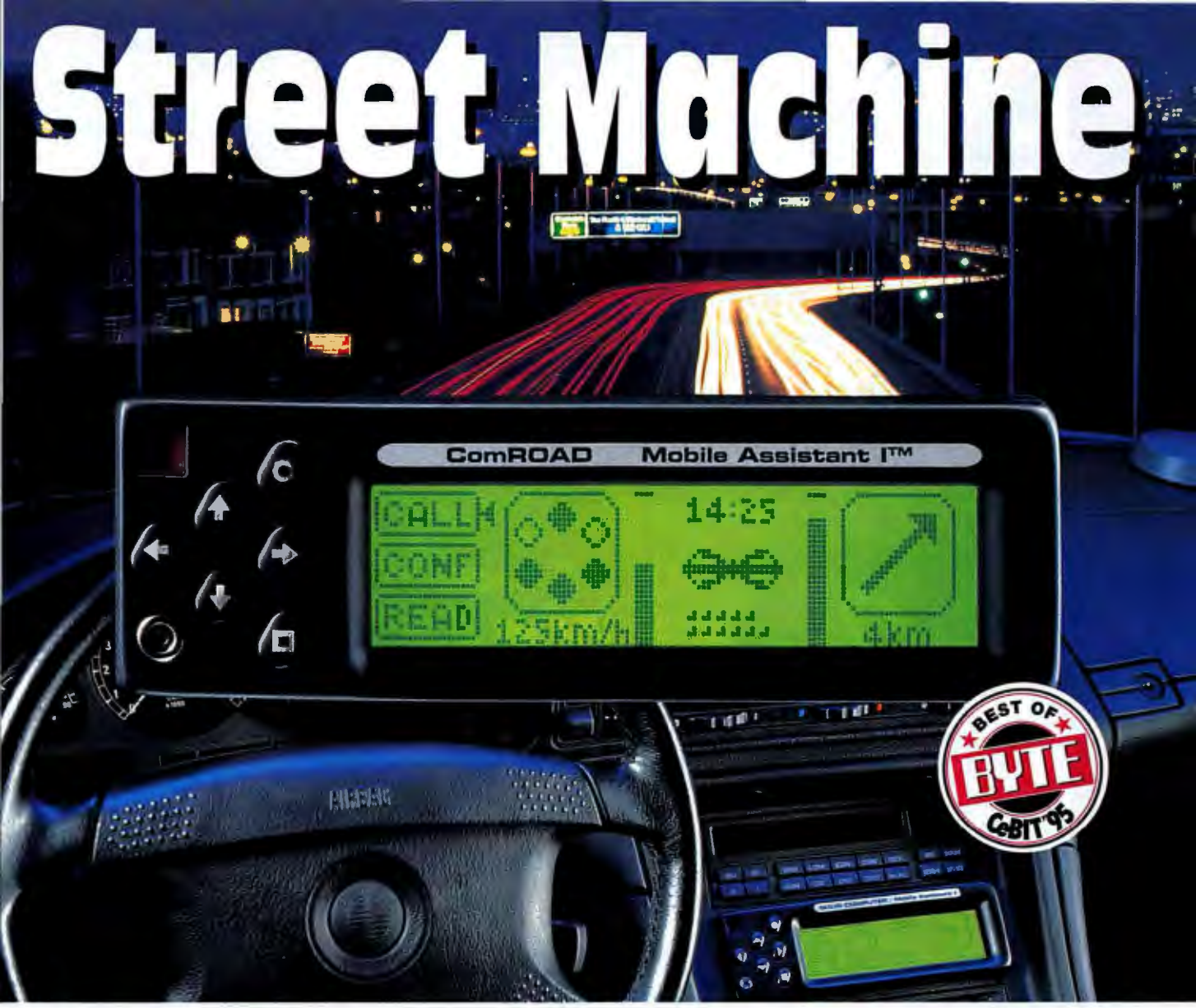

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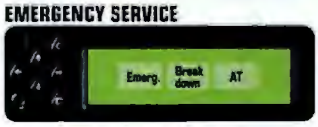

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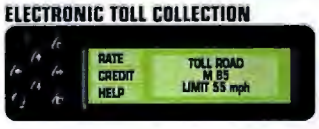

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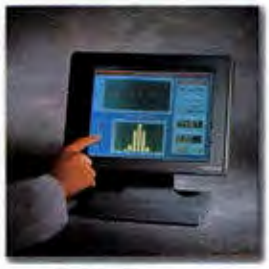

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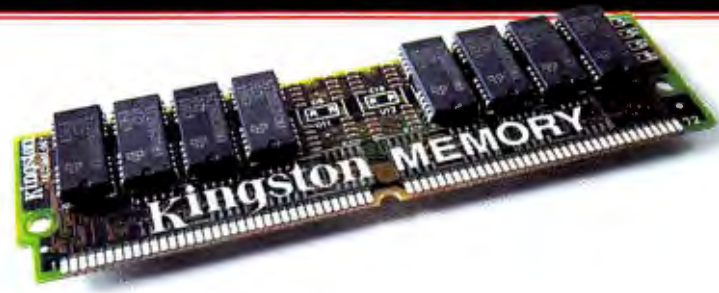

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Circle 208 on Inquiry Card (RESELLERS: 209).

Virtual CDs on the LAN

CD-QuickShare brings hard drive speed to CD-ROMs

REX BALDAZO

Sharing multiple CD-ROMs on a network can be difficult and costly. Even if you have quad- or six-speed drives, the average seek speed slows noticeably if multiple users access the same drive.

CD-QuickShare, from Stac Electronics, offers a cost-effective alternative. The program creates an image of a CD-ROM, compressing it if possible, on a network hard drive. A small device driver runs on each client workstation, fooling the Microsoft CD Extension (MSCDEX) into thinking that another CD-ROM drive is available.

An administrator creates images of the desired CD-ROMs in a network directory, and each workstation uses a Windows application to "insert" the desired image into the virtual CD-ROM drive. From the point of view of DOS or Windows, the image appears as if it were the original CD-ROM in a physical CD-ROM drive, instead of an image that is coming across the network.

Only the administrator can create new CD-ROM images or remove existing ones. And unfortunately, even though an administrator can create as many images as he or she wants (within the purchased licenses), each workstation has only one virtual CD-ROM drive and thus can use only one image at a time.

The performance of this virtual CD-ROM drive will depend on the speed of your network, but it also depends on the type of network. Running CD-QuickShare on a peer-to-peer network is not as fast or reliable as running it on a server-based network, Stac says. We encountered problems testing it on a Windows for Workgroups network, comprised of a mix of WFW 3.11 and Windows 95 machines.

From your workstation, you insert CD-ROM images in a virtual drive.

We never could install CD-QuickShare on two of our Pentium systems that were running Windows 95. The computers wouldn't hang right after loading CDSHARE.EXE, which happens in the CONFIG.SYS file; instead, they would bring up the Windows 95 GUI, let you log on to the network, and then they would hang. Other Windows 95–equipped Pentium systems ran CD-QuickShare without a problem, so we cannot pinpoint the blame as an incompatibility with the OS or the microprocessor.

Our biggest complaint: We couldn't resume the creation of a CD-ROM image if it was interrupted. On occasion, in the midst of compressing a large CD-ROM, there would be a hiccup in the network, from which CD-QuickShare could not recover. It would abort the session, and we had to start again.

An interesting application of CD-QuickShare is in stand-alone mode, when the CD-ROM images are stored on a local hard drive instead of a network drive. This proved useful for portable computers. With a sufficiently large hard drive, you could store a favorite CD-ROM on your laptop, without having to get a portable CD-ROM drive or an expensive laptop with a built-in CD-ROM drive.

In this mode, Stac expects that the performance of the virtual CD-ROM drive will approach or surpass the performance of a six-speed drive. In our subjective test using a popular multimedia title, we indeed found performance of the CD-QuickShare drive equal to or faster than that of a Plextor 6-Plex drive.

Home Users Need Not Apply

When creating an image, the administrator must specify how many licenses were purchased for the CD-ROM. CD-QuickShare enforces concurrent use to that number of licenses. There is no report-generation capability, but the administrator can view in real time which users are accessing any of the stored images.

CD-QuickShare is clearly aimed at corporate customers. The cost is $500 for a five-user/five-CD license. On balance, we think it is worth the money. Creating a CD-ROM image can be a hassle, but it's a great solution for Windows workstations. It's a utility that fills a need rather than creating one. ■

Rex Baldazo is a BYTE technical editor. You can contact him on the Internet or BIX at rbaldazo@bix.com.

Product Information

CD-QuickShare $500
(five-user/five-CD license)
Stac Electronics
San Diego, CA
(619) 794-4300
fax: (619) 794-4570
http://www.stac.com
Circle 1023 on Inquiry Card.

TECHNOLOGY FOCUS

You Can Fool MSCDEX

CDSHARE.EXE is the DOS device driver that gets installed in your CONFIG.SYS file and tricks MSCDEX into thinking a new CD-ROM drive is attached. Requests that are passed from MSCDEX to CDSHARE are converted into file I/O requests that are in turn handed off to MS-DOS. Using MS-DOS rather than a proprietary protocol assures network OS (NOS) independence, at the cost of some added complexity.

This architecture means that MS-DOS is being asked to perform both a CD-ROM file I/O and a network file I/O, essentially simultaneously. But MS-DOS frees its critical sections when it completes a network I/O request. CDSHARE has to extend the critical section to protect MS-DOS until the CD-ROM file I/O is over as well, especially if Windows is running.

This issue will go away once a Windows 95 version of CD-QuickShare is available. Stac did not provide a shipping date for that release.

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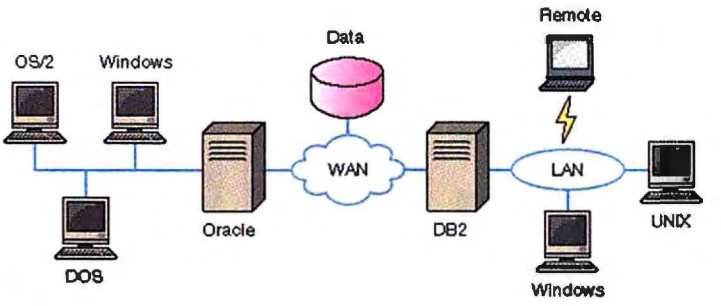

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HANDS-ON TESTING

16 PENTIUMS HIGH ON WIN 95

Need more horsepower? We pick the fastest 120-MHz and 133-MHz Pentium desktop PCs using our new Windows 95–based tests

ANTHONY J. LENNON AND JOHN MCDONOUGH

You can never get enough horsepower on your desktop. The 90- and 100-MHz Pentium PCs were okay for a while, but if you're still looking for more power, you'll want one of the 16 Pentiums we tested for this report. These speed demons are equipped with 120- and 133-MHz Pentium processors that add a new level of performance. Plus, they can really excel at running the new Windows 95 applications.

Intel's 0.35-micron, 3.3-V Pentium chips are designed for high-end desktops and high-performance servers. As a point of reference, Intel says the 133-MHz processor is twice the speed of the original 60-MHz Pentium introduced in March 1993. Indeed, Intel's Pentium drive is well under way, with 75- and 90-MHz Pentiums now at the entry point of vendors' product lines and 100- and 120-MHz Pentiums filling the mainstream.

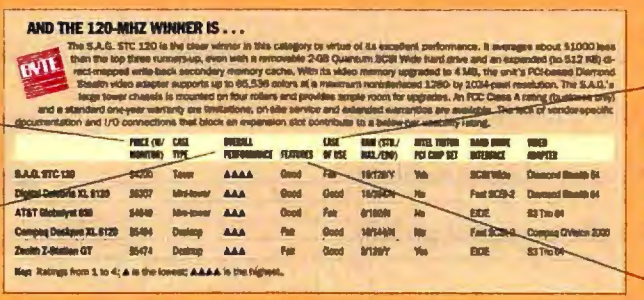
We rank these Pentium PCs in two categories based on their performance, features, and usability: There are seven 120-MHz systems and nine 133-MHz models. Overall, these systems cost an average of $4320 with monitors. It may seem strange that, on average, the 133-MHz desktops cost $250 less than the 120-MHz systems. However, the three highest-priced

How to use this guide

We determine the best Pentium system in the 120- and 133-MHz categories. Systems are listed in descending order based on their overall ratings. Performance is our most heavily weighted evaluation criteria (60 percent), followed by features and ease of use (20 percent each).

List price of the as-tested configuration with monitor. All the systems have 32 MB of RAM, at least 1 GB of hard disk storage, CD-ROM drive, and PCI-based video with minimum 1280- by 1024-pixel resolution.

We put each Pentium through a battery of low-level and application-based tests under Windows 95. Performance ratings are derived from the weighted average of the indexes of individual tests. Higher scores indicate faster performance.


AND THE 120-MHZ WINNER IS . . .

The S.A.G. STC 120 is the clear winner in this category by virtue of its excellent performance. It averages about $1000 less than the top three runners-up, even with a removable 2-GB Quantum 3CB Wide hard drive and an expanded (to 512 KB) direct-mapped write-back secondary memory cache. With its video memory upgraded to 4 MB, the unit's PCI-based Diamond Stealth video adapter supports up to 65,536 colors at a maximum noninterlaced 1280- by 1024-pixel resolution. The S.A.G.'s large tower chassis is mounted on four rollers and provides ample room for upgrades. An FCC Class A rating (business only) and a standard one-year warranty are limitations; on-site service and extended warranties are available. The lack of vendor-specific documentation and I/O connections that block an expansion slot contribute to a below-par usability rating.

	PRICE (W/ MONITOR)	CASE TYPE	OVERALL PERFORMANCE	FEATURES	EASE OF USE	RAM (STD./ MAX./SIM)	INTEL TRITON PCI CHIP SET	HARD DRIVE INTERFACE	VIDEO ADAPTER
S.A.G. STC 120	$4220	Tower	▲▲▲▲	Good	Fair	16/128/Y	Yes	SCSI-Wide	Diamond Stealth 64
Digital DataStar XL 6120	$6307	Mini-tower	▲▲▲	Good	Good	16/384/N	No	Fast SCSI-2	Diamond Stealth 64
AT&T Globalyst 650	$4849	Mini-tower	▲▲▲	Good	Fair	8/160/N	No	EIDE	S3 Trio 64
Compaq Deskpro XL 6120	$5494	Desktop	▲▲▲	Fair	Good	16/144/M	No	Fast SCSI-2	Compaq QVision 2000
Zenith Z-Station GT	$5474	Desktop	▲▲▲	Fair	Good	8/128/Y	Yes	EIDE	S3 Trio 64

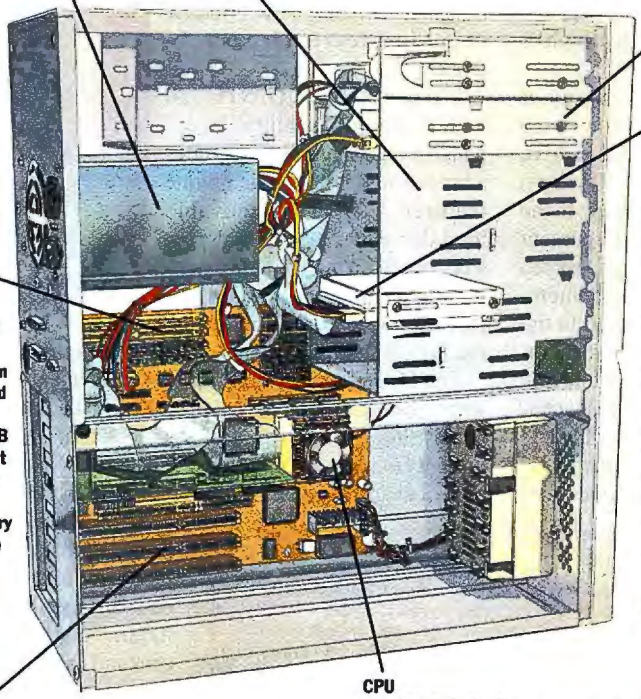
Key: Ratings from 1 to 4; ▲ is the lowest; ▲▲▲▲ is the highest.

Indicates how easy it is to configure and upgrade a system; also assesses the documentation.

Scores reflect the presence of key elements for expandability, flexibility, and reliability. Higher scores indicate more capabilities. See the Roll Call on pages 166–167 for a complete head-to-head features comparison.

PHOTOGRAPHY: STEVE BELKOWITZ © 1995

Inside a Speed Demon



POWER SUPPLY
Many of today's power supplies accept variable AC input (from 110 V to 240 V), a convenient feature for international use. Having the proper combination of components and power is something a reputable systems manufacturer should provide. Typical ratings for power supplies are between 200 W and 300 W.

DRIVE BAYS
Empty drive bays are essential for increasing a Pentium's mass-storage capacity. Drive bays with frontal access are necessary for adding any type of removable media. Purchase a tower configuration if mass-storage capacity is a concern.

CD-ROM
A high-end Pentium system should be configured with a CD-ROM drive to efficiently load system software (e.g., Windows 95) and run multimedia applications. The systems in this review feature a quad-speed CD-ROM drive, except for the Compaq Deskpro XL 5120, which has a dual-speed drive.

HARD DRIVE STORAGE
It is almost always cheaper to buy a Pentium with a larger hard drive than to add one later. All the systems in this review are configured with a minimum of 1 GB of hard drive storage, which is reflected in their list prices. Many of the systems offer integrated PCI-based enhanced IDE and Fast SCSI-2 ports, which frees an expansion slot. However, systems equipped with SCSI Wide PCI adapters (with data transfer rates of up to 20 MBps) provide the best overall performance.

SIMM BANKS
Graphical 32-bit applications are memory hogs. The OS requires at least 16 MB of RAM to function adequately. The tested Pentiums were configured with 32 MB of RAM and support at least 128 MB of main memory. Extended data out (EDO) memory is a must to reach the Triton's maximum cache data-stream speed of 100 MBps.

PCI SLOTS
At 33 MHz, a PCI local bus is more than 16 times faster than the ISA bus. PCI is auto-configuring and processor-independent. Look for systems featuring the Triton PCI chip set. Intel claims Triton can boost system Windows performance by as much as 30 percent.

CPU
The 133-MHz Pentium processor is the current state of the art in Intel-based systems. For easy processor upgrades, the Compaq Deskpro XL 5120 and Digital Celebris XL 5120 place their CPUs on proprietary processor modules. You can add a second Pentium processor on the Digital and Dell systems for use with OSes that support symmetric processing. Awkward placement of CPU cooling apparatus or cables can block access to expansion slots.

DECEMBER 1995 BYTE BEST 120- AND 133-MHz PENTIUMS

BEST

120-MHZ PENTIUMS

BEST OVERALL

S.A.G. Electronics STC 120

The S.A.G. STC 120 is the clear choice for power users. A SCSI Wide hard drive subsystem and an upgraded (to 512 KB) secondary memory cache contribute to excellent overall performance. With 4 MB of VRAM, the PCI-based Diamond Stealth video adapter supports up to 65,536 colors at a maximum noninterlaced resolution of 1280 by 1024 pixels. Only two 120-MHz systems cost less in the test configuration.
PAGE 158

133-MHZ PENTIUMS

BEST OVERALL

IPC Technologies Austin PowerPlus 133

The IPC Austin PowerPlus 133 is competitively priced and offers excellent overall performance with its ATI Mach 64 PCI-based video and SCSI Wide hard drive. The unit excels in tests that stress its processor and memory subsystem. Its large tower chassis offers excellent mass-storage potential. You can add up to 128 MB of RAM. You don't need tools to access the tower system's internal components.
PAGE 160

units in the 120-MHz category average $5217, and the 133-MHz category includes more systems from second- and third-tier vendors, who tend to put lower price tags on their machines. In any case, you can now get a good deal on a high-performance Pentium.

All the tested systems feature Peripheral Component Interconnect (PCI) local-bus video that provides at least 1280- by 1024-pixel resolution. Most have a minimum of 2 MB of video memory. The units are configured with 32 MB of RAM, at least 1 GB of hard drive storage, and an MPC 2–compliant quad-speed CD-ROM drive (except for the Compaq Deskpro XL 5120, which comes with a dual-speed drive). A minimum of 256 KB of secondary memory cache reduces or eliminates wait states on memory accesses.

The Polywell Poly 133T5, IPC Austin PowerPlus 133, and S.A.G. STC 133 provide the top overall performance. All three of these 133-MHz units contain SCSI Wide hard drive subsystems that provide data transfer rates of up to 20 MBps. The similarly configured S.A.G. STC 120 easily outperforms the remaining systems in its class.

This is the first BYTE Lab Report in which we assess the performance of systems running under Microsoft Windows 95. Windows 95 offers significant speed enhancements over its 16-bit predecessor, such as dynamically configured virtual-memory settings, optimized video-driver code, and a revised file system that has newer 32-bit protected-mode mini drivers. Although the 120- and 133-MHz Pentiums buzz through our suite of low-level InterMark and application-based benchmarks, remember that we use 16-bit applications in our tests. The next time we test Pentium machines, you should see a more noticeable gain in performance when we add 32-bit applications to our suite of Windows benchmarks.

ILLUSTRATION: BRUCE SANDERS © 1995

120-MHz Pentiums

Systems with 120-MHz Pentiums enjoyed a short run as the top-of-the-line Intel-based PCs. If manufacturers want their 120-MHz machines to compete against the newer 133-MHz units, they had better look at the price of their slower models. The average price of the tested 120-MHz systems ($4460) is $250 more than the average of the 133-MHz units. Also, prices for the 120-MHz systems range from a low of $2899 to a high of $5494 with monitors.

The S.A.G. STC 120 is the top performer in this category. It zipped through all nine of our Windows/DOS application-based benchmarks. The proficiency of the unit's SCSI Wide hard drive subsystem (which provides data transfer rates of up to 20 MBps) is clearly evident in our FoxPro benchmarks. For instance, in the DOS FoxPro test, the STC 120's geometric mean is 13 percent higher than that of its nearest competitor, the Compaq Deskpro XL 5120. The advantage of the STC 120's large secondary memory cache (512 KB) is evident in our low-level tests and in the WordPerfect benchmark, which stresses the processor and memory subsystem. The Triton-based unit also performs impressively in video-intensive tests with its Diamond Stealth 64 video adapter.

The AT&T Globalyst 630 and the Compaq Deskpro XL stand out in the disk-intensive database benchmarks and in the Excel and Word file I/O tests. The Digital Celebris XL 5120 does very well in tests that stress its processor and memory architecture (e.g., the PhotoShop and WordPerfect benchmarks). The Deskpro's QVision 2000 video adapter exhibits below-average performance in our low-level video benchmarks.

We gave the S.A.G. STC 120 high marks for usability. Its expansive chassis makes upgrades a breeze, and it has some unique features, such as a removable hard drive and a door that protects you from inadvertently turning off or resetting the system. However, its overall usability rating is only average because of poor documentation.

S.A.G. Electronics STC 120: Our top 120-MHz performer.

The Digital Celebris XL finishes with the highest-overall usability rating in the 120-MHz category. The mini-tower's side panels slide off when the unit's keylock is disengaged, and there is plenty of room for upgrades. The Celebris XL has vendor-specific documentation that is comprehensive and indexed.

The Tatung TCS-5210 lacks a reset switch. You have to remove its 3½-inch floppy drive to access the six SIMM slots on the motherboard, and drive-bay access and cabling is cramped due to the unit's slim-line design. The just-average documentation is not vendor-specific and lacks technical-support information.

The Tatung TCS-5120 and the Zenith Z-Station GT are the obvious choices for the space-conscious user. Their slim-line cases accommodate two 3½-inch and two 5¼-inch mass-storage devices.

AND THE 120-MHZ WINNER IS . . .

The S.A.G. STC 120 is the clear winner in this category by virtue of its excellent performance. It averages about $1000 less than the top three runners-up, even with a removable 2-GB Quantum SCSI Wide hard drive and an expanded (to 512 KB) direct-mapped write-back secondary memory cache. With its video memory upgraded to 4 MB, the unit's PCI-based Diamond Stealth video adapter supports up to 65,536 colors at a maximum noninterlaced 1280- by 1024-pixel resolution. The S.A.G.'s large tower chassis is mounted on four rollers and provides ample room for upgrades. An FCC Class A rating (business only) and a standard one-year warranty are limitations; on-site service and extended warranties are available. The lack of vendor-specific documentation and I/O connections that block an expansion slot contribute to a below-par usability rating.

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Digital Celebris XL 5120	$5307	Mini-tower	▲▲▲	Good	Good	16/384/N	No	Fast SCSI-2	Diamond Stealth 64
AT&T Globalyst 630	$4849	Mini-tower	▲▲▲	Good	Fair	8/192/N	No	EIDE	S3 Trio 64
Compaq Deskpro XL 5120	$5494	Desktop	▲▲▲	Fair	Good	16/144/N	No	Fast SCSI-2	Compaq QVision 2000
Zenith Z-Station GT	$5474	Desktop	▲▲▲	Fair	Good	8/128/Y	Yes	EIDE	S3 Trio 64

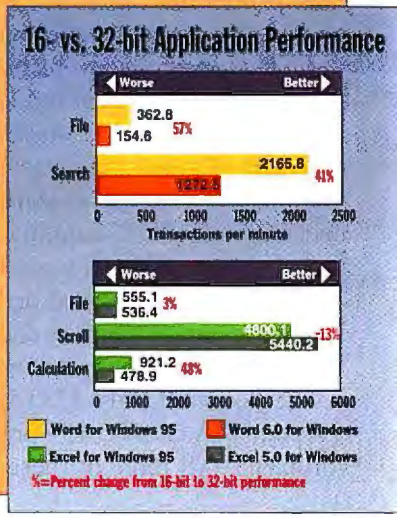
Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

32-BIT PERFORMANCE ADVANTAGES

By the time you read this review, there will be numerous 32-bit applications available for running under Windows 95. To gauge the advantages of 32-bit performance, we installed and tested Microsoft Word and Microsoft Excel for Windows 95 on the IPC Austin PowerPlus 133. Using NSTL's application-based benchmarks, we compared the results to the 16-bit versions (see the graph).

We discovered that the advantages of switching from 16- to 32-bit applications are dependent on the application itself and the type of processing performed. For instance, file I/O performance improved by almost 60 percent in the Word benchmark running Word for Windows 95 in place of the 16-bit Word 6.0 for Windows. In the Excel file test, the system performed an average of about 5.5 more transactions running the 32-bit version of the application.

The Word search test and Excel calculation benchmark stress processor and memory subsystems. In the search test, the 32-bit version of Word produces nearly 40 percent more transactions than the 16-bit version. And Excel for Windows 95 outperforms its 16-bit counterpart by nearly 50 percent in the calculation test. The PC's performance in the video-intensive Excel scrolling benchmark actually declines by about 13 percent. This may indicate that the default Windows 95 video drivers have not yet been optimized to achieve maximum performance.



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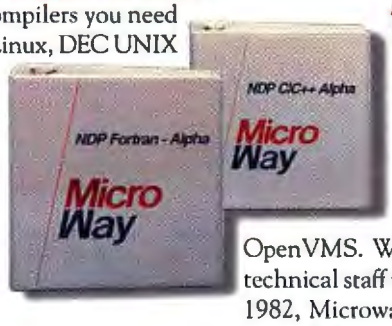
Memory, Cache, PCI . . .

The biggest challenge to running numeric intensive code on CPU's clocked over 200 MHz is building a cache/memory subsystem capable of keeping up with the CPU's numeric units. The 21164's Harvard architecture starts with two 32 deep 64-bit register files, followed by two 8K primary caches and an internal 96K cache. The 21164's external 128-bit data bus gets fed by 2 to 8 MB of Bcache built with 10ns SRAMS. The 256-bit wide interleaved memory subsystem that backs up the Bcache can hold up to 512 MB of DRAM. The coup de grace is the Screamer's PCI bus interface, which can accommodate both 32- and 64-bit PCI add-in cards. The Screamer is the biggest numeric winner Microway has introduced since we made it possible to run an 8087 in the IBM-PC in 1982!

A motherboard by itself does not a system make.

Microway adds the operating systems and compilers you need to put the 21164 to work. These include NT, Linux, DEC UNIX and OpenVMS, which now run thousands of applications including AutoCad, Excel and Word. The Screamer and Microway's NDP Fortran, C|C++ and Pascal compilers are available to both OEMs and end users.



DEC, Alpha, OpenVMS and DEC UNIX TM Digital.
NT, Excel and Word TM Microsoft. AutoCad TM Auto Desk.
Screamer, NDP Fortran and Microway TM Microway.

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133-MHz Pentiums

Power users looking for the best deal will want to consider one of these 133-MHz Pentium models. On average, they retail for less than $4212 with monitors. You can choose from price points ranging from $2948 to $5669.

The IPC Austin PowerPlus 133, Polywell Poly 133T5, and S.A.G. STC 133 are the top overall performers. All three systems are configured with PCI-based Adaptec SCSI Wide hard drive controllers. The Polywell and S.A.G. models excel in the FoxPro database benchmarks, but the Austin PowerPlus 133's performance in these disk-intensive tests is only average. IPC's system, configured with a Seagate ST32430W hard drive, performs poorly in NSTL's InterMark file-write tests and cannot match the performance of the S.A.G. and Polywell units in the sequential benchmarks.

However, the IPC machine stands out in tests that stress its processor and memory subsystem, such as the WordPerfect benchmark, where it takes top honors. The Polywell and S.A.G. systems feature upgraded (to 512 KB) secondary memory caches. The proficiency of the Austin PowerPlus 133's ATI Mach 64 PCI-based video subsystem is evident in the Excel insert and delete tests, where it outperforms the Polywell by an average of 15 percent.

Except for the Dell Optiplex DGX, the remaining systems we tested offer balanced overall performance. They feature integrated enhanced IDE (EIDE) hard drive subsystems. They all perform similarly in the disk-intensive database benchmarks.

The Gateway 2000 P5-133XL is configured with a Matrox MGA Millenium PCI video adapter that provides superior video performance, as displayed in the low-level InterMark tests. The proficiency of the Gateway's video subsystem is clearly evident in the Excel benchmark, where the unit produces 24 percent more transactions than its nearest competitors, the Polywell and All Computer Warehouse units. The USA Flex PT-133 stands out in the PhotoShop and WordPerfect benchmarks, which stress its processor and memory subsystems. The ACW P5-133A, with its 512-KB direct-mapped write-back secondary memory cache, excels in the WordPerfect for Windows search and compare tests.

Dell's Optiplex DGX offers subpar overall system performance. In fact, the S.A.G. 120-MHz Pentium model finishes with a higher overall performance rating (and costs $1469 less as configured). The Dell lags behind the other 133-MHz models in video-intensive benchmarks, such as the Word for Windows and Excel screen tests. Low-level screen benchmarks verify the relative inefficiency of the Dell's integrated ATI Mach 64 PCI-based video adapter. The system is unimpressive in processor-intensive tests, such as PhotoShop and the Autodesk AutoCAD Garden Path benchmark. Also, it lags behind in the FoxPro tests, which stress its integrated Fast SCSI-2 hard drive subsystem.

The Dell Optiplex DGX is configured with a relatively large 512-KB direct-mapped write-back memory cache, but it is the only 133-MHz model we tested that does not feature Intel's Triton PCI chip set. Also, like the ACS and Polywell units, the Optiplex DGX doesn't support EDO RAM, which outperforms conventional DRAM at competitive prices. However, Dell's Optiplex is the only tested 133-MHz system that supports a second Pentium chip, so it can run OSes that support symmetric multiprocessing. The Dell is also unique in that it can accommodate up to 512 MB of RAM when 64-MB SIMMs are available. Systems that use the Triton chip set are limited to 128 MB of RAM.

IPC Austin PowerPlus 133 mixes solid performance with excellent usability.

We gave the IPC Austin PowerPlus 133 and Gateway 2000 P5 133-XL our highest usability ratings. The IPC's side panel slides off easily after you remove three hand-tightened screws; the Gateway's cover is held in place by six screws and slides off from the rear. Both units come with vendor-specific documentation that is clearly written, comprehensive, and includes numerous charts and diagrams.

We gave the ACW P5-133A a low usability rating because of its ill-conceived design. The system's 3½-inch EIDE hard drive is mounted over the expansion slots, which means you must remove the drive cage to install, or take out, an expansion board. Also, one side of the motherboard was not secured to the system chassis. The system lacked vendor-specific documentation, and technical-support information was not available when we tested.

Reason Technology offers the best warranty: six years on parts and labor. Most other vendors offer you three-year warranties.

IT'S A CLOSE CALL

The IPC Austin PowerPlus 133 takes top honors over the Gateway 2000 P5-133XL by the slimmest of margins. The Austin PowerPlus costs $344 less than the Gateway in their test configurations and earns a higher usability rating. You don't need tools to remove the tower's side panel, and there's ample room for upgrades. And it comes with good documentation. Low-level testing verifies the efficiency of the unit's memory subsystem, a configuration that includes EDO RAM and a 256-KB (expandable to 512 KB) two-way set-associative write-back memory cache. The Triton PCI-based model also benefits from the throughput of its SCSI Wide hard drive subsystem. The PowerPlus 133's efficient ATI Mach 64 local-bus video adapter contains 2 MB of VRAM and supports 1600- by 1200-pixel resolution.

	PRICE (W/ MONITOR)	CASE TYPE	OVERALL PERFORMANCE	FEATURES	EASE OF USE	RAM (STD./ MAX./EDO)	INTEL TRITON PCI CHIP SET	HARD DRIVE INTERFACE	VIDEO ADAPTER
IPC Austin PowerPlus 133	$3807	Tower	▲▲▲▲	Good	Excellent	16/128/Y	Yes	SCSI Wide	ATI Mach 64
Gateway P5-133XL	$4151	Tower	▲▲▲▲	Excellent	Excellent	16/128/Y	Yes	EIDE	Matrox MGA Millenium
Polywell Poly 133T5	$4850	Mini-tower	▲▲▲▲	Good	Good	32/128/N	Yes	SCSI Wide	Diamond Stealth 64 V
USA Flex PT-133 Ultimate Tower	$4600	Tower	▲▲▲▲	Good	Excellent	8/128/Y	Yes	EIDE	STB Velocity 64 PCI
Reason Square 5 LX-TR/IE	$4295	Mini-tower	▲▲▲▲	Good	Excellent	8/128/Y	Yes	EIDE	Diamond Stealth 64 V

Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

TRITON-BASED PENTIUMS

Intel's 82430FX, or Triton, four-component PCI chip set was introduced in Pentiums earlier this year to boost performance for multimedia and other hungry applications. Most high-end Pentiums that are currently shipping incorporate the Triton design; however, its predecessor, the Neptune PCI chip set, is still used in some PCs. Except for the Dell Optiplex DGX, all the 133-MHz systems we tested for this Lab Report use the Triton chip set. Three of the seven 120-MHz models incorporate the Triton.

Triton is the third-generation Pentium processor PCI chip. Its integrated bus master IDE drive controller significantly reduces CPU utilization, freeing the processor to perform other tasks. Intel states that bus mastering reduces the CPU bandwidth required for IDE transfers from 20 percent to 1 percent. The controller supports programmed I/O (PIO) Mode 3 (up to 16.7 MBps) and PIO Mode 4 (up to 16.7 MBps) and can provide data transfer rates up to 22 MBps in bus-master mode.

"Enhanced IDE provides better throughput for hard drives that support the faster IDE mode," says Mike Feibus, a principal at Mercury Research, which tracks PC components. "Support for EDO [extended data out] RAM and higher-performance PCI also improves performance. Clearly the presence [of PCI] has grown dramatically. Most of the Pentium PCs shipping have it, and it has become the de facto standard. It's the one to beat right now."

Triton also supports newer memory technologies like EDO DRAMs. Intel claims that the Triton chip set can increase data-stream speeds to as high as 100 MBps when using EDO memory. With a secondary memory cache, it can increase Windows system performance up to 30 percent over a Neptune system with conventional DRAM, Intel says. The core PCI logic supports 256 KB or 512 KB of write-back secondary memory cache using pipelined burst, burst, or standard static RAM.

An integrated plug-and-play port that can be used for audio devices enhances usability by making ISA motherboard peripherals into pseudo-PCI devices. The motherboard devices are rerouted to unused system resources. The Triton chip set also enables native signal processing (NSP), which is a way to run PC applications that demand more system resources for multimedia signal processing. Capabilities such as voice and data, telephony, wavetable MIDI audio, and speech recognition require sufficient MIPS along with a real-time environment for this type of processing.

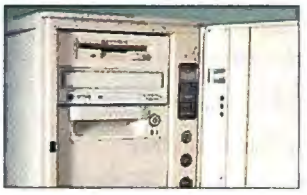
The Triton chip set supports bus mastering, EDO memory, and native signal processing.

The current Triton won't work with dual-processor PC configurations and doesn't support parity-memory checking, which checks the integrity of data after it has been sent.

Next year, Intel will unveil two new versions. The Triton II is designed for high-end servers and will support larger amounts of memory (the current Triton supports a maximum of 128 MB). The Triton VX will be aimed at lower-level Pentium systems.

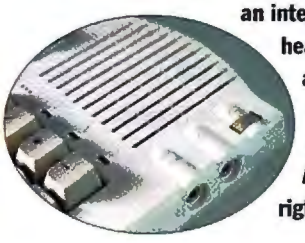
HONORABLE MENTIONS

The S.A.G. Pentium units have some unique features. Their SCSI Wide hard drives are mounted in removable enclosures that are protected by a locking mechanism. A swinging door protects you from inadvertently turning off or resetting the system. The tower systems are mobile on their four coaster feet.



The Digital Equipment Celebris XL 5120 and the Dell Optiplex DGX can take an additional Pentium processor for use with OSes that support symmetric processing, such as Windows NT and OS/2. The Celebris XL 5120's processor and cache circuitry are located on a CPU module that connects to the main logic board. You can upgrade the module with another Pentium processor or even with an Alpha RISC processor.

The Compaq Deskpro XL 5120's keyboard contains an integrated speaker and microphone, headphone and microphone jacks, and a mouse connector. You can optionally plug the mouse into the rear-panel connector on the system. A volume control is located to the right of the speaker on the keyboard and works with Microsoft Sound System software. The XL 5120 also features an integrated PCI-based Ethernet controller and a processor board that can be upgraded.



The Reason Square 5 LX-TR/IE features an embedded sound board on its Intel Aladdin series motherboard. A CrystaLake Wavetable upgrade card was included with the system. It adds complete General MIDI and Roland General Synthesizer compatibility to the Sound Blaster Pro and Microsoft Sound System digital capabilities integrated onto the motherboard.

Dubious Achievement

The ACW P5-133A is poorly designed. A drive cage for two 3½-inch drives is mounted over the expansion slots, so you must first remove the bay when you want to install or remove an expansion board. Also, the left side of the motherboard is not secured to the system chassis.

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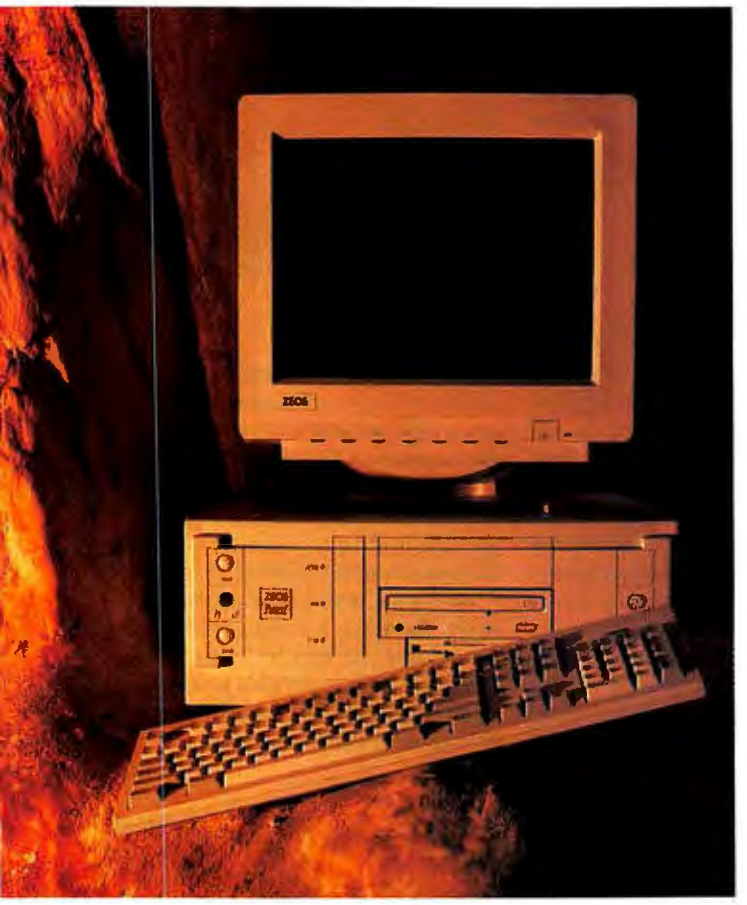

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PC MAGAZINE EDITORS' CHOICE — Pentium-66 April 12, 1994; DX4-100 June 28, 1994

COMPUTER SHOPPER — Pentium-60 April 1994; Pentium-90 August 1994

PC WORLD — 486DX2-66 January 1994, February 1994, March 1994, June 1994, December 1994, January 1995, February 1995, March 1995, April 1995; DX4-100 October 1994, November 1994, December 1994; Pentium-60 December 1994, January 1995, February 1995, April 1995; Pentium-66 June 1994, July 1994, August 1994, September 1994; Pentium-90 August 1994, September 1994, October 1994, November 1994, January 1995, February 1995

PC Best — Pentium-66 May 1994; Pentium-90 February 1995

Windows Experts Pick — Pentium-66 June 1994; Pentium-90 August 1994

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➤ ZEOS 14" 1024 x 768 NI SVGA color monitor, .28mm dot pitch		➤ **ZEOS 15"** 1024 x 768 NI SVGA color monitor, .28mm dot pitch		➤ **ZEOS 15"** 1024 x 768 NI SVGA color monitor, .28mm dot pitch	
➤ Six-bay desktop case with two cooling fans		➤ Six-bay desktop case with two cooling fans		➤ Six-bay desktop case with two cooling fans	
➤ Microsoft Mouse		➤ Microsoft Mouse		➤ Microsoft Mouse	
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- ➤ Ten-bay vertical case with two cooling fans
- ➤ Microsoft Mouse
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PAN-BYT-9512

How We Tested

Testing was open to all 120- and 133-MHz Pentiums. We requested that vendors configure their systems with a minimum of 32 MB of RAM, at least a 1-GB hard drive subsystem, and an MPC 2–compliant CD-ROM drive. Performance is the most heavily weighted (60 percent) category in determining winners in both processor classes. However, we also did a head-to-head features analysis and a detailed usability assessment (weighted at 20 percent each).

PERFORMANCE

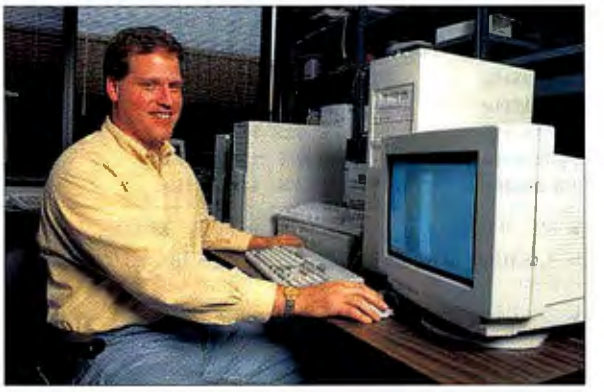
We determined the performance of each system with a suite of BYTE low-level DOS tests and NSTL's application-based Windows and DOS benchmarks, along with NSTL's low-level InterMark Windows tests.

NSTL's Windows application suite consists of Microsoft Excel 5.0, Microsoft Word 6.0, Novell WordPerfect 6.0, Microsoft FoxPro 2.6, Autodesk AutoCAD release 12, and Adobe PhotoShop 2.5. The DOS application suite includes WordPerfect 6.0, Lotus 1-2-3 release 3.4, and FoxPro 2.5. The application-based tests portray real-world performance by running macros that execute common functions of each application. For example, the Word for Windows benchmark includes subtests that measure search-and-replace functions, changing fonts, scrolling by page and line, spelling checking, and printing to a file.

Our DOS low-level test isolates the floating-point and integer performance of each system's CPU relative to a 90-MHz Dell Pentium. NSTL's InterMark subsystem-level Windows tests exercise the Windows Graphical Device Interface (GDI), as well as low-level graphics, CPU/FPU, and hard drive performance. The GDI component determines how well a system executes basic calls within Windows.

We installed Windows 95 on a freshly formatted 500-MB primary partition; we put our test files on a 500-MB extended partition. We ran the Windows tests with 1024- by 768-pixel resolutions and 256 colors using default video drivers (when possible).

Due to the late release of Windows 95, the application-based tests were not automated (but will be for our next system review). We ran each test three times, or until we achieved consistent results. A fresh install of Windows 95 was re-created prior to each test using an NSTL-designed utility that builds a mirror image of the primary partition. We derived the overall performance score from the weighted average of the indexes of individual tests.



NSTL project manager Anthony Lennon tests Pentium performance, features, and ease of use.

Note that performance results of the test systems running under the new 32-bit Windows OS cannot be directly compared to systems in previous reviews running under Windows for WorkGroups 3.11, even though we use the same benchmarks. Windows 95 offers significant speed enhancements over its 16-bit predecessor, such as dynamically configured virtual-memory settings, optimized video-driver code, and a revised file system featuring newer 32-bit protect-mode mini drivers. We used only 16-bit applications for testing. It is likely that 32-bit applications will provide increased performance under Windows 95 (see "32-Bit Performance Advantages" on page 158).

EASE OF USE

For usability, we focused on two areas: system design and documentation. In looking at system design, we rated how easy it is to remove and replace the cover and how easy it is to upgrade the system's RAM and add mass-storage devices. We took points off if I/O connections blocked an expansion slot.

We also looked for a reset button and clearly marked I/O ports. We went into each system's setup utility to see if the integrated hard drive controller and built-in I/O ports could be disabled (if applicable). This is important if you want to use the I/O port's interrupt settings or want to switch to an alternate hard drive subsystem (i.e., from IDE to SCSI). We gave top honors to systems with vendor-specific manuals that were comprehensive, had easy-to-read diagrams, and offered up-to-date technical information.

FEATURES

We asked each vendor to complete a lengthy questionnaire about its system's features and support options. We then weighted each feature and calculated an overall features score.

Important features to consider when choosing one of these systems are those related to expansion (e.g., the maximum RAM capacity, the number of floppy-drive bays, and available PCI and ISA/EISA expansion slots).

Features related to performance include the size of the secondary memory cache, the presence of EDO RAM, and a SCSI Wide hard drive interface. Intel claims that use of its Triton chip set can significantly boost system performance, especially when used with EDO RAM (see "Triton-Based Pentiums" on page 161). Systems configured with SCSI Wide hard drives, which offer data transfer rates of up to 20 MBps, display the best performance in our disk-intensive benchmarks.

Warranty and support policies are what frequently separate major PC manufacturers from second- and third-tier vendors. The length of the standard warranty is our highest rated feature.

Contributors

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Susan Colwell, Technical Editor/BYTE

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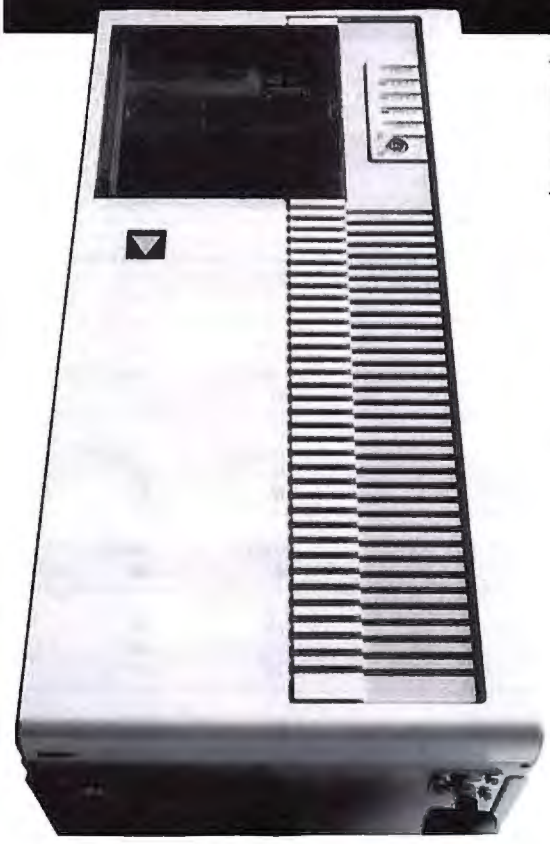

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Price as tested without monitor/with monitor	$2683/$2988	$4075/$4849	$4995/$5494	$4995/$5494	$4908/$5307	n.a. /$4151	$2649/$2948
Performance rating	9.0	7.2	7.2	7.9	7.1	9.2	9.0
Features rating	Fair	Good	Fair	Good	Good	Excellent	Fair
Usability rating	Poor	Fair	Good	Excellent	Good	Excellent	Poor
MICROPROCESSOR							
Model	Intel Pentium 133	Intel Pentium 120	Intel Pentium 120	Intel Pentium 133	Intel Pentium 120	Intel Pentium 133	Intel Pentium 133
Voltage	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V
Maximum processors/as tested	1/1	1/1	1/1	2/1	2/1	1/1	1/1
SECONDARY PROCESSOR CACHE							
Standard/max./total as tested (KB per processor)	512/512/512	256/256/256	256/256/256	256/512/512	256/256/256	256/256/256	256/512/256
Speed (ns)	8	15	10	15	8	15	8
SYSTEM RAM							
Standard/max./total as tested (MB)	32/128/32	8/192/32	16/144/32	8/512/32	16/384/32	16/128/32	16/128/32
Speed (ns)	70	70	70	60	70	60	60
EDO (extended data out) RAM	○	○	○	○	○	●	●
EXPANSION BUS							
Architecture/local-bus architecture	ISA/PCI	ISA/PCI	EISA/PCI	EISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI
Intel Triton PCI chip set	●	○	○	○	○	●	●
EXPANSION SLOTS/AS TESTED							
16-bit ISA	3/2	4/4	0/0	0/0	3/3	2/0	3/2
32-bit EISA	0/0	0/0	3/3	3/3	0/0	0/0	0/0
32-bit PCI	4/3	2/2	1/0	0/0	2/1	3/2	4/3
I/O PORTS							
9-/25-pin serial	2/0	2/0	2/0	2/0	2/0	1/1	1/1
PS/2 mouse	○	●	●	●	●	●	○
IDE/enhanced IDE	○/●	●/●	●/○	●/○	●/○	○/●	○/●
Fast SCSI-2 on motherboard	○	○	●	●	●	○	○
Ethernet port on motherboard	○	○	●	○	○	○	○
MASS STORAGE							
Hard drive manufacturer/model as tested	Seagate ST31220A	Western Digital WDAC31600	IBM DPES-31080	Quantum DSP3107L	Seagate	Western Digital WDAL31600	Quantum Fireball 1080A
Total storage capacity as tested (GB)	1.1	1.6	1.05	1.0	1.0	1.6	1.1
Interface (IDE/SCSI)	EIDE	EIDE	Fast SCSI-2	Fast SCSI-2	Fast SCSI-2	EIDE	EIDE
Local-bus interface	●	●	●	●	●	●	●
DRIVE BAYS							
Total/available 3.5-inch drive bays	4/3	3/1	2/1	2/1	2/1	5/3	2/2
Total/available 5.25-inch drive bays	5/4	3/2	3/1	3/1	3/1	4/3	6/3
CD-ROM DRIVE							
Manufacturer/model as tested	Mitsumi 400 FX Series	Sony CDU-76E	Matsushita CD-503-B	NEC CDR-511	Toshiba XM-5201B	Sanyo C3G	Toshiba CD-5302
Speed	4x	4x	2x	4x	4x	4x	4x
Disk loading	Drawer	Drawer	Drawer	Caddy	Drawer	Caddy	Drawer
Average access time (ms)	250	250	325	240	200	250	200
Estimated maximum throughput (KBps)	700	684	300	600	600	600	600
Buffer size (KB)	128	256	256	256	256	256	64
Interface	EIDE	IDE	SCSI	SCSI	SCSI	EIDE	EIDE
VIDEO							
Manufacturer/model as tested	Diamond Stealth 64 Video	S3 Trio 64	Compaq QVision 2000	ATI Mach 64	Diamond Stealth 64	Matrox MGA Millenium	Diamond Stealth 64 Video
Chip-set manufacturer/model as tested	S3 Vision 968	S3 Trio 64	Matrox MGA II	ATI Mach 64	S3 Vision 964	Matrox MGA	S3 Vision 968
Highest noninterlaced display resolution (as tested)/refresh rate (Hz)	1600 by 1200/76	1280 by 1024/75	1280 by 1024/76	1280 by 1024/80	1280 by 1024/72	1600 by 1200/72	1600 by 1200/76
Color depth at highest noninterlaced display resolution (bits)	256	256	256	256	256	256	256
Video memory	VRAM	DRAM	VRAM	VRAM	VRAM	WRAM	VRAM
Standard graphics memory size/max./total as tested (MB)	2/4/2	1/2/2	2/2/2	2/2/2	2/4/2	2/4/2	2/4/2
MONITOR							
Manufacturer/model as tested	Proton GM 1563	AT&T TX-D1751L	Compaq 151FS	Dell UltraScan 17XE	DEC PCXBV-PF/PH (14-inch)	Sony CPD17F13	Aurora SM583
Highest noninterlaced display resolution/refresh rate (Hz)	1280 by 1024/60	1280 by 1024/75	1024 by 768/72	1280 by 1024/78	1024 by 768/75	1280 by 1024/60	1024 by 768/60
WARRANTY AND SUPPORT							
Warranty (years)/coverage	1/P, L, R	3/P, L, R	3/P, L, F, R	3/P, L, R	3/P, L	1 L/3 P	3/P, L, F
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● = yes; ○ = no; N/A = not applicable.

*Scores for monochrome performance are actual, real-world performance scores.

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Good	Good	Fair	Good	Good	Good	Poor	Good	Fair
Excellent	Good	Fair	Excellent	Fair	Fair	Poor	Excellent	Good
Intel Pentium 133	Intel Pentium 133	Intel Pentium 120	Intel Pentium 133	Intel Pentium 120	Intel Pentium 133	Intel Pentium 120	Intel Pentium 133	Intel Pentium 120
3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V
1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
256/512/256	512/512/512	256/256/256	256/512/256	256/512/512	256/512/512	256/1024/256	256/256/256	256/512/256
15	15	16	8	8	8	15	8	20
16/128/32	32/128/32	8/128/32	8/128/32	16/128/32	16/128/32	8/256/32	32/128/32	8/128/32
60	60	70	60	60	60	60	60	70
●	○	○	●	●	●	○	●	●
ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI	ISA/PCI
●	●	●	●	●	●	○	●	●
2/2	4/2	3/3	2/1	4/3	4/3	2/1	4/4	2/1
0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
3/1	4/2	2/1	3/2	4/2	4/2	2/2	4/2	1/1
2/0	1/1	2/0	2/0	1/1	1	2/0	1/1	2/0
○	○	○	○	○	○	●	○	●
○/●	○/●	○/●	○/●	○/●	○/●	○/●	○/●	○/●
○	○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	○	○
Seagate ST32430W	Quantum Atlas XP32150W	Seagate ST31220A	Western Digital WDAC31600	Quantum Atlas XP32150W	Seagate ST15150W	Conner Peripherals CFS 1275A	Western Digital WDAC31600	Western Digital WDAC31200
2.1	2.1	1.1	1.6	2.0	4.0	1.2	1.6	1.2
SCSI Wide	SCSI Wide	EIDE	EIDE	SCSI Wide	SCSI Wide	EIDE	EIDE	EIDE
●	●	●	●	●	●	●	●	●
4/3	4/2	2/1	3/1	0/0	0/0	2/0	6/4	2/0
3/1	3/2	3/1	3/2	9/6	9/6	2/1	6/5	2/1
Plextor PX-63C	Sanyo CRD-254SH	Toshiba XM-5302B	Plextor 6 Plex SCSI	Sony CDU-76S	Sony CDU-76S	Teac CD55A	NEC MultiSpin 6Xi	Toshiba XM-5302B
6x	4x	4x	6x	4x	4x	4x	6x	4x
Caddy	Drawer	Drawer	Caddy	Drawer	Drawer	Drawer	Caddy	Drawer
115	150	190	145	190	190	195	150	190
900	600	600	600	684	684	600	925	684
256	256	256	256	256	256	64	256	64
SCSI	SCSI	EIDE	SCSI	SCSI	SCSI	Proprietary	SCSI	EIDE
ATI Mach 64	Diamond Stealth 64 Video	Diamond Stealth 64	Diamond Stealth 64 Video	Diamond Stealth 64	Diamond Stealth 64	S3 Trio 64	STB Velocity 64 PCI 4MB	S3 Trio 64
ATI Mach 64	S3 Vision 968	S3 Trio 64	S3 Vision 968	S3 Vision 964	S3 Vision 964	S3 Trio 64	S3 Vision 968	S3 Trio 64
1600 by 1200/76	1600 by 1200/76	1280 by 1024/75	1600 by 1200/76	1280 by 1024/72	1280 by 1024/72	1280 by 1024/75	1600 by 1200/80	1280 by 1024/75
256	256	256	256	65,536	65,536	16	256	256
VRAM	VRAM	DRAM	VRAM	VRAM	VRAM	DRAM	VRAM	DRAM
2/4/2	2/4/2	2/2/2	2/4/2	2/4/4	2/4/4	1/2/1	2/4/2	2/2/2
Smile Austin (17-inch)	Sampo 710L	Reason Technology 5F5	ADI 5EP	CTX 1565GM	CTX 1565GM	Tatung CM-15VBE	CTX 1785GME	Nokia/ZDS ZCM-1740
1280 by 1024/74	1280 by 1024/78	1024 by 768/76	1280 by 1024/60	1280 by 1024/66	1280 by 1024/66	1024 by 768/72	1600 by 1200/60	1280 by 1024/100
3/P, L, R	3/P, L, F, R	6/P, L, R	6/P, L, R	1/P, L, R	1/P, L, R	2/P, L	3/P, L, F, R	3/P, L, F,
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- 256KB L2 Cache
- 420MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
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- 256KB L2 Cache
- 810MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
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- 8MB RAM (40MB Max RAM)
- 256KB L2 Cache
- 420MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
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- 32-bit Local-bus Video, 1MB Video RAM
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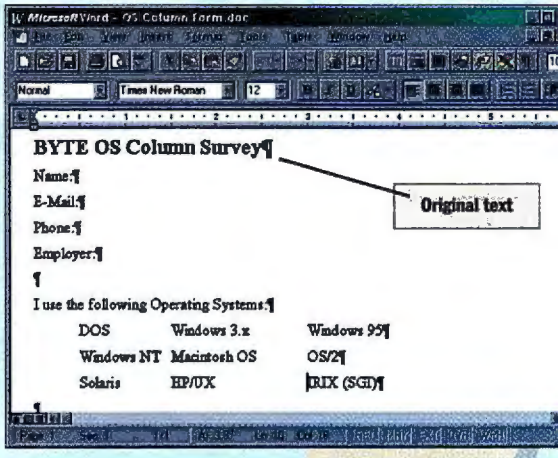
Web Publishing Made Easier

Seeding text files with HTML tags is no fun. We looked at four programs that claim to do the work for you.

REX BALDAZO AND STEVEN J. VAUGHAN-NICHOLS



From Your Word Processor to the Web

HTML-conversion programs either import plain text files, in ASCII or a popular word processor format (above), or provide a simple word processor for writing text from scratch.

Once, text was static, and it sat in rigid arrays between white-spaced prison bars. Then hypertext and hypermedia unlocked the door, and the World Wide Web pushed it wide open. Now tens of thousands of would-be on-line publishers are rushing through it to create Web documents based on Hypertext Markup Language (HTML). Hot on their heels, software developers are recognizing a golden opportunity to sell tools that make on-line publishing as easy as possible.

Interleaf's Cyberleaf, for example, is a sophisticated file translator that speeds up HTML document production and management. Other programs are little more than collections of HTML macros stuck on the back of a text editor. In between are tools that vary in complexity—some of which require expert knowledge of HTML, while others attempt (and fail) to be complete WYSIWYG editing environments.

For this review, we passed over enterprise-level programs, like FrameMaker, which have an HTML component but are designed primarily to handle networked document creation, CD-ROM publishing, on-line technical documentation, and so on. We also skipped minimal HTML-conversion programs (e.g., freeware products for Microsoft Word and Novell's WordPerfect). Instead, we focused on software that truly automates the process of tagging documents for publication in HTML-compliant form.

Two of the four programs we reviewed, SoftQuad's HotMetal Pro and InContext Systems' Spider, provide both authoring (i.e., you can use them to create an original from scratch) and editing (i.e., conversion) of existing documents. Cyberleaf handles only the latter process, but it adds a major feature that none of the other products has: the ability to coordinate and link your HTML documents to create a repository. Brooklyn North Software Works' HTML Assistant Pro is mostly for authoring; given its limited import features, it is best used for creating Web pages from scratch.

Most Web editors, including HTML Assistant Pro and HotMetal Pro, are available in freeware versions that contain most of the features found in the professional releases, so you can gain a quick appreciation of each one's strengths and weaknesses. (See the Product Information box for the addresses of the vendor Web pages where you can download the freeware.)

One thing's for sure: All these editors are worth the price of admission. While you can write excellent Web pages with only a text editor and some expert knowledge of HTML (the HTML encoding is all done in ASCII text), even the lowliest of these products makes it easier to unleash your text on the Web.

The Problem Defined

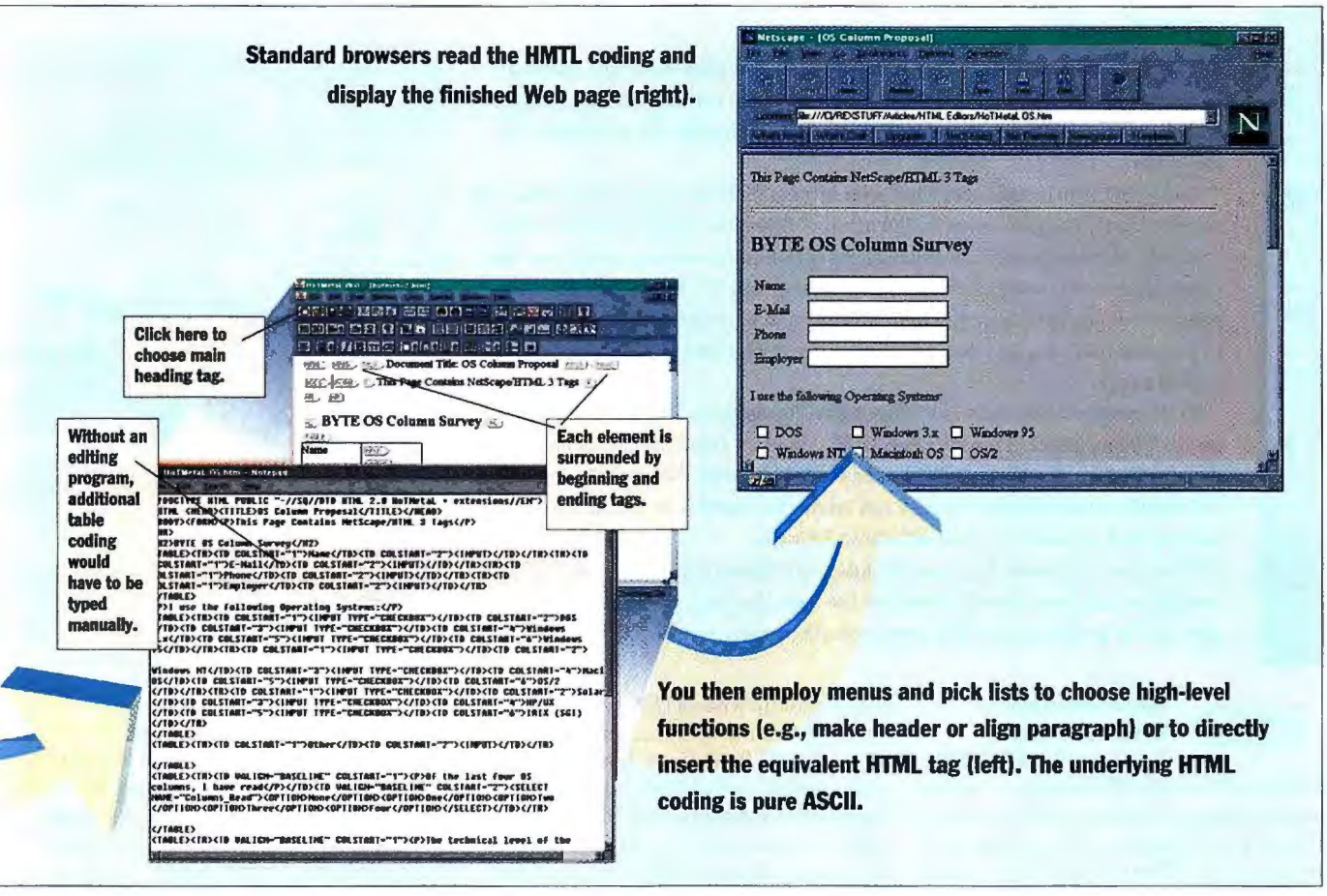
HTML tags are simply ASCII codes, embedded and visible in the text, that Web browsers, such as Mosaic and Netscape, can interpret as formatting commands. At a minimum, HTML authoring/editing tools automate the tagging process, but this says nothing about the HTML know-how you need to put the tags in the right place.

The better tools provide guidance in this area, insulating you from HTML by querying for decisions such as whether a title is meant to be a section heading, where to place links to other documents, and so on. These tools check a tagged document to see if it's in compliance with HTML rules, and they can even prevent you from making an invalid choice.

We ran the same text file through all four programs and watched them perform the major steps shown in the illustration "From Your Word Processor to the Web" above. In particular, we looked for compliance with HTML versions and extensions, enforcement of HTML rules, interoperability with popular word processors and graphics programs, and usability features, such as an integrated browser and point-and-click commands. The table "Features of HTML Editing Tools" on page 174 is, in part, a checklist of these criteria.

Cyberleaf: Big-Time Web Publishing

Interleaf's Cyberleaf 1.0 is expensive ($1595) and requires heavy-duty hardware: a Digital Equipment AXP, Hewlett-Packard 700/8xx, IBM RS/6000, or Sun SparcStation 2/IPX with a minimum of 24 MB of RAM and 129 MB of

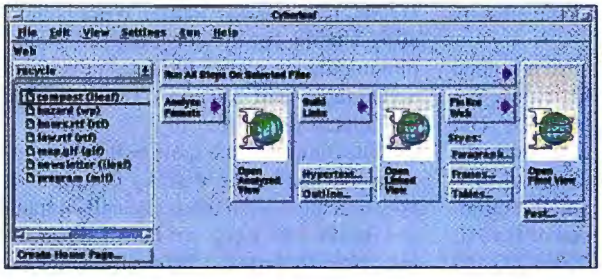


hard disk space. The Microsoft Windows version, due out in the first quarter of 1996, will most likely have a similarly ravenous resource appetite. But the commitment should be worth it—Cyberleaf is a big-time publishing environment from a company whose Interleaf software is a leader in document management.

First things first: Cyberleaf does not help with the authoring portion of HTML (if you don't count the Home Page Editor, which lets you write new text but provides a minimal set of word processing tools). Instead, it comes ready to convert Microsoft Word, WordPerfect, Rich Text Format (RTF), Interleaf, FrameMaker, and ASCII files into HTML 2.0 or 3.0 formats. Cyberleaf can also automatically convert a wide array of graphics-file types into GIF format.

With Cyberleaf, you're not just getting a conversion program; you're getting a complete Web development and maintenance environment. When your Web page needs are measured in megabytes and hundreds of links, Cyberleaf is the program to choose.

In our test runs, once it was given the proper marching orders, Cyberleaf had no trouble converting a Word document into HTML. With its workflow-oriented interface, Cyberleaf excels at bringing together documents from disparate word processors and desktop publishing (DTP) programs and quickly and easily converting them into a complete Web document.



Cyberleaf has the most graphical interface of the programs we reviewed. It offers easy point-and-click access to files in a document repository.

Cyberleaf analyzes a document and comes up with appropriate HTML equivalents. For example, by its enabling you to custom-set a Word paragraph style into what you select as the best-matching HTML style, you gain more control over the conversion process. Once you have Cyberleaf set up to your satisfaction, it tears through your files, converting them at a speedy clip.

What puts Cyberleaf into a class by itself is its ability to manage updates to the documents that make up your Web page. Removing a document to which others have pointers can result in broken links to external documents throughout the Web. Cyberleaf identifies such broken links, although it does not have the ability to fix them automatically.

Cyberleaf does, however, automatically maintain intradocument and interdocument hyperlinks in your internal repository, even as you update your documents. Outlines and reusable conversion parameters also help you quickly add new text.

When it comes to graphics, Cyberleaf also kicks rump and takes names. It has excellent graphics-file translators (see the features table for a partial list). Our favorite one automatically turns any image into a thumbnail-size graphic along with the HTML programming to let viewers opt to see the full-size image.

continued

TECHNOLOGY FOCUS

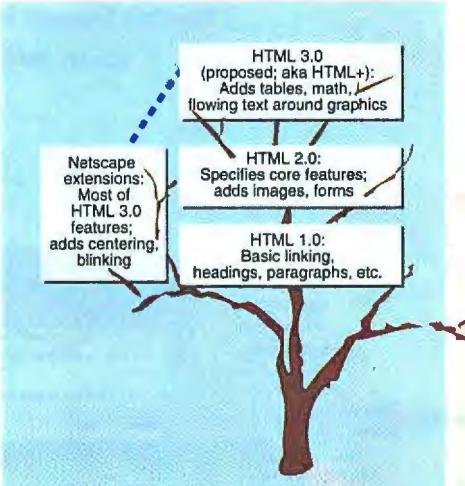
HTML Horrors

Once upon a time, writing for the Web was easy. You used Hypertext Markup Language (HTML) for text, and Graphics Interchange Format (GIF) for images, and all was right with the World Wide Web. Things change, but not always for the better.

Today, the Web is becoming filled with incompatible text, graphics, audio, and video formats. The good news is that some of these new formats enable authors to create documents that are much closer to their original conception than the bland sameness resulting from Web pages using only HTML and GIF. The bad news is that you must have the right browser and the right helper application (a program that can, say, load and display a graphics file) to see these new, improved pages.

HTML compatibility alone can't guarantee consistency. There are still documents floating about in the very first HTML standard (version 0.9), in version 1.0 (the seminal version that provided rules for linking), and especially in version 2.0 (which adds embedded images and interactive forms). So far, so good: Any modern Web browser can deal with these formats.

Meanwhile, a standards group, the Internet Engineering Task Force (IETF), is working to nail down specifications for the next standard, HTML 3.0, which promises to greatly expand the communications options available in Web



TThe HTML family tree, including the "illegitimate" but influential offspring of Netscape. Only some features of each level are listed.

Not for Pros Only: HTML Assistant Pro

Brooklyn North's HTML Assistant Pro ($99.95) is more of an authoring program than an editor, because it cannot work directly with imported word processor files. The only way that we could use it to get our Word document into HTML was to do it the hard way by saving it in ASCII, thus losing any Word-formatting niceties. In addition, the program comes without a browser of its own. It does, however, make it child's play to call up the browser of your choice to get in-process views of your work.

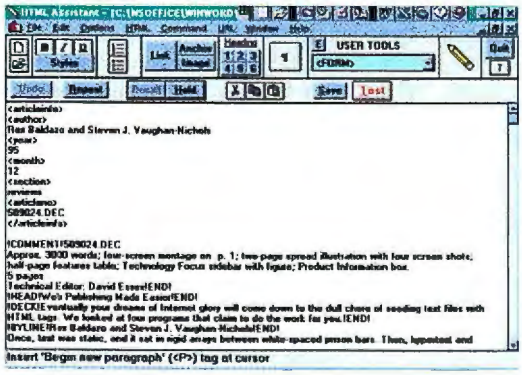
Pro makes extensive use of toolbars. These are very helpful, if you know HTML. Otherwise, you'll spend a lot of time with the help files. Fortunately, these files are well organized and well written. If you want to learn how to write HTML, you'd be hard pressed to find a better teacher.

Pro has its limitations, however. It directly supports only HTML 2.0 or lower. If you want to venture into the not-completely charted waters of HTML 3.0 or the Netscape enhancements, you must add these options to the editor. On the plus side, Pro makes it easy to do just that with its option to add HTML tags to the preexisting Users Tool toolbar.

If you need to create pages in a hurry, Pro includes an automatic page generator. It's nothing fancy, but it enables you to make a basic Web page within minutes. After that, you can use Pro's editing tools to fancy-up your raw pages.

Pro's editing utilities, once you know what they do, are easy to use. One nice feature lets you extract uniform resource locator (URL) addresses from Netscape, Cello Bookmarks, and the National Center for Supercomputing Applications (NCSA) Mosaic's INI files to quickly place your favorite Web sites on a page.

HTML Assistant Pro is a good program, but unfortunately the times may have passed it by. Old hands at HTML will find it a comfortable and powerful program to use. However, the rapidly growing new breed of HTML users, who want WYSIWYG and drag-and-drop links, will not find Pro to their liking.



Like HotMetal Pro and Spider, HTML Assistant Pro offers drop-down menus for choosing HTML tags.

Setting Type in HotMetal Pro 2.0

We had hoped to test HotMetal Pro 2.0's ability to import documents from such popular Windows word processors as Ami Pro (now called Word Pro) and Word. Unfortunately, a bug in Windows 95 caused it to balk at just about every document we threw at it. Still, for generating HTML from scratch, HotMetal ($195) is quite competent. It displays HTML tags as icons around the main text (see the screen at right). You can optionally suppress the tags, but, as with older versions of WordPerfect, it's a lot easier to edit with the tags visible.

HotMetal is smart about tag pairs: If you start to select the beginning or ending tag of any pair, it automatically highlights the entire tag. This makes it easy to cut, copy, and paste elements. However, editing tag attributes requires using the nonintuitive F6 key, not double-clicking or right-clicking to bring up an attribute dialog box. In addition, the editor displays HTML tags inconsistently. When generating a table, for instance, instead of displaying the tag pairs, HotMetal puts up an actual table, and you add your text within the cells of the table.

Unfortunately, the table editor is primitive. No matter how many columns or how much text is in them, the cells remain at a fixed width. Long text lines wrap, making the cells taller; a browser would attempt to make the column as wide as possible to accommodate the text. And there's

documents. Tentatively included in the specification are rules for flowing text around graphics, displaying math formulas and graphics with captions, and improved linking.

Alas, rather than waiting for the IETF to complete the 3.0 standard, Netscape, maker of the leading Web browser and server software, is boldly adding its own additions to HTML, which are incompatible with other browsers. Netscape extensions add a few additional controls, such as the ability to center text and to make it blink on and off.

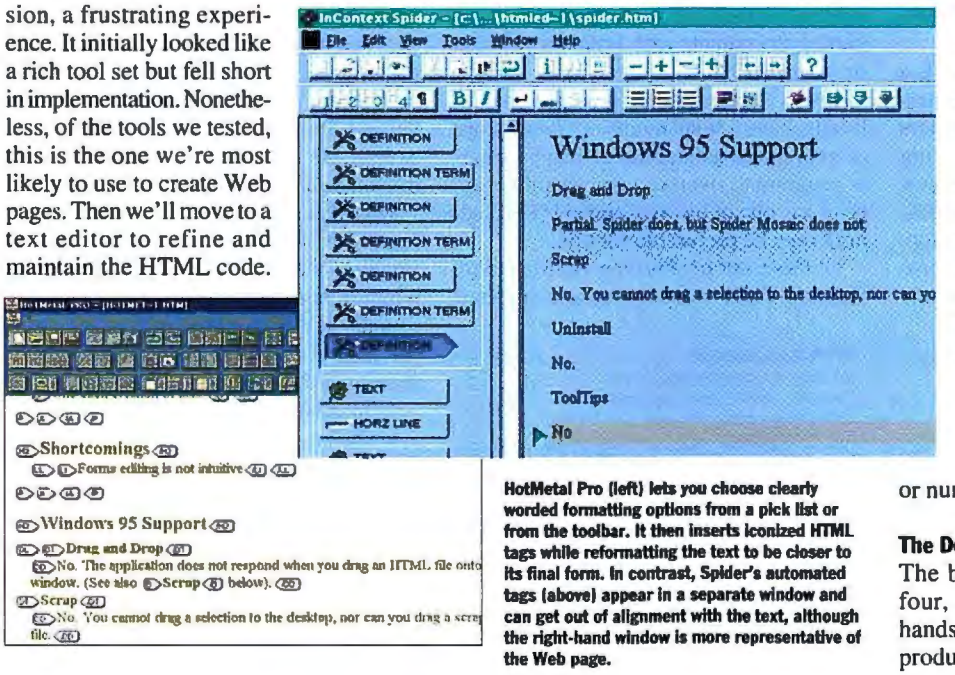
Since Netscape Navigator is the most popular browser on the market, Netscape-enhanced pages are appearing everywhere—much to the despair of users of other browsers. Browsers are programmed to ignore unrecognized HTML tags, but they can still incorrectly display a richly designed Web page that uses a lot of nonstandard features. At best, users of, say, Air Mosaic will get 99 percent of a Netscape-enhanced page. At worst, all they'll see is a muddle of indecipherable garbage.

The four HTML editors reviewed here play it fairly safe. All support at least up to HTML 2.0. HotMetal Pro and Spider, with support for HTML 3.0 and Netscape extensions, are pushing the leading edge more than Cyberleaf and HTML Assistant Pro are. This approach provides some insurance that you'll have the right tools to publish in whatever standard takes off, but the final form of any standard—de facto or de jure—is likely to differ from what's included in the current versions of HotMetal Pro and Spider.

no way to add rows or columns to a table besides using a text editor to add the lines and then reimporting the new text file into HotMetal.

HotMetal supports some Netscape and HTML 3.0 extensions, but there's no strict way of enforcing which version of HTML you can create. There is, however, an option to check your code, which generates a report detailing the HTML 3.0 and Netscape extensions used in your document.

Generating an HTML page with HotMetal Pro 2.0 was, on occasion, a frustrating experience. It initially looked like a rich tool set but fell short in implementation. Nonetheless, of the tools we tested, this is the one we're most likely to use to create Web pages. Then we'll move to a text editor to refine and maintain the HTML code.



HotMetal Pro (left) lets you choose clearly worded formatting options from a pick list or from the toolbar. It then inserts iconized HTML tags while reformatting the text to be closer to its final form. In contrast, Spider's automated tags (above) appear in a separate window and can get out of alignment with the text, although the right-hand window is more representative of the Web page.

Spanning the Web with Spider

Spider ($99), from InContext Systems, is really two programs. There's Spider, which is the HTML editor, and Spider Mosaic, which is a customized Mosaic browser. InContext has done some work to integrate the two, but they too often expose their heritage as separate products.

Spider uses a two-pane window to display the page under development (see the screen below). You can adjust the relative sizes of the panes by sliding the border between them. The left-hand pane is the logical view, showing the HTML tag structure of the document. Icons supplement the tag names, but we found them to be annoyingly cute after extended use.

The right-hand pane holds the text that appears between the tag pairs. Anchors in the text are bracketed by left and right arrowheads. Editing them is straightforward: A right mouse-click causes a dialog box to pop up with the appropriate attributes. Unfortunately, as with most of these editors, you must understand HTML to know how to apply the correct attributes.

One nice feature is that the Web pages (and their associated links) that you browse through Spider Mosaic can be imported directly into documents that you're editing in Spider. So, if you happen to be browsing, say, http://www.byte.com/, you can import any of the links on that page into your own document using the Web Manager option in Spider.

Unfortunately, that's the extent of integration between the two tools. Where Spider Mosaic supports drag and drop to open HTML files, Spider does not. And Spider Mosaic exhibits a problem when it minimizes under Windows 95: The title bar remains on the desktop. It's more an annoyance than anything else, and InContext is working to resolve the bug.

We also found that Spider balked at reading documents produced by some other HTML editors, because it's finicky about the Document Type Definitions (DTDs) specified in the optional DOCTYPE tag. Deleting this tag is the easiest workaround, or you can edit it to use one of the DTDs supplied with Spider.

In addition, the interface in Spider needs a workaround. There are no tool tips for the toolbars, and given the large number of cryptic buttons on the toolbars, it's difficult to figure out what to do next. The interface has additional quirks, such as not allowing you to delete by using the Delete key (you must type Ctrl-D instead). Ultimately, we have to question the usability of Spider's interface when working on lengthy or numerous Web pages.

The Denouement

The best HTML-conversion tool of the four, irrespective of price, is Cyberleaf, hands down. While two of the other three products, HTML Assistant Pro and Hot-

FEATURES OF HTML EDITING TOOLS

	CYBERLEAF	HOTMETAL PRO	HTML ASSISTANT PRO	SPIDER
HTML features				
HTML versions supported	2.0, 3.0	0.9, 1.0, 2.0, 3.0	0.9, 1.0, 2.0, 3.0	0.9, 1.0, 2.0, 3.0
Supports Netscape HTML extensions	○	●	●	●
Enforces HTML rules	●	●	●	●
Supports forms creation	●	●	●	●
Templates included	●	●	●	●
WYSIWYG view of entire Web page	●	○[1]	○[1]	●
Preview graphics in WYSIWYG form	●	○[1]	●	●
Integrated Web page viewer	●	○[1]	○	○
Number of file formats supported	30	30+	4	1 (HTML only)
Major file formats	ASCII, HTML, GIF, JPEG, RTF, PostScript, FrameMaker, WordPerfect, Interleaf	ASCII, HTML, GIF, JPEG, RTF, Ami Pro, Word, WordPerfect	ASCII, HTML, GIF, JPEG	ASCII, HTML, GIF, JPEG
Can set HTML preferences during import	●	●	○	●[2]
Automatic insertion of URL addresses	●	○	○	●
Word processing features				
Word processor formats supported	Word, WordPerfect, Interleaf, FrameMaker	Word Pro, Word, WordPerfect	None[3]	None[3]
Spelling checker	○	●	●	●
Thesaurus	○	●	○	○
Supports macros	●	●	●	○
Standards-compliant table editing	●	●	●	●
Provides document management	●	○	○	○
General features				
OSes supported	Unix (SunOS, Solaris, HP/UX, AIX, OSF)	Windows 3.x, Macintosh	Windows 3.x,	Windows 3.x
Minimum RAM requirements (MB)	24	8	4	4
Hard disk requirements (MB)	65	15	1	7

[1] Available using a separate browser.
[2] Not a menu choice, but available via Spider's DOCTYPE DTD utility.
[3] Can import ASCII files exported from word processor.
● = yes; ○ = no.

Metal Pro, don't even come with a browser for viewing pages, Cyberleaf makes it easy to monitor your progress with full-color, integrated viewers.

Cyberleaf's lack of authoring tools is a design decision, not a shortcoming: Interleaf figures that serious Web publishers will want to use some of the formatting and layout of their existing word processor files, so Cyberleaf comes with the best import features of the group. In addition, Cyberleaf's repository management provides a whole layer of functions that the others don't attempt but are necessary for large-volume enterprises. And it's more automated than the other packages, converting documents with little intervention on your part.

If you're experimenting with Web publishing, have a small number of documents, or plan to use a database manager or other program to oversee your document repository, one of the low-priced HTML editors may be preferable for you.

Of these, our favorite was HotMetal Pro. Unlike HTML Assistant Pro and Spider, it can import Word, WordPerfect, and Word Pro files, so you can retain more of the value of existing layouts. (The other two don't compensate for this shortcoming by packing word processor features into their authoring environments.) HotMetal lags behind Spider in graphics viewing, but overall, we're more comfortable working in HotMetal.

HTML-conversion tools will evolve rapidly as standards solidify and software vendors scramble to provide the right combination of file compatibility, HTML automation, and document management. These tools are also sure to grow more popular as the demand for Web publishing continues to explode. ■

Product Information

Cyberleaf 1.0.....$1595
Interleaf, Inc.
Waltham, MA
(617) 290-0710
http://www.ileaf.com
Circle 1130 on Inquiry Card.

HotMetal Pro 2.0.....$195
SoftQuad, Inc.
Toronto, Ontario, Canada
(800) 387-2777
(416) 239-4801
http://www.sq.com
Circle 1131 on Inquiry Card.

HTML Assistant Pro.....$99.95
Brooklyn North Software Works
Bedford, Nova Scotia, Canada
(800) 349-1422
(902) 493-6080
http://fox.nstn.ca/~harawitz/index.html
Circle 1132 on Inquiry Card.

Spider.....$99
InContext Systems
Bethesda, MD
(800) 263-0127
(301) 571-9464
http://www.incontext.ca
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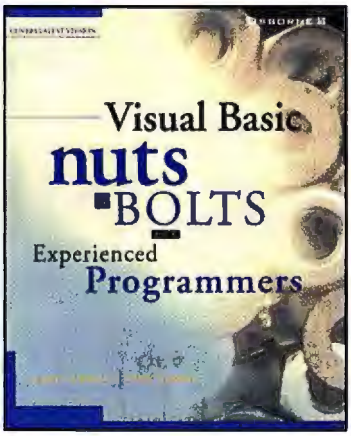

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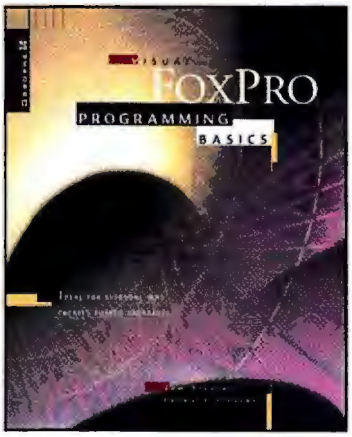

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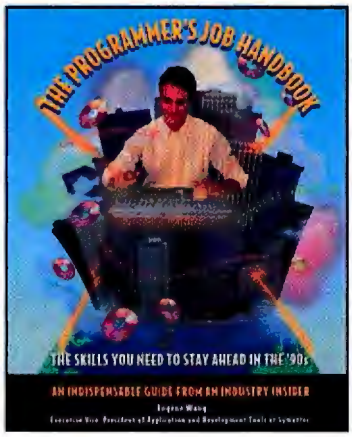

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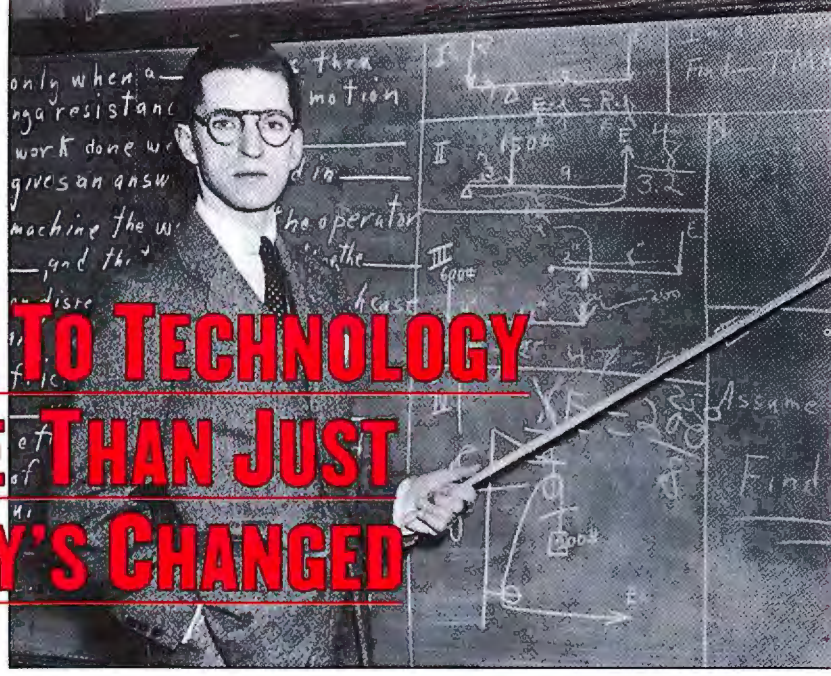

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The Penthouse Suite

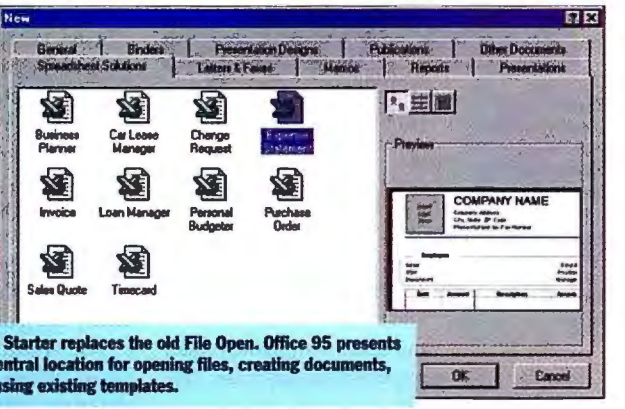
Microsoft Office 95 moves up to true 32-bit native code and delivers improved integration, full OLE 2 support, and binders

STAN MIASTKOWSKI

Despite the hype surrounding Windows 95, the application software that people use daily remains the truest measure of the new operating system's relevance. Not surprising, Microsoft is first out of the gate with an upgraded suite of true 32-bit applications tuned to the abilities of Windows 95.

Office 95 is packed with new features, but it is the usability that sets this suite apart from competitors. Microsoft claims to have spent some 14,000 hours testing the new capabilities, observing a wide range of users, sending out specially instrumented versions to selected users, logging support calls, and employing contextual inquiry—a technique based on social anthropology—to research how people work. The results show.

Office 95 is tightly tied to the Windows 95 environment; but overall, it reflects a natural evolution—not revolution—from the Office 4.3 suite for Windows 3.1. All Office 95 applications—Word, Excel, PowerPoint, Schedule+, and Access (in the Professional version)—are true 32-bit native applications developed using the Win32 API. This makes Office 95 compatible with both Windows 95 and Windows NT. The newest addition to the mix is the Office Binder, a format that lets you work with multiple documents and applications from within a single "binder" file.



File Starter replaces the old File Open. Office 95 presents a central location for opening files, creating documents, or using existing templates.

As developers know, "32-bit" doesn't guarantee better performance, but Microsoft claims it has wrung out some real improvements by taking advantage of the new environment. The company has optimized the most-frequently used code in Office into small segments. A prime example is the Excel recalculation engine, completely rewritten in 32-bit assembler. Common operations go faster and memory is handled more efficiently. In addition, Office 95 can detect a Pentium and take advantage of its separate instruction and data pipelines, boosting performance.

Tasks and Threads

Performance is a balance of many techniques, including the efficient use of multitasking, multithreading, and shared code. True preemptive multitasking is perhaps the greatest enhancement to Windows 95. Multitasking multiple Office applications is clearly faster and more stable under Windows 95. Office 95 also takes advantage of multithreading, essentially allowing you to execute multiple commands at the same time within a single application. Threads are used in the PowerPoint Slide Sorter, for background printing in Word and PowerPoint, and in Access queries. However, Excel recalculation does not use threads; instead, the optimized 32-bit recalc engine is called as a separate task.

Shared code allows Office applications to look and work alike. Office indexing works across all document types, and the spelling checker is common to all the suite applications. Shared DLLs are prevalent; for example, there's a single container

TECHNOLOGY FOCUS

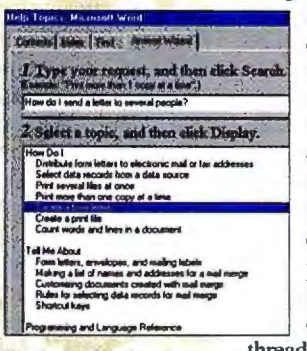
Inside Help

Office 95's natural-language help system employs Bayes' Rule, an equation often used in artificial intelligence systems (including speech and pattern recognition, decision analysis, and expert systems) to infer probabilities.

You start with known probabilities and causal relationships. For instance, let's say someone has a headache and you want your system to diagnose the reason for the malady. The patient is a hopeless hypochondriac and thinks his headache indicates a brain tumor. You know some basic facts about these conditions. For instance, the probability that a person with a brain tumor will have a headache is 90 percent, or in proper notation: `P(headache|brain tumor) = .9`

You also know the random probability of a person having a headache (let's say 10 percent) and of a person having a brain tumor (one in 1000). From these two unconditional probabilities and the causal relationship, Bayes' formula derives an unknown probability; in this case, the probability of a person with a headache having a brain tumor:

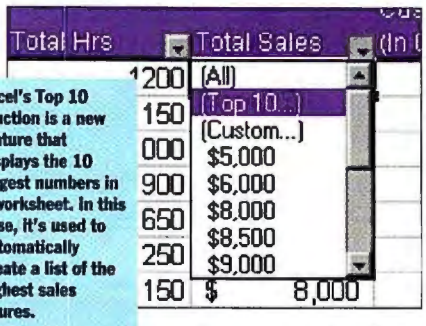
```
P(brain tumor|headache) = (P(headache|brain
  tumor)*P(brain tumor))/P(headache), or
P(brain tumor|headache) = (.9*.001)/.1=.009
```



Using Bayes' formula, we now know that nine out of every 1000 people afflicted with a headache actually have a brain tumor. More to the point, we have derived an unknown probability from two known independent probabilities and a causal relationship (or joint probability).

***Bayesian updating* lets us add new information dynamically (one piece at a time) until we reach an acceptable level of certainty. The system can then determine if new information is needed or if a reasonable decision can be made with the current information.**

(MSOFC95.DLL) for shared dialog boxes. The Office Binder represents a culmination of a shared environment. You can store multiple documents—including Word files, Excel spreadsheets, and files from any other Office 95-compatible application—within a single binder. Clicking on any document in the binder exposes the menu structure from the creating application.



Excel's Top 10 function is a new feature that displays the 10 largest numbers in a worksheet. In this case, it's used to automatically create a list of the highest sales figures.

Developers, Grab an Object

Office 95 has become a serious development tool. The entire suite is essentially a group of objects tied together with OLE 2. Users and developers have access to more than 300 of these objects through Visual BASIC for Applications (VBA), a full-bore programming language incorporated within Excel and Access. (Word still includes the WordBASIC development language.) Using VBA from either of these programs, you can put together custom software that employs available objects from any Office application. For example, your VBA-developed application can make use of the Access Report Object or the Excel Chart Object. The Bank of Newport (Rhode Island) used VBA and Access's Open Database Connectivity (ODBC) abilities in the Jet Database Engine (another object) to create an Office 95 front end for tellers to access the bank's mainframe computers.

For more-involved projects, especially for third-party developers who want to create products that both look like and work like Office 95, it's worthwhile to join Microsoft's Office Compatible program (for information, phone (800) 765-7768 or send E-mail to offcomp@microsoft.com).

Product Information

Microsoft Office for Windows 95
Standard Edition $249
Professional Edition
(including Access 95) $349
Microsoft Corp.
Redmond, WA
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Office Intelligence

The idea behind Microsoft's IntelliSense technology is to streamline tasks by completing them automatically or making suggestions interactively. In Office 95, IntelliSense takes advantage of multitasking, multithreading, and shared code. For example, AutoCorrect, the automatic spelling checker in Word that now works across applications, continually checks your spelling as you type. You can immediately right-click on the word to get spelling suggestions or you can keep on typing. In any case, the final check will be much faster since the dictionary look-ups have already been done.

AutoFormat automatically generates bulleted lists and horizontal borders from common entries (for example, making a border from multiple dashed lines). Start typing an entry in an Excel 7.0 worksheet and AutoComplete finishes the entry for you, based on existing cell entries. AutoCalculate lets you quickly sum a few cells by simply highlighting them.

The automatic features of Office 95 can sometimes appear uncanny. If you've accidentally hit your Caps Lock key and type something like "tHIS" to lead off a sentence, AutoCorrect not only changes it to "This," it turns off Caps Lock. If you find some of the automatic features annoying, you can shut them off. And because Office uses Windows 95 registry files instead of INI files, different users of a PC can each have their own customized Office settings.

Help on the Way

When using Office 4.3, we often found ourselves hunting, sometimes futilely, through longs lists of help topics. The Answer Wizard is the solution, and it works surprisingly well across Office 95 applications. The Answer Wizard lets you type in a plain-text query—like "How do I print this sideways?"—and up pops a list of related topics. It's not foolproof, but it's pretty accurate. Answer Wizard uses decision theory—Bayes' Rule specifically—to parse your query and connect it to help topics by creating a stack of rules based on probability.

Once you've beckoned Answer Wizard to locate the topic you want to explore, the help system uses innovative ways to explain concepts. For example, to demonstrate how to insert columns in your Excel worksheet, the system shows movement of screens instead of a series of static images. This approach makes it much easier to learn new tasks.

The object-oriented technology at the heart of Office 95 allows a new document type called a binder. Binders are single documents that can contain files from different Office applications or from certified Office-compatible applications.

Big Space Required

Office 95 is large. *Very* large. A full installation of the standard package (sans Access) requires 89 MB of hard disk space; a typical installation takes 55 MB; a compact installation, 28 MB. And it's hungry, too: 8 MB of RAM is a minimum, and that will allow you to run only two applications concurrently. You'll need 16 MB for decent performance. You'll also want to have a 486/50 or faster processor.

Easy Upgrade

In corporate environments, the question of upgrading from Windows 3.x to Windows 95 is a thorny one, but doing the actual upgrade to Office 95 isn't as much of a problem. File formats for Word 7.0 and Excel 7.0 are identical to earlier versions. PowerPoint has a new format, but the program comes with an import utility for files created with earlier versions. And the cutting-edge help technology will reduce—if not virtually eliminate—training costs.

The bottom line is that Office 95 pays for itself in increased productivity. ■

Shared Office 95 OLE Server Components

Data Map	Analyzes data geographically
Imager	Imports and edits images; provides TWAIN scanner support
Query	Accesses data from worksheets or databases
Graphing Tool	Creates, edits, and manipulates graphs
ClipArt Gallery	Provides location for viewing the 1000+ included images
WordArt	Creates special effects with text
Equation Editor	Works with mathematical elements

Stan Miastkowski is a BYTE consulting editor. He's coauthor of the Windows for Workgroups Bible *(Addison-Wesley, 1993). You can reach him on the Internet by sending E-mail to stanm@bix.com.*

Access 95 Advances Database Design

Microsoft Access for Windows 95 replicates desktop databases and adds nifty productivity tools for users and developers

RICK DOBSON

The new version of Access from Microsoft isn't just a repackaging job with the Windows 95 look and feel. The program's replication technology advances the state of desktop databases by managing multiple remote copies of a database. After working extensively with a late beta version, we can say Access's replication is easy to apply, and it's also highly programmable. Access can even replicate database objects, such as modules and forms, which you can't do with most high-end database products.

Access 95, along with Lotus Notes and Oracle, is leading the charge for database replication. The upcoming Notes 4.0 will offer more granular, field-level replication—as compared to Access's row-level replication. Personal Oracle 7 for Windows 95 provides a more complex set of replication rules that scale up to the parent Oracle database manager. Access doesn't yet have the equivalent for its enterprise counterpart, Microsoft SQL Server. (The Technology Focus on page 182 explains Access 95 replication in greater depth.)

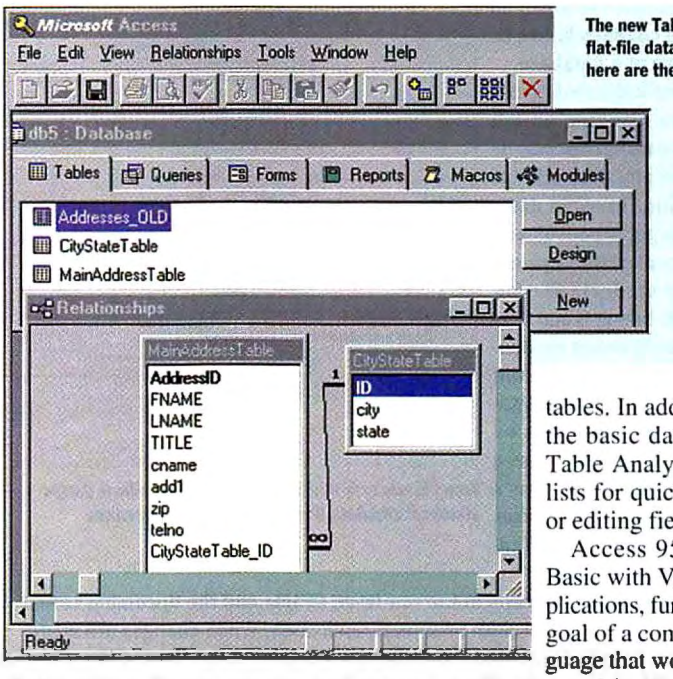
Developers will benefit from other enhancements, including Access 95's ability to be an OLE Automation Server, a switch from Access Basic to Visual Basic for Applications (VBA), and some new "wizards." Among other things, the wizards build databases automatically; allow developers to view ASCII data during import; convert data tables from flat, legacy designs to relational ones; and simplify getting security settings right.

To get all these new features, though, you have to switch to Win 95. Access 95 won't run on Windows 3.1.

Wizards of Productivity

Access 95 introduces wizards that speed up application development. The most important ones handle database design and use of legacy tables.

A new Database Wizard offers about 20 preset designs for operations ranging from contact managing, asset tracking, and ledger keeping to maintaining lists of wine and music collections. Each design includes tables, forms, reports, and event procedures. The preset applications include sample data sets and custom forms and reports for viewing data.



The new Table Analyzer Wizard converts flat-file databases to relational. Shown here are the database container and Relationships window after the Table Analyzer has created a relational design. The original flat table, named Addresses, has been renamed Addresses_OLD, and two new relational tables have been built. The wizard also creates a new query (not shown) that ties the two relational tables together to reproduce the records in Addresses.

Developers can use these designs to expedite the early steps in building custom applications. But for those who prefer working without design templates, Access 95 offers the Performance Wizard, which reviews database objects to suggest improvements. Access can then carry out some of the recommended actions, such as indexing a field, modifying the code in a module, or converting a macro to Visual Basic for Applications.

Two wizards dramatically improve processing legacy tables. A new Import Wizard readily converts ASCII and spreadsheet tables to database tables. We liked being able to view data while scrolling through the screens in which you decide how to import the table fields. The wizard lets you set indexes, specify data types, and decline to import fields.

The Table Analyzer converts any flat-file table into a set of relational tables (see the screen above). The user can now process a query that has the same name as the original table; the difference is that the new query is tied to a new, relational set of tables. In addition to improving the basic database design, the Table Analyzer creates lookup lists for quickly adding records or editing fields.

Access 95 replaces Access Basic with Visual Basic for Applications, furthering Microsoft's goal of a common scripting language that works in every Office application and in Visual Basic. Besides improving Access's interoperability, the change in language brings improvements in programming, setting start-up options, and debugging.

Form and report modules now serve as class modules, thanks to VBA (in Access, a module is a container for one or more procedures). Developers can construct methods and properties for custom classes with these modules. Sub functions define custom methods, and new Property Let, Get, and Set statements let you set and read custom properties. The reserved word New lets you create instances of custom classes. Still, as desirable as the class modules are, many Access developers will long for the full class-construct functions that Microsoft built into Visual FoxPro.

A new Startup Dialog lets programmers control an application's start-up sequence. The same dialog also permits disabling of shortcut menus. You can impose security restrictions that prohibit users from modifying these settings.

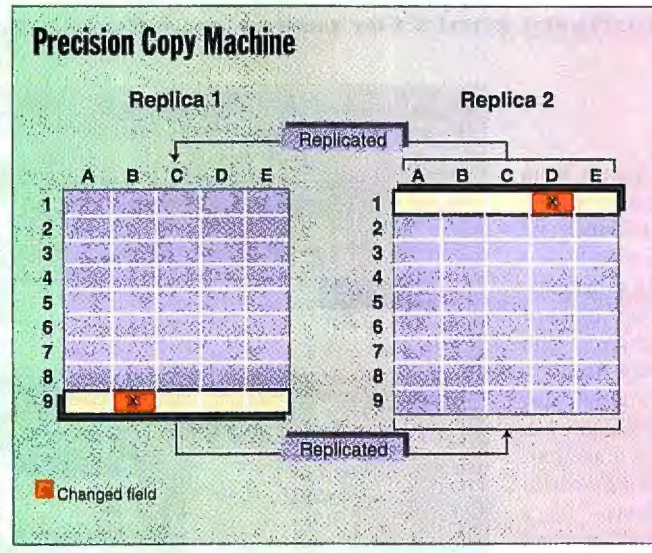
The move to VBA also results in an easier-to-understand module window that has enhanced debugging features. Access 95 dramatically improves the readability of modules by using continuation lines and

TECHNOLOGY FOCUS

Replicating Access Databases

Access 95 lets you drag an entire database to the Windows 95 Briefcase, creating a replica that can be moved to a floppy or a laptop for use at a remote site. This makes it necessary to ensure that changes made by remote users of replica databases are reflected in the original database. Access 95 solves this problem with data replication: the ability to coordinate changes in two or more copies of a database.

Access replication is deferred and asynchronous, which means a database copy may be changed at any time without coordination. To avoid database copies getting out of sync between replication cycles, higher-end products like Microsoft SQL Server 6 and Oracle use synchronous replication, which requires constant communication between database copies, restrictions on which copies of a database may be changed, or both. Access's lack of such restrictions makes conflicts possible among its coequal databases.



Access 95 uses a row-level replication scheme to coordinate changes in copies of a database. Changes may occur in both directions.

Access replication happens at the row level; Oracle and the upcoming Lotus Notes 4 are more granular, with field-level replication. When changes are made to a single field, Access copies the entire row containing the field to the other replica's equivalent row, erasing any data that was there. Replicating only the changed records is more economical than managing multiple copies of the entire database.

Managing replication adds substantial overhead. Each table that is a replicated object has at least three new fields added to it (Memo and OLE object fields require still more fields to track their update status). In addition, the database gets at least three new tables and a fourth category of tables to track update conflicts, which occur if two replicas change the same record after it has been updated.

color coding to distinguish comment lines and keywords from code. The basic Immediate Window is also better, with a new Watch pane for tracking the value of key expressions as a procedure runs. You can specify how an application responds when it reevaluates a watch expression, telling it to either show the value or stop.

Security Access

Access 95 simplifies security. A new workgroup information file—its format is not compatible with Access 1.x and 2.0—offers control of new features, such as who can create replicas or set the Startup dialog controls. However, these and other improvements come at the expense of file-level backward compatibility.

In addition to the traditional user-level security in previous versions, Access 95 introduces database password security. This is very appropriate for departments where anybody in a workgroup has total access to a database but those outside the department have none. Database password security is similar to the share-level security in Windows for Workgroups.

A Security Wizard, available from the Tools menu on the database menu bar, automates the process of setting basic user-level security. It reduces the chance that developers will leave routes to database objects open to users who are not supposed to access them.

Product Information

Access for Windows 95 . . . $339
Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
http://www.microsoft.com
Circle 1052 on Inquiry Card.

Access 95 has three important security enhancements. First, it grants permission to replicate a database. Second, it lets you set a password for a database. Third, it grants access to the startup properties of a database.

Now Serving OLE

Two of Access 95's most significant improvements are new OLE Automation features and better menuing capabilities. As an OLE Automation Controller, Access 2 could readily tap the exposed functionality in other applications, such as Excel and Word. Access 95 builds on this by making itself available as an OLE Automation Server. Now, any program that can be an OLE Automation Controller, such as Visual Basic, Visual C++, Excel, and Project, can launch Access and manipulate its objects.

Developers will like the expanded custom menuing that they'll be able to incorporate into the applications they build. Adding shortcut menus is no more complicated than invoking the familiar Menu Builder. You then use the new SetMenuItem action in either macros or procedures to make custom menu items appear gray or deselected.

No-Brainer Upgrade?

Access 95's interoperability with the rest of Microsoft Office makes the upgrade decision almost automatic for organizations that will standardize on Office 95. This is even more true in companies that need database replication for mobile workers.

Companies that haven't made the move to Windows 95—but that have a substantial need for data replication among their mobile workers—have a more difficult decision. Should they adopt Windows 95 in order to get the advantages of Access 95?

If you are a Windows shop that has no existing replication solution, you should adopt Windows 95 and reap the replication benefits of Access 95. But if you currently use Oracle or Sybase replication servers, then stick with the solution that works for you now. ■

Rick Dobson is president of CAB, a consultancy specializing in database development and Windows 95. You can reach him at Rick_Dobson@msn.com.

Symantec C++ Differences

Smart distributed compiling and Windows-compliant tools make Symantec C++ 7.2 an enticing alternative for serious developers

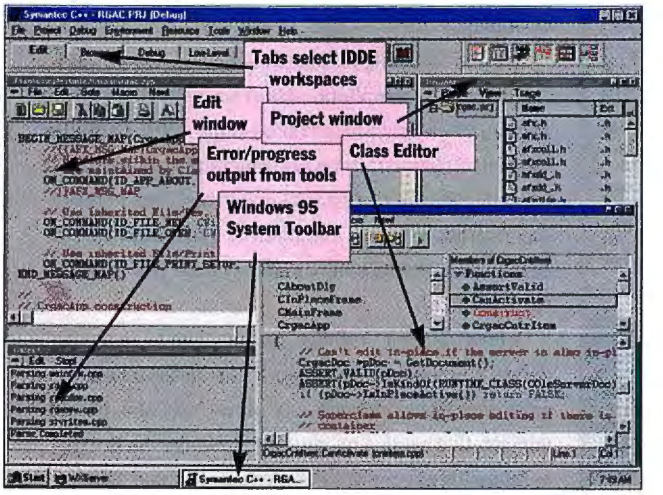
RAYMOND GA CÔTÉ

Symantec has shaken itself awake with the release of Symantec C++ 7 for Windows. This new version is a graphically pleasing environment that offers fast compile times and a slew of features that ensure compatibility with key Windows standards.

Symantec C++ has always been the "other" Windows-based C++ compiler behind Microsoft's and Borland's market dominators. On the Macintosh, it went from being the leader to losing hordes of customers to Metrowerks' CodeWarrior, a fall that was due partly to Symantec's lack of PowerPC support but more to a feeling that the company wasn't listening to its customers. With this new C++, plus a PowerPC upgrade (see "What's New for the Macintosh" below), Symantec is again a contender.

Comfortable Environment

A good way to try out a new compiler is to import code already written in another compiler, but the conversion process can really be a pain. It's easy with the new Symantec C++, as we found out when we tested both the pre-Windows 95 version 7.0 and the 7.2 update, which includes final Win 95 code. The package provides a Microsoft-compatible version of Nmake, as well as a Resource Editor that is compatible with the Microsoft Foundation Classes (or MFC). There's also code for MFC 2.5 and MFC 3.0. The debugging output from Symantec's compilers and linkers is fully compatible with Microsoft formats, which lets you continue to use your favorite debugging software, such as CodeView from Microsoft or BoundsChecker from NuMega. Moving your files manually into the Integrated Development and Debugging Environment (IDDE) does take some work, but we were able to move 100 project files in about 10 minutes.



The new Integrated Development and Debugging Environment (IDDE) offers tabbed access to several levels while cramming information onto each screen.

Once you've looked, will you stay? Perhaps. Symantec's IDDE does a nice job of using the tab metaphor to pack lots of information on the screen. By selecting individual tabs, you move among several different workspaces: editor, browser, and debugger (see the screen above).

The IDDE has all the tools you expect from an up-to-date environment. You can configure the integrated editor for Windows-style control keys and for the standard Brief and Epsilon editors. A built-in version of Basic provides macro processing. The Resource Editor is quick, easy to use, and can exchange resource files with a Visual C++ project. Executables are linked using a new 32-bit multithreaded version of Optlink 6.0 that is lightning fast. A new link option compresses the code within the executable, which, according to Symantec, results in faster load times. This option may be helpful on slower machines, but we saw no improvement on a 66-MHz 486 running Windows 95.

Various compiler options and settings let you build applications for DOS, extended DOS, Windows 3.1, Win32s, Windows NT, and Windows 95. The package also supports Visual Basic extensions, DLLs, static libraries, and OLE custom controls (OCXes).

Behind all these programming tools is the integrated Multiscope 3.0 Debugger (one of the tabbed workspaces). On Pentium machines, this new version of Multiscope provides multithreaded debugging and hardware watchpoints under Windows NT and Windows 95.

The one item delightfully missing from Symantec C++ 7.0 is yet another framework. What a relief. The company is instead focused on fully supporting MFC 2.5 (the 16-bit version) and MFC 3.0 (the 32-bit version).

Agents, Not Wizards

Where Microsoft uses Wizards to help you through tasks, Symantec delivers Express Agents. C++ 7 provides four types of these helpers. The ProjectExpress agent sets up an initial project file and environment configurations for anything from DOS to Windows 95 as well as libraries. There's also an option for a simple command line–style interface under Windows.

Once you've established your project directories and settings, the ProjectExpress agent can invoke AppExpress, which generates a skeleton application. You simply tell the AppExpress agent if your application requires a simple form or a multiple-document interface. Perhaps it is an OLE

What's New for the Macintosh

The latest version of Symantec's C++ for the Macintosh environment adds PowerPC support for Apple's Power Mac computers. Release 8 ($399) is a PowerPC-native version of the latest 68K version of Symantec's Macintosh C++ compiler (release 7, which is included on the CD-ROM). The new integrated development environment and compiler require a PowerPC, so you can't build new applications on older 68K-based systems. However, the latest version of Visual Architect (an application generator) and the resource editors run on either 68K or PowerPC platforms.

Although Symantec provides development tools for both Windows and the Macintosh, it makes no pretense of supporting true cross-platform development. The two products separately follow their own life cycles.

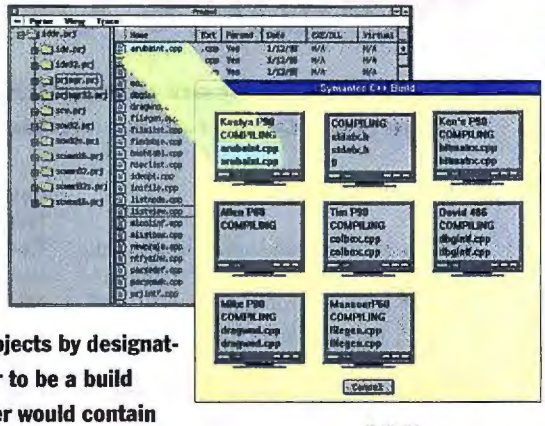
TECHNOLOGY FOCUS

Distributed Compiling Speeds Development

Recompiling (building) hundreds of source files totaling, say, 5 MB, can take a dozen hours. It's a productivity killer that programmers perform as infrequently as possible. Reducing this compile time could let developers see the results of their changes daily instead of weekly.

The new NetBuild feature in Symantec C++ 7 lets you distribute compilation chores across the network to computers that are less busy than yours. Compiles formerly done serially on one machine are now happening in parallel on several machines. This potentially speeds up some compiles by a minimum of 100 percent (assuming you're using at least five 90-MHz Pentium PCs).

Before starting NetBuild, you must go to each candidate machine on the network and install a small control program. Whenever you run NetBuild, the administrative routine on your local PC checks the dependencies of your project file to determine which source files need to be compiled. Then, the first file is fed to the local compiler. The administrator looks for any machines that are free. When it finds one, it passes the remote machine the full path of the file to be compiled. The remote machine then logs on to your local machine, mounts one of its drives for accessing the particular file, and begins the compilation.



NetBuild distributes source files to other machines for faster, parallel compiling.

You can be even more efficient on large projects by designating one computer to be a build server. This server would contain precompiled headers (the Windows system files and other commonly accessed housekeeping code) that otherwise would be compiled for each source file.

NetBuild won't always be faster than a single-machine build. On projects of roughly 25 or fewer source files, you're just as well off going the traditional route, Symantec says.

NetBuild does little to analyze the resources on each networked computer. It can, however, redistribute work on the fly if a node goes down. Symantec plans to add intelligent scheduling and resource "sniffing" in later versions.

Control. After you have made all your selections, you can preview a live version of the application, then go back and adjust your agent's parameters until the application has the right feel. AppExpress finishes by generating the initial source code along with a basic help file.

Anyone who works with the Microsoft Foundation Classes knows the hassles involved in starting a new project. It's not so much the number of classes you have to write—it's all the typing. The ClassExpress agent helps cut down the amount of labor by letting you define new classes for visual elements and map them to Windows messages. Even so, we're still waiting for a tool that will let us look at individual screens from the final program and double-click on screen elements to see the coding structure behind them—a Visual Basic designer for C++.

Product Information

Symantec C++ 7.2 . . . $399
Symantec Corp.
Cupertino, CA
(800) 441-7234
(503) 465-8470
fax: (503) 334-7400
http://www.symantec.com
Circle 1050 on Inquiry Card.

Our favorite Symantec agent is VBXExpress, which builds C++ wrappers around Visual Basic extensions. VBXExpress extracts the extensions' properties directly from the VBX, so there is nothing to configure manually. You only have to name a new class for the VBX, as well as the header and source file, and press Generate. Presto! You can now talk with the VBX using familiar C++ syntax. We were able to use one of the Visual Basic grid extensions in about 15 minutes the first time we tried it.

Browsing the Source

No C++ developer environment is complete without a class browser. Symantec provides a typical Smalltalk-style browser for viewing and editing source code. A project database maintains class declaration and usage locations for quick retrieval. A background parser that scans source files whenever they change keeps this central database up to date. You continue working while the parsing occurs. We had to wait a minute or two the first time we opened a large new project while all the files were parsed and the database was updated. However, after the initial pass, we noticed only a slight slowdown while parsing individual files. This is a simple yet sophisticated way to ensure your browser is always up to date.

A Contender Again

The maxim that whatever doesn't kill you makes you stronger applies to Symantec, which has a strong new product in C++ 7. The company still has much work to do to convince disgruntled developers that they'll get the support they need. But technologically, Symantec C++ 7 is a serious competitor to the Borland, Microsoft, and Watcom products. Windows developers will like the tightly integrated development environment and special tools such as the VBXExpress agent. Macintosh developers will sigh with relief that they can finally move their existing applications based on the Think Class Library to the PowerPC platform. ■

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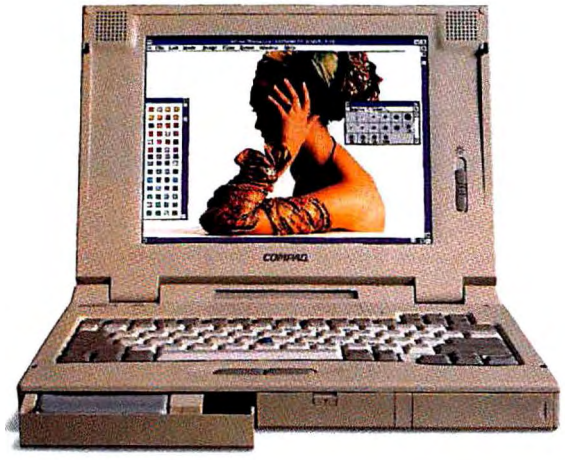

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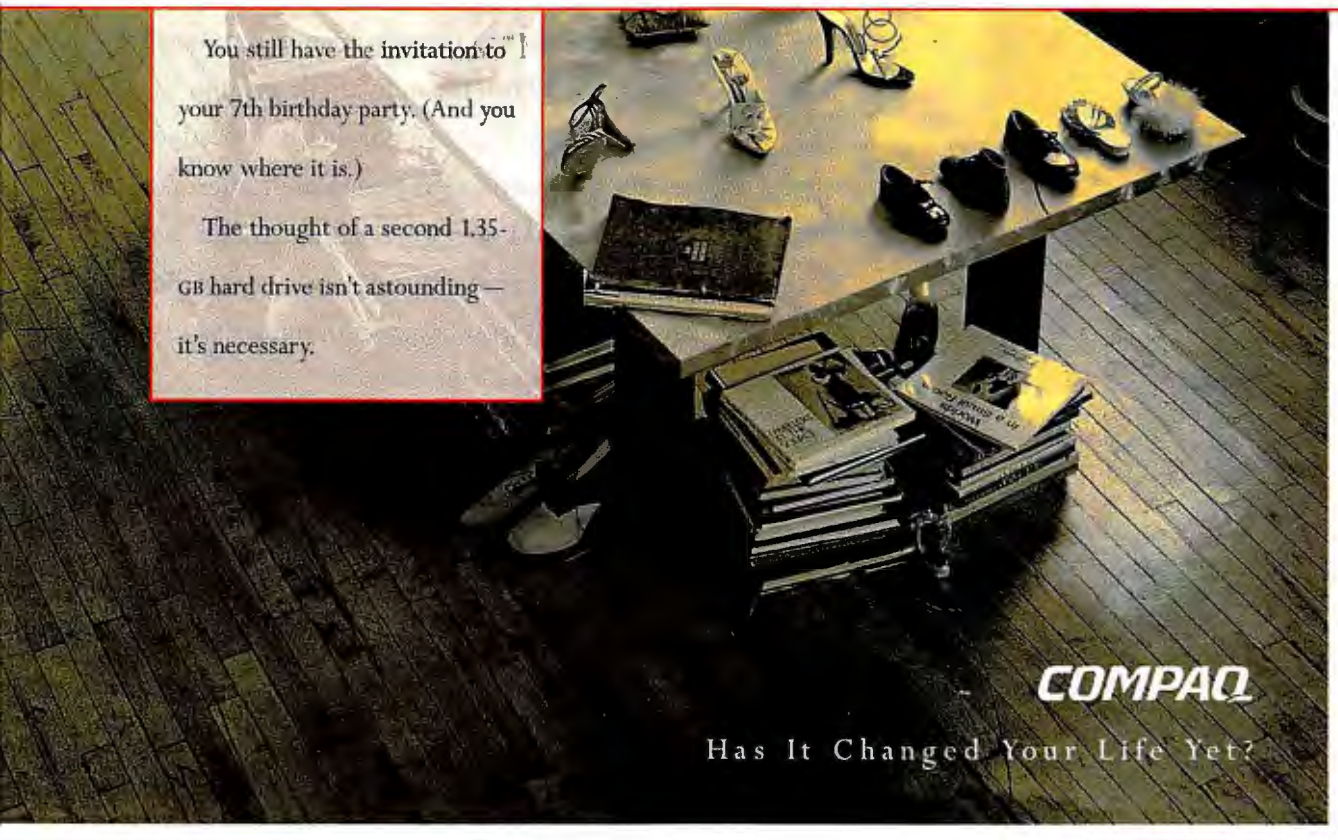

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Systems Design in ObjecTime

An object-oriented modeling system that generates C++ code directly, ObjecTime bypasses the dangerous translation step from model to implementation

MIKE BIENVENU

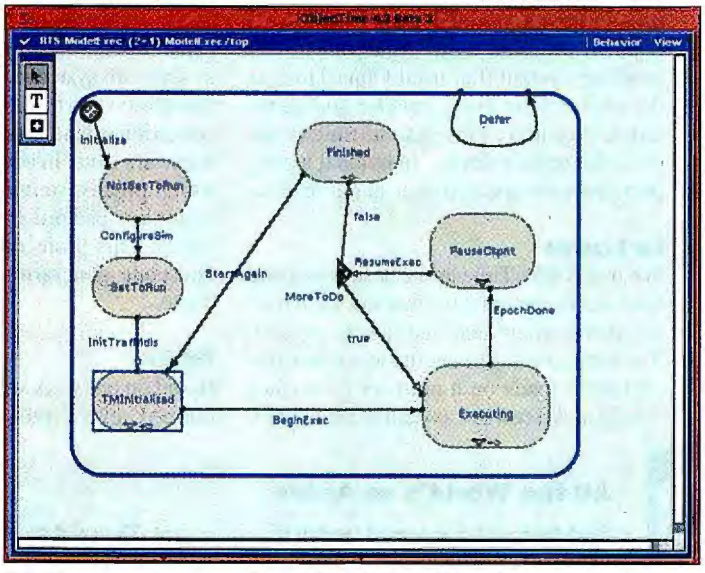
If you use a CASE tool to design and develop large-scale software projects, you should consider a move to ObjecTime. With it, you can create and edit an object-oriented system from the top down and then run the design in an interactive environment with full monitoring and debugging capabilities. Good programmers who understand ObjecTime are able to work three or four times faster than they could in any similar environment, such as Rumbaugh/OMT (Object Modeling Technique).

ObjecTime generates complete, compilable C++ code directly from the design diagrams. You can compile this code with ObjecTime run-time libraries to create applications that will run independently of the ObjecTime tool. As a result, you can build commercial applications within the ObjecTime environment that your customers can execute without their having to buy the complete ObjecTime tool. The ObjecTime microRTS (run-time system) does become part of your application in this case, however. It costs about $200 per copy.

ObjecTime is not cheap. Licenses are granted on either a fixed-node (runs on only one workstation) or a floating-node (runs on any workstation on the network but on only one seat at a time) basis. They cost on the order of $20,000 to $25,000 per seat.

Objects in an ObjecTime system under construction can access existing libraries of other code (which does not have to be C++). Consequently, you can create an object-oriented framework for existing code that isn't object-oriented, and your migration to an object-oriented development environment can occur gradually, as time and resources allow.

ObjecTime is based on the real-time object-oriented modeling (ROOM) methodology (see the Technology Focus on page 190), which was developed by engineers on a network-switching project at Bell-Northern Research in 1986. The tool became commercially available in 1992 with the formation of the company called ObjecTime. ObjecTime runs on Unix platforms, including the IBM RS/6000 and workstations from Sun Microsystems and Hewlett-Packard.



ObjecTime represents a program's execution behavior as independent, communicating objects called *actors*. This view inside an actor (called ModelExec) shows its internal states (rounded rectangles) and the possible transitions from one state to another.

The Whole Ball of Wax

One of the great failures of design methodologies in general (not just object-oriented) is that there has rarely been any direct translation from the design methodology to the code. Many, if not most, of the design errors in projects occur because the design was ambiguous or not properly translated into the software architecture and eventual code.

ObjecTime eliminates these translation steps by creating a methodology and a tool that let a team seamlessly move from high-level design all the way down to code, with no translation steps. High-level systems architects and designers use the tool at the abstract level, defining sequences of operations between the major parts of the system or software under construction. The more-detailed portions can then be added in the same tool, in the same methodology. Everyone sees the same diagrams, and problems can easily be traced to either coding errors or design errors.

In addition, ObjecTime is one of the cleanest, best-designed tools we've seen in the CASE market. The company provides excellent 24-hour technical support. Also, the tool is designed so that, if you manage to crash it (not an easy feat), it generates an exception file as it's crashing and automatically sends that file back to ObjecTime technical support.

ObjecTime at Work

Working in the ObjecTime environment consists primarily of creating and editing actor, protocol, and data classes (explained in the Technology Focus), the sum total of which forms the design of your system or application. Actors are tied together with bindings that represent a connection over which a certain set of messages can be exchanged (i.e., a protocol). Once you've defined your system's structure and behavior, you execute and debug your design in ObjecTime's RTS.

The RTS incorporates numerous debugging features, including actor state monitoring, variable inspection, and message tracing and injection. Message tracing lets you follow the flow of messages into and out of an actor's ports; injection lets you "insert" a message on the fly and observe the system's behavior. Additionally, as the RTS executes, you can watch transitions "fire" (as an actor's internal condition moves from one state to another)—they turn bold momentarily, thus providing a valuable quick check on the execution process.

Extensive drag-and-drop programming, along with built-in automated error checking, makes for fast and error-free design. ObjecTime will not let you drop things in the wrong places. Furthermore, the system's drag-and-drop features minimize typographical errors.

Because ObjecTime can communicate

with other Unix processes via messages over a standard TCP/IP socket, a separate GUI process can talk to your ObjecTime application. We used both UIM/X and XVT GUIs successfully in this fashion.

Finally, ObjecTime models can incorporate legacy code. We used this capability extensively in a project that depended on a large amount of legacy FORTRAN code. It enabled us to create an initial working system that used ObjecTime as the overarching event handler and simulation executive. This gave us time to address the replacement of individual legacy portions with updated code at our leisure.

For Example

We used ObjecTime as the design tool and final development environment for a traffic management test-bed design project. The traffic management modeled the overall traffic loads on a network of surface streets and freeways as demand (i.e., rush hours) and/or road conditions (i.e., accidents) changed.

This project had an interesting collection of requirements that ObjecTime easily addressed: the reuse of legacy FORTRAN code, software and hardware in the loop capabilities (meaning that other hardware or software systems could be incorporated into the system for testing under real-world conditions), and a distributed-processing hardware suite. In addition, we had to have a GUI process running on a PC, while the major test-bed processes ran on Unix platforms. This project used both the design and code-generation features of ObjecTime.

Product Information

ObjecTime . . . . $20,000–$25,000 per seat
ObjecTime, Ltd.
Kanata, Ontario, Canada
(800) 567-8463
(613) 591-3535
fax: (613) 591-3784
sales@objectime.on.ca
Circle 1051 on Inquiry Card.

Pitfalls

Based on our work with ObjecTime, we've noticed several potential pitfalls. First is the "runaway programmer" effect. Programmers find themselves making progress at a much faster rate than they're used to, with the immediate feedback of seeing their designs execute. The upshot: Programmers become so entranced with getting ObjecTime to do neat things that they lose sight of what the project needs. If good programmers work three or four times faster in ObjecTime, they can also diverge that much faster if they are not properly managed.

Second, some projects can stress the message-passing capability of ObjecTime's interactive environment. For the most part, this occurs when an actor has a large replication factor (i.e., many instances of the same class) and those instances all send messages at the same time. We have noticed a slowdown in the message exchanges between other actors in different parts of the model when this occurs.

Finally, ObjecTime's screens, while perfectly suitable for those who really understand the system under design, are not what you want to exhibit at big demonstrations. Most managers and customers will need to see something less technical than the raw ObjecTime screens. You'll need something that helps them visualize the operations of the system.

The Object

ObjecTime is not the only design environment that can directly derive executable files from the diagrams, but it is the only tool we've seen that offers such a complete environment for the entire development project. ObjecTime has significantly better applicability than other methodologies to design-only projects, too, because the design can be verified through execution without having it prototyped into code.

If you're looking at the development of new systems, or significant redesigns of your existing systems, ObjecTime translates into increased programmer productivity. ■

Mike Bienvenu has been working in object-oriented systems design since 1992. He is with the Washington, D.C., office of Sparta, Inc., and has a Ph.D. from Rice University in electrical engineering. He can be reached at mpb@mclean.sparta.com or on BIX c/o "editors."

TECHNOLOGY FOCUS

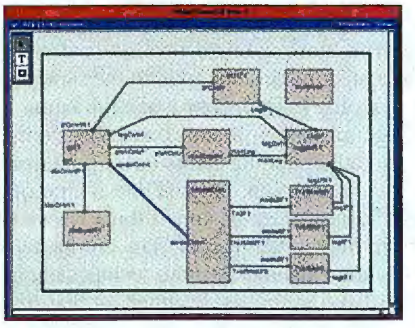
All the World's an Actor

Real-time object-oriented modeling (ROOM) handles objects as either actors or data classes. When developing in ROOM, you usually turn larger objects—such as systems and processes—into actors. Passive objects that either manipulate or encapsulate data become data classes. Both actors and data classes have methods and support full inheritance, with optional overrides and exclusions.

You can think of an actor as the fundamental execution unit within ROOM. An actor is an object that encapsulates data (in this case, state variables) as well as actions (or what the ROOM methodology refers to as the actor's behavior). To put it simply, actors do things.

Actors communicate with their environment via ports. (You might find it helpful to think of an actor's ports as being analogous to the I/O ports on your computer.) A port is an interface into the actor through which messages pass. It's the medium of communication among actors. A message is composed of an identifier (i.e., this is a SetThermostat message), as well as message data (i.e., what temperature to set the thermostat to). The valid message types that are able to move through a port define a protocol.

Another important feature of ROOM's actors is that they can be nested; a single large actor that performs various jobs can actually be a container of multiple smaller actors. The internal actors are bound to one another by their ports. Ultimately, some of the internal actors' ports are exposed to the outside world, where they appear as the ports of the container actor.



In a ROOM-based system, an application consists of communicating actors. The entire application is therefore treated as an actor that contains other actors. Actors communicate via bound ports—shown as solid lines connecting the representative boxes. Notice that, in the ObjecTime run-time system, bindings flash to show the exchange of a message between actors.

More RAM for Win 3 Holdouts

Some RAM doublers work, some don't, and Win95 doesn't need them

JOHN M. GOODMAN

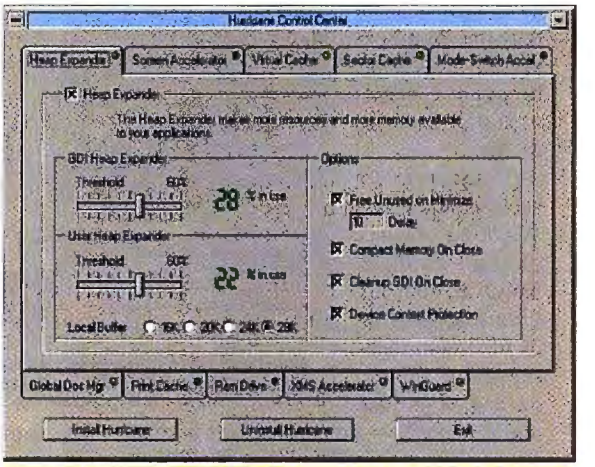
If you're not making the move to Windows 95, you can get more out of Windows 3.x with a RAM doubler utility. We surveyed the field and tested the four most promising products: RAM Doubler from Connectix Software, Hurricane from Helix Software, MagnaRAM from Quarterdeck, and SoftRAM 95 from Syncronys Softcorp. (Quarterdeck released MagnaRAM 2.0 as we were going to press. Like SoftRAM 95, it works with Windows 3.x and 95.) We then compared their memory-management skills with Windows 95.

Our tests show that RAM Doubler and Hurricane are proficient at getting full use of your RAM, as is Win 95. Depending on your PC, there can be a performance trade-off with RAM doublers and Win 95: Programs take longer to load from disk. But the delay doesn't offset the benefits of better-managed memory.

What's the Problem?

When running in 386 enhanced mode, Windows 3.x lets you run more programs than can fit in physical memory by swapping currently unused program data to disk and then pulling it back in when needed. This scheme is called virtual memory. However, several architectural snags typically keep you from using all of even the physical memory you have.

First, there's the limitation of global DOS memory. Although Windows runs in protected mode, it runs DOS and other real-mode code in Virtual-86 mode. In real mode, the CPU can address only the lowest 1 MB of RAM. Windows itself and every Windows application needs a small chunk of that megabyte to run. Unfortunately, Windows does nothing to reserve the lower 1 MB for certain critical uses. For example, Windows loads all DLLs as low in memory as possible, even though they would work fine in extended memory (above 1 MB). Until DOS memory is full, Windows doesn't put them higher.

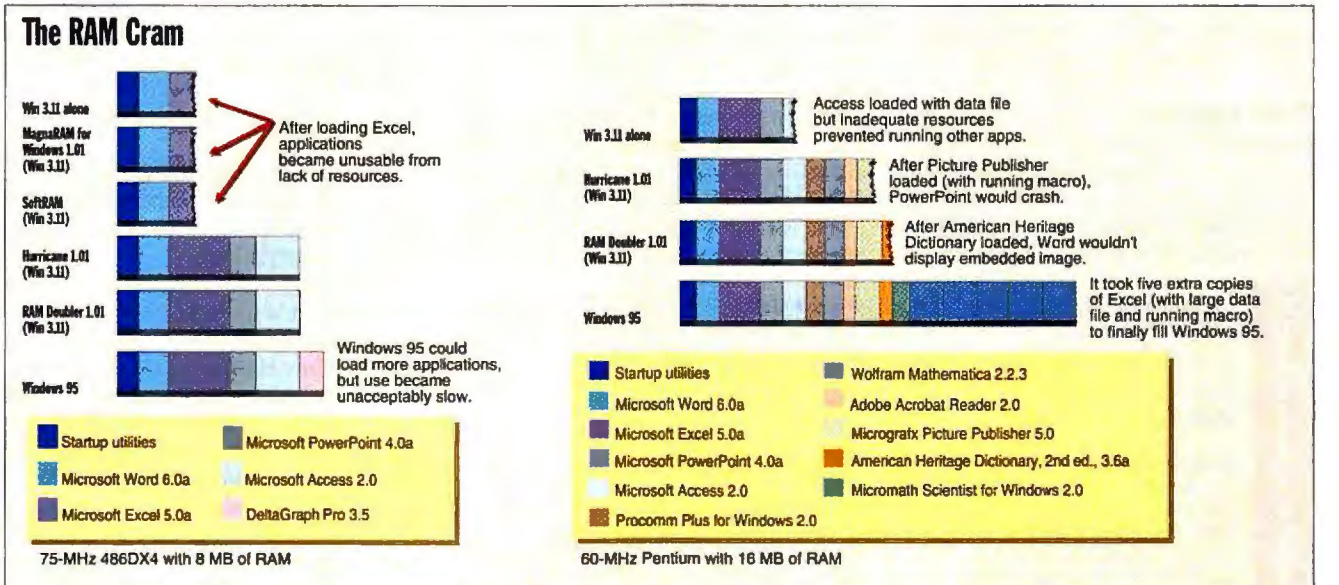


The Helix Hurricane Control Center lets you switch on or off 10 distinct features of the product. The software uninstalls easily.

A more infamous Windows limitation is the paltry amount of memory dedicated to system resources. In 64-KB memory regions called *local heaps*, the Windows components USER.EXE and GDI.EXE keep track of each item (such as menus, titles, icons, and buttons) that makes up a Windows display. When any of the heaps gets too full, Windows stops working.

Even with adequate DOS memory and resource space, your system may still resort to virtual memory. Typically, virtual memory is 10,000 times slower than RAM. So anything that can free up more physical RAM can greatly increase performance.

MagnaRAM and SoftRAM 95 both try to expand the apparent amount of total Windows memory. They first set the PageOverCommit variable in Windows' SYSTEM.INI file to a large value to make



Hurricane and RAM Doubler let Windows 3.11 run more programs at once; SoftRAM and MagnaRAM did not. On both an 8-MB Sharp PC-8800 notebook (75-MHz DX4) and a 16-MB Zeos Pantera (60-MHz Pentium), Windows 95 loaded the most programs into RAM. But more thorough memory management does exact an initial loading penalty. The size of the block representing each application is proportional to the memory resources consumed, as reported by Microsoft's Sysmeter utility.

More RAM for Win 3 Holdouts

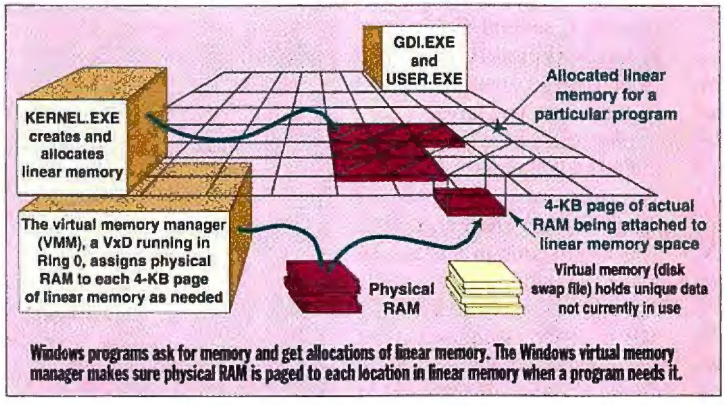
Windows create more linear memory (by increasing disk swap space). Then they set aside part of physical RAM as a buffer in which they can compress data that otherwise would go to the swap file. They also may recover RAM that's no longer needed by programs but that the Windows virtual memory manager (VMM) wouldn't know to recover.

This strategy can substantially lessen Windows' reliance on the swap file. However, both programs spend a lot of time compressing data. If your hard disk is fast, and especially if your processor is relatively slow, it may take MagnaRAM and SoftRAM 95 longer to compress your data than it would to store it in the swap file uncompressed. Worse, by enlarging linear memory (which requires more RAM for the tables to track it), and by taking a substantial chunk of physical RAM for their buffer, these programs drastically reduce the amount of physical memory that the VMM can use for Windows programs.

Neither program helps with the problems related to global DOS memory or system resources. We couldn't load any more programs with them than we could without them. SoftRAM 95 doesn't do any better with Win 95. MagnaRAM 2 works with Win 95 but, according to the company, the new product is built on the same architecture as the Windows 3.x version.

Windows' Memory Dance

When Windows 3.x starts, it creates a hypothetical space called linear memory. Windows programs request memory from the Windows KERNEL module, which allocates linear memory. It's not physical RAM, but programs address linear memory as if it were RAM, even though there may initially be no RAM at those addresses. Windows maps the virtual addresses from the program's address space to physical pages of memory. The program sees only the linear memory. When a program accesses a memory address that isn't physically present, a page fault interrupt triggers Windows' virtual memory manager (VMM), which cleverly places RAM just where and when it is needed.



Windows programs ask for memory and get allocations of linear memory. The Windows virtual memory manager makes sure physical RAM is paged to each location in linear memory when a program needs it.

Double Your Fun

Connectix RAM Doubler works well. It takes a minimalist approach by providing no user-settable parameters. The program reports only one number; namely, how much worse off you would be in terms of free memory resources without RAM Doubler. Though it uses compression, it does so differently than MagnaRAM or SoftRAM. RAM Doubler lets you load more programs by helping with global DOS memory as well as system resources.

Helix Hurricane, in comparison, doesn't use compression, but it manages to free up significant amounts of physical RAM, which is just as good. It is the only one of the group we tested that can move free upper memory into the pool of physical memory that the VMM uses.

Hurricane's WinGauge utility monitors critical memory factors, and the included Discover for Windows is one of the finest PC exploratory tools we have seen.

On the downside, Hurricane's complexity can work against it. Because it works more invasively than RAM Doubler, you're more likely to run into compatibility problems. We couldn't, for example, get its all-important Heap Expander capability to work with Dell Dimension XPS90 and Gateway P5-120 Pentium systems. Also, we noticed more Windows program crashes when using Hurricane than when using RAM Doubler (almost always when near memory capacity).

Performance Hit

Windows 95 does the best job of providing plenty of system resources, but it takes the most time to load programs. Among the real RAM doublers, Hurricane provided better performance than RAM Doubler on a system with 16 MB of memory. On a memory-constrained 8-MB notebook with lots of PC Card drivers, RAM Doubler was the better performer.

Our testing found that, compared to unadulterated Windows 3.11, applications loaded 10 to 50 percent slower with the RAM doublers installed and 80 to 100 percent slower under Windows 95. All the Windows applications loaded with larger data files that often included OLE links (Word, Excel, and PowerPoint). Word, Excel, and Access also executed macros upon loading.

These performance hits are acceptable, though. It's much more important that Hurricane and RAM Doubler enhance Windows 3.x multitasking.

If you want better performance—especially if you want to know what is happening inside your PC or want to tweak it to a tee—buy Hurricane. If you just want to make Windows 3.x more stable without a lot of low-level control hassles, get RAM Doubler. Either way, Windows 3.x will run more applications than you probably thought it could. ■

John M. Goodman, a Ph.D. in physics, is the author of Memory Management for All of Us *(Sams, 1993) and other books. You can contact him at agoodman@realm.net.*

Product Information

Hurricane 1.0 ..... $79.95
Helix Software
Long Island City, NY
(800) 451-0551
(718) 392-3100
Circle 1134 on Inquiry Card.

RAM Doubler 1.0 ..... $99
Connectix Corp.
San Mateo, CA
(800) 950-5880
(415) 571-5100
support@connectix.com
Circle 1136 on Inquiry Card.

MagnaRAM 1.0 ..... $44.95
(Version 2 now available; free to owners of 1.0)
Quarterdeck Corp.
Marina Del Rey, CA
(800) 683-6696
(813) 523-9700
http://www.quarterdeck.com
Circle 1135 on Inquiry Card.

SoftRAM 95 2.0 ..... $99.95
Syncronys Softcorp
Culver City, CA
(800) 691-7981
(310) 842-9203
Circle 1137 on Inquiry Card.

Data to the Nth Dimension

Arbor Software's Essbase Analysis Server 3.2 soups up spreadsheets and other front ends with multidimensional data display and analysis

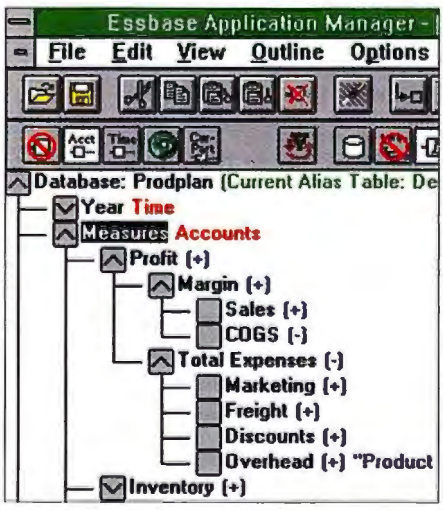
EDMUND X. DEJESUS

With Arbor Software's Essbase Analysis Server 3.2, you can quickly construct data-query applications to satisfy the most detail-hungry data analysts as well as the most computerphobic members of upper management. You can deploy a variety of front ends, including the spreadsheet that you're probably already using for data-analysis chores, and you can load data automatically from many relational databases and data warehouses.

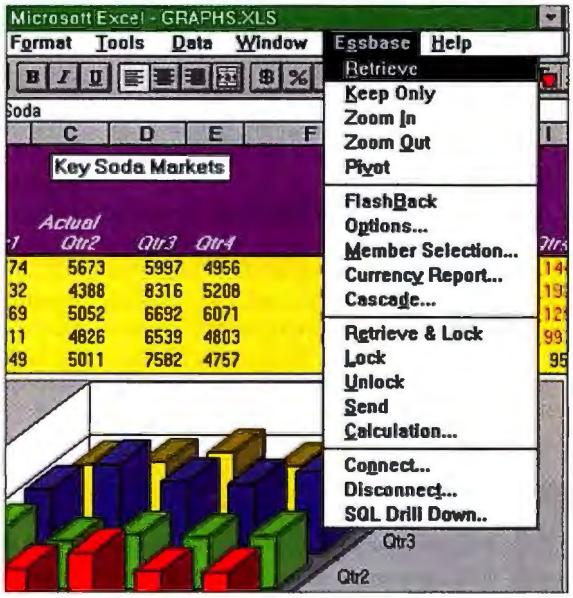
Or, should you feel the urge, you can drill through the consolidated multidimensional data with automatically generated SQL calls to access the underlying raw data. At $43,250 for five concurrent user licenses, Essbase is pricey, but you get a complete solution for your money that offers a combination of speed and power.

Essbase supports a variety of client front ends, including such popular spreadsheets as Excel for Windows 4.0 or higher, Excel for Macintosh System 7, 1-2-3 for Windows release 4.0, and 1-2-3 for DOS release 2.4. By using existing spreadsheets, you can minimize your training and development costs by retaining your existing spreadsheet applications.

Other applications that front for Essbase include Cognos's PowerPlay, Trinzic's Forest & Trees, Andyne's Pablo, and several Comshare programs. You can develop your own front end for Essbase using Arbor's published API (and API Reference Manual) with Visual Basic or other development tools.



You can explicitly define dimensions, members of dimensions, calculation formulas, and field-name aliases in Essbase Application Manager's Outline Editor.



Essbase can use many popular spreadsheets as client front ends. These include Excel for Windows 4.0 or higher (shown here), Excel for Macintosh System 7, 1-2-3 for DOS release 2.4, and 1-2-3 for Windows release 4.0.

Up and Analyzing

To access Essbase from your spreadsheet, you first run the Spreadsheet Client program on the client system. Launching Excel 5.0 starts Essbase automatically as a nonintrusive add-in, producing an Essbase menu in the Excel menu bar and a handful of Essbase icons on the toolbar.

First, you must connect to the Essbase server by giving a user name and a password and then selecting from a list of the applications and databases to which you have access. Member selection is probably your next step. Here you can specify which of the many dimensions in your database you want to examine. You can also view the "outlines" that define dimensions, their members, and any underlying formulas (using the many internal Essbase functions).

Selecting Retrieve returns the data for the dimensions you've specified (all data resides on the server) and populates the spreadsheet with labeled values. You decide how to handle missing values, determine which language aliases for database field names to use, apply formatting, and control many other options. The data values retrieved are real numbers, not pointers to locations, so you can distribute the resulting spreadsheet to anyone who needs the data—without their needing access to Essbase (handy for use on laptops).

Double-clicking on data or labels zooms you in to the next-lowest level of detail. Pivoting between row and column displays of any member is as easy as dragging the member label to the row or column where you want it to appear. The whole table automatically rearranges instantaneously to accommodate your changes.

To break out child levels of a member (e.g., individual sales territories) as separate spreadsheets, you select Cascade. A combination of Essbase data calls and spreadsheet macros performs the task automatically, producing individual spreadsheet files that you can distribute.

The macro capabilities of your spreadsheet can combine with Essbase functions and Visual Basic for Applications to create attractive and powerful applications within the spreadsheet. All the power of advanced spreadsheet graphing is at your disposal. You can specify that Essbase saves any changes made to the spreadsheet back in the Essbase database, or you can make the data read-only.

The SQL Drill

One new feature in version 3.2 is the optional SQL Drill Through. This lets you "drill through" the displayed numbers to examine the underlying database data (e.g., point-of-sale transaction records). The server creates SQL statements and sends

them to the source database. Essbase can import data from many sources, including spreadsheets, flat ASCII files, and relational databases, such as dBase, DB/2, Oracle, Sybase, and most any other SQL- or Open Database Connectivity–compatible (ODBC) database.

Essbase can load data automatically, according to schedules that you determine, using data-load rules that you specify to select and filter the data. It can automatically construct multidimensional outlines, determining the dimensions, members of dimensions, and many other features by itself.

Alternatively, you can hand-craft outlines, deciding on levels of consolidation along dimensions, calculation formulas (including mathematics and logic, as well as conditional and multiple-pass operations), zoom levels, field-name aliases, and myriad other options. Essbase suggests denseness/sparsity labels for data (see the Technology Focus box below), but you can override its suggestions.

An administrator can assign access to users down to the individual cell level, ensuring that folks don't see what they shouldn't. You can also assign read and write privileges at several levels. Essbase Application Manager lets administrators assemble multidimensional databases, handle user access, and set up data-loading from other databases. You can run Application Manager from a client machine.

Professional data analysts may find the 2-D world of a spreadsheet confining. That's why Arbor Software has formed partnerships, ensuring that Essbase can use a variety of other third-party, multidimensional, on-line analytical processing (OLAP) client tools, such as the aforementioned PowerPlay, Forest & Trees, Pablo, and Comshare programs. These tools enable the company to offer an assortment of slice-and-dice and display features. You can also write custom applications to Essbase's published API.

Product Information

Essbase Analysis Server 3.2 . . .$43,250
Arbor Software Corp.
Sunnyvale, CA
(408) 727-5800
www.arborsoft.com
Circle 1120 on Inquiry Card.

No Free Lunch

Though expensive, Essbase is a solid investment. You get a complete solution for your money, with a combination of speed and power, open client/server front-end and database access, automated data loading and handling, and administrative and security features.

These strengths are all fueling Arbor's explosive growth. They're also making it the standard against which similar products must be measured. ■

Edmund X. DeJesus is a BYTE senior editor. He has been a professional programmer for over 15 years. You can contact him on the Internet or BIX at edejesus@bix.com.

TECHNOLOGY FOCUS

Handling Sparse Data

Suppose you have sales data for the past 1000 time periods, for 100 salespeople selling 100 products in 100 geographical areas. You're talking about a four-dimensional database with 1 billion cells (i.e., possible intersections of dimensions).

Of course, the Topeka office just opened last summer, young Farnsworth has been selling for only a few months, and they don't handle ski boots at the Fort Lauderdale office. Such considerations make the original billion possible cells dwindle to a mere 100 million actual cells.

This is an example of *sparse data*: The actual number of data values is but a fraction of the theoretically possible number. And the amount of wasted space grows exponentially with the number of directions.

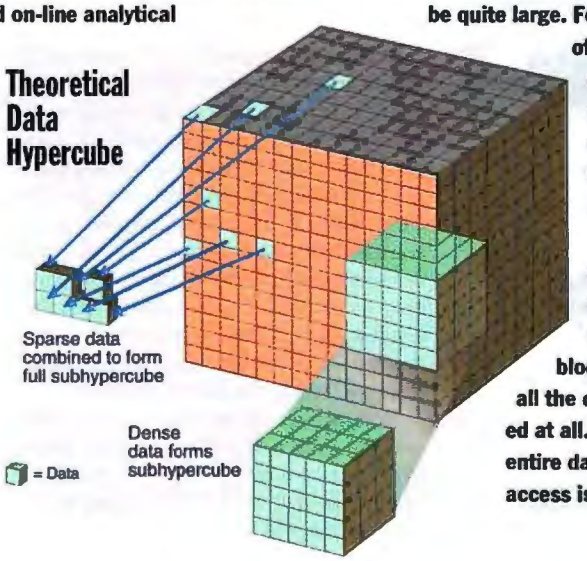
Handling sparse data is a major problem of multidimensional databases, multidimensional analysis, and on-line analytical processing (OLAP). Different vendors have different ways of dealing with sparsity. Most, including Arbor Software, use some form of data compression.

Most also use some system of *metadata* that keeps track of where the populated cells are in some efficient way. But you don't want to waste more time interpreting the metadata and retrieving data than you would by simply wading through those empty cells.

Essbase first divides its vast theoretical hypercube into dense dimensions and sparse dimensions. *Dense dimensions* have values in most cells. *Sparse dimensions* don't have values in most cells (as a rule of thumb, less than 20 percent of sparse-dimension cells have values). The trick is to avoid wasting space on the sparse dimensions and to allow rapid access to the data in the dense dimensions.

Arbor has a patented storage method to maximize performance in both dense and sparse dimensions. Combinations of dense dimensions form data blocks, packed tight with values. Essbase also creates data blocks for combinations of sparse dimensions—if there's anything in them. It doesn't allocate data blocks for empty combinations of sparse dimensions.

In effect, the data blocks thus gerrymander the mostly empty hypercube into mostly full subhypercubes. Some of these can be quite large. For instance, the data block of your earliest 10 products sold by your first 10 salespeople in the original 10 cities produces a very dense subhypercube of 1 million values.



There's a certain amount of overhead involved in describing the details about each of these dense data blocks. But this is dwarfed by all the cells that are not represented at all. Since Essbase keeps its entire data-block index in memory, access is very fast.

The Better Virtual PC

With 486 emulation and 33-MHz 486 speed, SoftWindows 2.0 runs enhanced-mode Windows apps on Power Macs

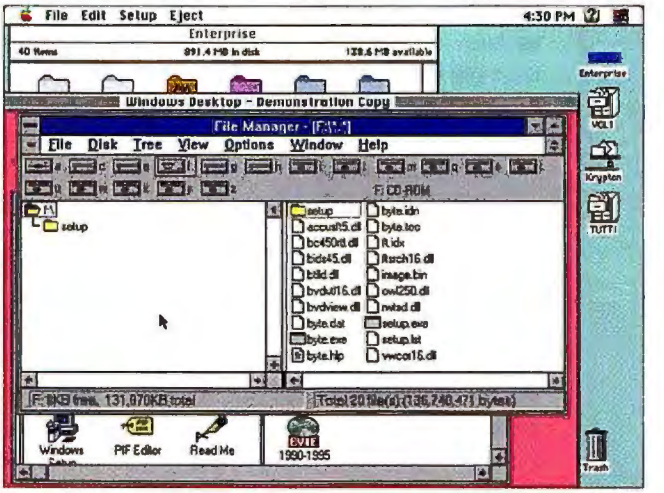
TOM THOMPSON

You like Macs, but PCs dominate your work environment. You've got a problem. You can't run the PC software needed to access a networked CD-ROM data source, for example. Or worse, your company depends on custom in-house DOS and Windows applications. You want to take advantage of the Power Mac's performance and usability benefits, but you've got to run those critical DOS and Windows apps.

Hardware solutions like Apple's DOS-Compatible Power Mac hybrid system (see "One Box, Two Computers," April BYTE), or one of the PC-on-a-card products from Rely or Orange Micro, can give you DOS/Windows compatibility with 486-level performance. But there's a less-expensive software solution that requires less commitment: Insignia Solutions' SoftWindows 2.0 ($499 list; $299 estimated street price).

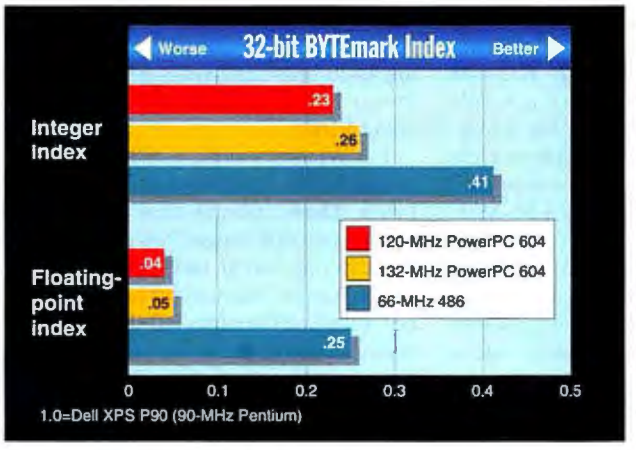
In this latest release, Insignia has boosted its PC-hardware emulation technology so that it now acts like a 486 processor instead of a 286. Now that it supports protected-mode x86 code, SoftWindows can run the most eclectic DOS or Windows applications. Insignia also bundles drivers that give the program access to the Power Mac's Ethernet port, sound hardware, and CD-ROM drive, so that SoftWindows literally becomes an emulated PC system, complete with CD-ROM drive and network connection.

Though it costs less, software emulation does raise a performance issue. SoftWindows is an emulator that, at times, runs on top of another emulator (some of the Mac OS code it relies on runs inside a 680x0 emulator). On faster Power Macs, we found that SoftWindows 2.0 provides roughly one-quarter of the integer performance of a typical 90-MHz Pentium system; in other words, it's like using a 33-MHz 486 (see the graph of BYTEmark 32-bit test results below).



Windows 3.11 running under System 7.5.2 on a Power Mac, thanks to 486 emulation by SoftWindows 2.0. The Windows File Manager shows icons for network drives and a networked CD-ROM (currently selected).

SoftWindows 2.0 can run Windows 95, too, but very slowly. One reason for this sluggishness is just the bulk of Win 95; another is that Insignia Solutions optimized the SoftWindows environment for Windows 3.1 code. If you're using the emulation package to integrate a Mac into a networked PC environment, and all the PC users are moving to Windows 95, hang in there: Insignia is tuning SoftWindows for Win 95 (but has not said when it will be ready). In September, Insignia released SoftWindows 2.0 for various flavors of Unix.



On a Power Mac 8500/120, the SoftWindows 2.0 emulator posts raw integer performance roughly equivalent to that of a 33-MHz 486 (half that of a 66-MHz 486). Floating-point speed is a different story, but that doesn't have an impact on general Windows performance.

Plug-n-Play Setup

SoftWindows comes on floppies or CD-ROM. Basic system requirements are 38 MB of hard drive space (more if you increase the simulated DOS drive's size beyond the 33-MB default), 12 MB of RAM, and a Power Mac running System 7.1.2 or later.

When you launch SoftWindows, it creates a window of the size specified in the setup with 8-bit color depth. This window can be as big as 800 by 600 pixels, but the program does not support higher color depth. From this window, you get to watch the weird but impressive sight of a virtual PC system booting DOS. At this point, you can continue working in DOS or you can start Windows.

SoftWindows comes with drivers for Ethernet, Token Ring, and LocalTalk network interfaces. It supports AppleTalk, TCP/IP, and IPX protocol stacks. SoftWindows includes client software for Novell NetWare 3.1.x and 4.0, Microsoft LAN Manager 2.2 and Windows for Workgroups 3.11, Banyan Vines 5.5.2 and 5.5.4, PC NFS v4 and v5, DEC PathWorks 4.0 and 5.0, and PC/TCP 2.3 and 3.x.

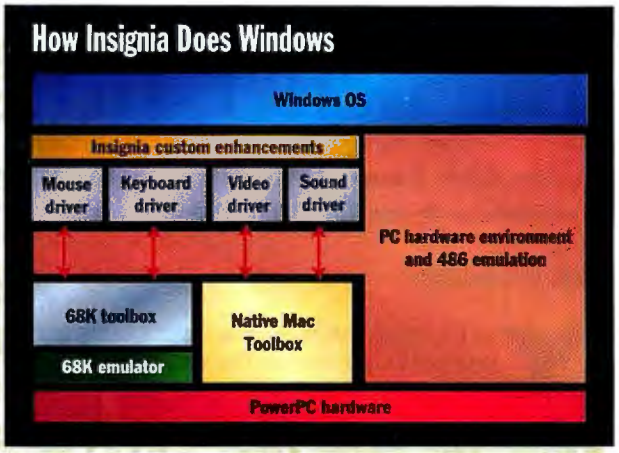
A NETBATCH subdirectory contains batch files that automatically install the client software at boot time. On a Power Mac 8500/120, all we had to do to gain access to BYTE's NetWare servers was add a line in the AUTOEXEC.BAT file to run the NetWare Ethernet batch file. On Apple's DOS-Compatible Mac, you must

TECHNOLOGY FOCUS

Implementing a Virtual Machine

Emulating a complex processor like the 486 with its protected memory modes and memory paging is no simple matter. For this version of SoftWindows, Insignia Solutions discarded its 286 emulator code and started from scratch. Making the emulation task even more complex is the fact that DOS-based applications often write directly to other hardware components of the PC architecture. SoftWindows must also trap direct accesses to hardware, interrupt calls to the PC BIOS and to DOS, and make them work on the Power Mac hardware platform. For compatibility, the emulator must imitate some of the PC hardware, such as the floppy controller. For good performance with Windows apps, SoftWindows must also handle calls to Windows functions.

Emulating the 486's complexity takes a performance toll. Insignia Solutions' software engineers offset this performance hit in two ways. First, they had access to the Windows source code and could eliminate certain processor-specific algorithms, such as checks for a certain 386 bug. Second, they used custom device drivers to route certain low-level operations to native portions of the Mac OS. For example, the graphics driver maps Windows GDI calls to native QuickDraw calls, and the sound driver maps some operations to the native Mac Sound Manager. The keyboard and mouse drivers relay most of their data through the Mac Event Manager, which can suffer degradation because this Manager is still emulated 680x0 code.



Insignia Solutions modified the Windows operating system to optimize it for the PowerPC/Power Mac environment.

use a different protocol stack for each system (that is, the DOS Card must run the IPX or TCP stack if the Power Mac is running AppleTalk). With SoftWindows, the PC emulation can run the same protocol stack as the host Macintosh, which simplifies access to network resources. However, pioneering Power Mac 9500 users will need Open Transport 1.0.6 or a later version to take advantage of SoftWindows' network functions.

We were able to run a remote batch script on the Power Mac for setting up access to a data source on a networked CD-ROM drive. Our queries to this data source worked fine, although a tad sluggishly due to the network and the emulation overhead. To access the Power Mac's CD-ROM drive, all you have to do is type the command `USECD`, which will automatically load the DOS MSCDEX CD-ROM driver. After doing this, we copied files from a PC-formatted CD platter into the simulated DOS hard drive without any problems.

We could also run the search engine for the BYTE CD-ROM, another PC-formatted platter, from the Power Mac. This search engine requires 386 enhanced mode, which proved the 486 emulator's capabilities. The performance of this Windows app was decent; we did searches, and the system displayed both text and graphics with only minor delays.

Running Doom under DOS was yet another test of 386 enhanced mode. While the game performed admirably, it was hard to steer due to the time lag of keyboard events reaching the program. You shouldn't run time-critical programs under SoftWindows, but since most programs of this ilk are games, this limitation probably suits management just fine.

Product Information

SoftWindows 2.0 . . . . $499
Insignia Solutions
Mountain View, CA
(800) 848-7677
(415) 335-7100
fax: (415) 335-7105
http://www.insignia.com
Circle 1022 on Inquiry Card.

Performance: Respectable, Not Overwhelming

We ran the 32-bit version of the BYTEmark tests under SoftWindows 2.0 on both a Power Mac 8500/120 and a Power Mac 9500/132. The raw x86 performance is hardly overwhelming, but it's respectable considering the complexity of the emulator: Speed is roughly half that of a 66-MHz 486 for the integer operations that dominate most applications. However, using our results as a guide to the actual performance you'll see is tricky. Where possible, Insignia uses the Windows source code to map certain operations to native Power Mac OS functions, which can result in a performance boost (see "Implementing a Virtual Machine" above).

In other areas, execution goes through two layers of emulation and performance suffers. The consensus among BYTE editors is that SoftWindows' DOS emulation runs acceptably on a Power Mac 7100/80 or better, while the Windows emulation needs a Power Mac 8500/120 or better. Our 7100/80 test system didn't have a level 2 cache—you would get better Windows performance with a cache card installed in this machine.

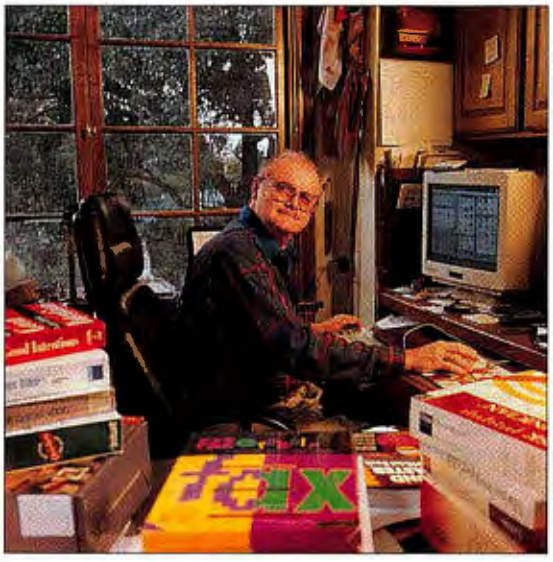
Even then, a Windows application's performance can vary, depending on how well the app is written, how compute-intensive it is, and how many of the Windows API calls it uses that map to native PowerPC code. If you want to run custom DOS applications with SoftWindows, you'll need at least an 80-MHz 601-based system from Apple or Power Computing. Such systems are fairly inexpensive; Apple's low-end Power Mac 7200/95, for example, costs about $1600.

For Windows work, you'll need a 604-based machine running at 120 MHz or faster. These systems aren't cheap; Apple's basic 604-based Power Mac 8500 costs around $4000. But if you're already buying serious Macs to perform other duties, then SoftWindows 2.0 should fit your business needs. ■

Tom Thompson is a BYTE senior technical editor. He has a B.S.E.E. from the University of Memphis. He is also an Associate Apple Developer. You can reach him on AppleLink as T.THOMPSON or on the Internet at tom_thompson@bix.com.

JERRY POURNELLE

A New Mutation



AMY ETRA © 1995

As usual, Windows 95 is the focus of attention at Chaos Manor. But first, a new virus.

By now, you've probably heard about the first truly multiplatform, multi-OS virus. It can strike if you download an infected Microsoft Word document that has Word BASIC macros. It's called WinWord.Concept. As I write this, the only version known outside the lab has the annoying but not fatal effect of transforming your Word documents into templates, making it impossible to edit them without changing them back; but it's clear that a similar virus could have a nastier payload that deletes or corrupts files.

I learned about this virus in a fax alert. S&S International sends out virus alerts to subscribers to Dr. Solomon's Anti-Virus Toolkit. The alert included instructions for downloading a remedy. This was several days before the news exploded on the Internet and over a week before Microsoft announced a remedy.

The virus is unusual in that it operates from inside Word, meaning that it is dangerous for Mac and Windows users. Worse, you can be infected even though all you've done is download and open a Word document; it will then spread to any other documents you have that use that document's template. Worst of all, it points the way to other ways of transmitting a virus through downloading embedded objects.

The situation is now under control, but everyone is nervous. My conclusion is that it's time to subscribe to a good antivirus service that does alerts. I recommend Dr. Solomon's. They have a good track record of early detection and disarming of new virus threats, and I like their approach. I know Dr. Solomon, and I'm confident that he'll continue to invest in virus analysis, detectors, and remedies.

I'm still using Windows 95. Until this morning—it's 4:00 a.m.—I've been mildly unhappy. The problem was that no matter what I did, I would get hesitations in my Q&A Write DOS character-based text editor. I'd also get them in Word for Windows and Procomm Plus 2 under DOS. It wasn't a terrible situation, but every few minutes, I would type two or three letters, and they wouldn't appear on-screen for about half a second. That glitch broke my flow.

I tried disabling every multitasking program, including Norton Utilities, and closing every window but the one I was working in, but it did no good. Finally, I decided there was nothing for it: I probably had some old Win 95 beta code that was never properly removed, and the only way to get rid of it was to scrub the Windows Directory entirely and install from scratch.

This would let me install my shrink-wrapped shipping copy of Win 95. It's supposed to be identical to the gold beta version I have installed, but this way I can be sure I'm running what you have. So here I go.

Four hours later, and I'm done. Some of my adventures are instructive.

My first move was to make a DOS 6.2 boot floppy disk complete with the DPT and Corel SCSI drivers so the system could find the optical and CD-ROM drives. Then I booted in DOS, copied the parts of the Windows subdirectories I thought I'd need, gulped hard, and deleted the Windows Directory and all its subdirectories.

Next I had to install Windows for Workgroups

ILLUSTRATIONS: MARIAN HEIBEL © 1995

3.11, because I have only an upgrade version of Win 95. The installation didn't take long, but when I went to set up the screen, I found that I had somehow managed to delete the drivers for ATI Technologies' Graphics Pro Turbo Mach 64 card. Downloading a new set from ATI's BBS took about an hour. Incidentally, we're extremely happy with that card in Windows 3.x, 95, and NT.

Windows worked, but for reasons I do not understand, W4WG 3.11 refused to access my optical drive. It believed there was a removable-medium drive there, but it refused to believe there was a disk in it. I could access it from DOS just fine. On the other hand, the network worked splendidly, and I was able to access my other machines.

Installing Win 95 was a bit of a bear; I'm glad I had it on a CD-ROM. First, I tried running it from DOS. The Setup program launches a Scandisk program, and that promptly found a bunch of programs with long filenames. It tried to fix those but gave up after a while. It also insisted on scanning my E drive, which is the optical drive. It never found any problems but wouldn't continue unless I let it do its thing on all the hard drives, including that one.

Next, it wanted me to exit Setup and run it from within Windows. I tried that; and Setup said it was doing a routine check of my hardware. Half an hour later, I was locked up to hardware reset. This wasn't encouraging, so I launched Setup from DOS again. Once again it complained I ought to run it from Windows, but I told it to go ahead from DOS, after which things went pretty fast.

However, when Win 95 started up, it complained that my Intel EtherExpress card wasn't working properly. Since that card had just been working in W4WG, this didn't seem likely; but Win 95 couldn't find my network. It seemed pretty clear that Win 95 had the wrong settings for the EtherExpress card, but the Win 95 Network icon in Control Panel didn't offer any way to change settings.

I fooled around with help for a while and eventually learned about the Device Manager. Once I got to that, I was able to see what was wrong: Win 95 was assuming that my EtherExpress card was set for interrupt request (IRQ) 5, when it was set at IRQ 10. Once I told it to look for IRQ 10, the network came up fine.

There was one other glitch. Although the Device Manager saw Valiant, the ValuePoint machine, and saw that Valiant had a printer named HPLASERJ, it didn't see Valiant in its printer's browser list. When I manually typed in `\\valiant\hplaserj` for the printer name, it found it just fine. So it goes.

My hesitation glitch is gone, and so is the Q&A paste error I told you about in October. Win 95 is working very well indeed, so my problem must have been some leftover beta code. I advise all former Win 95 beta testers to terminate the old code with extreme prejudice.

Now to reinstall Norton Utilities for Windows 95 and hope that it doesn't bring my glitch back.

I consider NU an indispensable accessory to Win 95. I have always trusted Norton Disk Doctor more than the DOS CHKDSK or Scandisk utilities, and while I haven't often needed UNDELETE, the few times I did, I needed it a lot.

NU for Win 95 has a bunch of other features, including a neat display of CPU resource usage that helps tune up programs. Q&A Write, if allowed to run in

Circle 123 on Inquiry Card.

the background, will eat up 100 percent of your CPU resources even though it has been made into an inactive icon on the toolbar. The remedy is to go into the program's properties and check the "always suspend" button to tell Win 95 not to run Q&A in the background. This does no harm—after all, a word processor doesn't *do* anything in the background.

NU for Win 95 also showed me that WinWord was eating 100 percent of my resources. I never did learn why; the problem fixed itself when I shut down and rebooted. Earlier, I couldn't find WinWord at all. That is, I could see the WinWord icon on the toolbar and could click on it, but nothing would happen. If I right-clicked, I could maximize it and all would be well, but if I then tried to reduce it to an icon, it would vanish.

This happened while I was on the phone to the chief technician at Symantec, and we puzzled over it for half an hour. I tried things like cascading windows. Nothing. Finally, in desperation, I did a right-click on the toolbar and chose minimize all windows. Then I did it again, choosing to undo the minimizations. Voilà! There was WinWord in a window where it belonged.

If you run Win 95, you really need Norton Utilities. It will help you tune up and avoid disasters.

My conclusions remain about the same. Of the new OSes, OS/2 Warp Connect is technically superior, but Win 95 is good enough, now that I don't have half-second glitches in my DOS editor. Of course, I never did have them on the OS/2 machine.

I like OS/2 Warp Connect. Unfortunately, it is published by a firm with less-than-optimum marketing capabilities. IBM promotes OS/2 Warp Connect for corporate customers and gives game compatibility a low priority, while Microsoft has a gaming fanatic as part of the Win 95 design team.

While some Win 95 installations are difficult, most are smooth because of Microsoft's attention to legacy hardware. I don't understand why Win 95 didn't automatically find my EtherExpress card's IRQ setting, but the error wasn't fatal—and I had no trouble with the CD-ROM drive and the optical drive. Some OS/2 installations go easily; but far too many are a nightmare for unsophisticated users.

No one, even IBM, is working very hard to develop software for OS/2, while most major companies are working full speed on stuff for Win 95. On the other hand, as yet there aren't any Win 95 applications

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This suggests a possible strategy. OS/2 Warp Connect isn't expensive. It runs DOS and most Windows applications just fine, and it networks easily to W4WG as well as other OS/2 Warp Connect machines. Assuming you don't have major installation problems, OS/2 could be a pretty good place to wait while the Win 95 dust settles, Microsoft gets out the inevitable maintenance release, and we see what IBM will do about Win 95 compatibility.

Having said all that, I continue to use Win 95, but I still print and do communications with an OS/2 system.

I'm giving up on the eraser-head mouse substitutes. I gave the Lexmark Classic Touch with Integrated Pointing Stick keyboard a good try—long enough that the rubber cap on the pointing device has worn through—and I'm going back to a mouse and my good old Northgate OmniKey Plus keyboard.

We also gave extensive trials to Cirque's GlidePoint fingerpad or mushpad, which we liked better than the eraser head. It works, and if you like it, you may like it a lot. It takes up less room than a mouse. Next I'll be trying several flavors of Logitech trackballs.

I'm trying to be fair. Certainly trackballs, fingerpads, and eraser heads work, and one or another may be preferable for certain applications. The eraser head on my Gateway 2000 Liberty portable saves space and is certainly good enough for the road. Alex likes both the eraser head and the fingerpad, and he uses both more than I do. But the fact remains that for overall mousing, I haven't found anything I like better than the Microsoft "Big Teardrop" Mouse 2.0, with the older Microsoft "Dove soap bar" Home Mouse a close second. Your mileage may vary, since it's all very personal.

If you have Win 95 and you like playing with your system, Martin Matthews' *Windows 95 Power Tools* (Random House, 1995) may be useful. It tells you where to find tools for editing the Win 95 registry. Alas, it's very skimpy on how the registry works or what you can do with it, which is a lot. At the Microsoft Win 95 dog and pony show, they were using the registry to do some amazing things.

The book has a better explanation of the System Policy Editor and what you can do with that, and a good section on networking. There's also a CD-ROM of shareware. Some of it is extremely useful.

Windows 95 Power Tools is about the

Circle 117 on Inquiry Card (RESELLERS: 118).

best book of its kind I have seen so far. I expect better ones in the future.

Tapedisk is an idea whose time came a while ago. Now that gigabyte hard drives cost only a few hundred dollars and multigigabyte drives cost well under a thousand, there aren't many who will need this.

Tapedisk will convert just about any SCSI tape drive into what looks to your system like a big hard drive. It does this in the only way possible, by caching the file allocation table (FAT) and directory information in memory. Thus, when you are done writing to your Tapedisk, you *must* close things properly before you shut down; otherwise, you are in for some grief. You can recover from a shutdown without proper closing, but you won't like doing it. You don't want to use this without an uninterruptible power supply (UPS).

Tapedisk will work across a network: if you can see drives on the remote machine, one of those drives can be a tape. This works with W4WG networks.

Tapedisk is surprisingly fast and, once properly installed, easy to use. You can write to a tape drive from inside a DOS or Windows application, as, for instance, "Save As" in Word, even over a network (provided you've mapped the remote tape to a drive letter on your local machine). It's cheap storage, and with a digital audiotape (DAT), you can archive a large amount of stuff. You could have a whole library of tapes, each one looking like a big hard drive.

Accessing the information is easy. You can use XTree, Norton Commander, or almost anything else to find, access, and copy files from tape to disk. This is a lot faster than going through an archiving system like Palindrome's Network Archivist. You can, for instance, create special directories to store older copies of files that will change and get at them quickly. You can also store your whole disk image and get it back by booting with a floppy disk.

Having said that, I will still use Network Archivist on my DAT drive. Network Archivist protects me from stupid blunders, and there are times I need that protection. I am rather angry at its handling of drive volume labels, but I suppose I'll get over it. The solution is to write down the *exact* volume label of your hard drive *before* you need to restore to it.

The bottom line for me is that it's easier to add a new gigabyte hard drive to the system if I want a place to keep temporary files I have to get at quickly and use my DAT drive for true backup and archiving. If you have a SCSI tape drive you're not getting much use from, Tapedisk may be the way to go.

The English historian Thomas Babington Macaulay introduced competitive examinations for civil-service positions to the Western world, modeling them on Chinese Mandarin examinations. The notion caught on, and competitive exams can make a real difference in people's lives.

Although the SAT is not quite as important in American life as its equivalent in Japan, your SAT score has a lot of impact on what university you can attend and what kind of scholarship you can get, and that can make a real difference in later life. They've recently changed the SAT tests. Many experts say the changes make it easier to study for the SAT. *continued*

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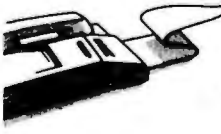

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There has always been a practice effect in taking exams; it's easy to show there are test-taking skills that can be learned independent of the specific test. There's also strategy. Should you guess, and if so, under what circumstances?

Princeton Review Management has a program called Inside the SAT. The company is not associated with Princeton University, but they have a lot of experience with SAT courses; and they've put much of that knowledge into this program. They also include a book on college admission and how you can better your chances of getting in. How useful it is will depend on how sophisticated you already are, but it won't hurt anyone to read it.

No computer program or crash course can substitute for sound preparation and good study habits; but this package can take a lot of the initial shock out of the SAT. I've had some experience with both tests and test preparation, and I believe that while this program won't perform magic, it can help you in two ways. First, it provides practice in test taking, and that's always important. Second, the vocabulary and math coaching sections can help fill in any gaps in specific knowledge and capabilities.

In these competitive times, even a small edge can be important. I think Inside the SAT will provide at least that.

If you read general business magazines like *Business Week*, you've seen a lot about Oracle. You probably know that Oracle is a DBMS capable of building and maintaining enormous relational databases on client/server systems. You may or may not know that the company has expanded into publishing tools that can be built into business management systems and applications.

If you don't know what a relational database is, or you do but know little about Oracle, you need *Oracle: A Beginner's Guide* by Michael J. Corey and Michael Abbey (Osborne/McGraw-Hill, 1995). The book starts with how a relational database differs from a flat-file system. It continues through SQL, data objects, Oracle tools and applications, and what Oracle does and how it does it. When you finish, you probably won't be able to install Oracle unaided, but you might; and you will

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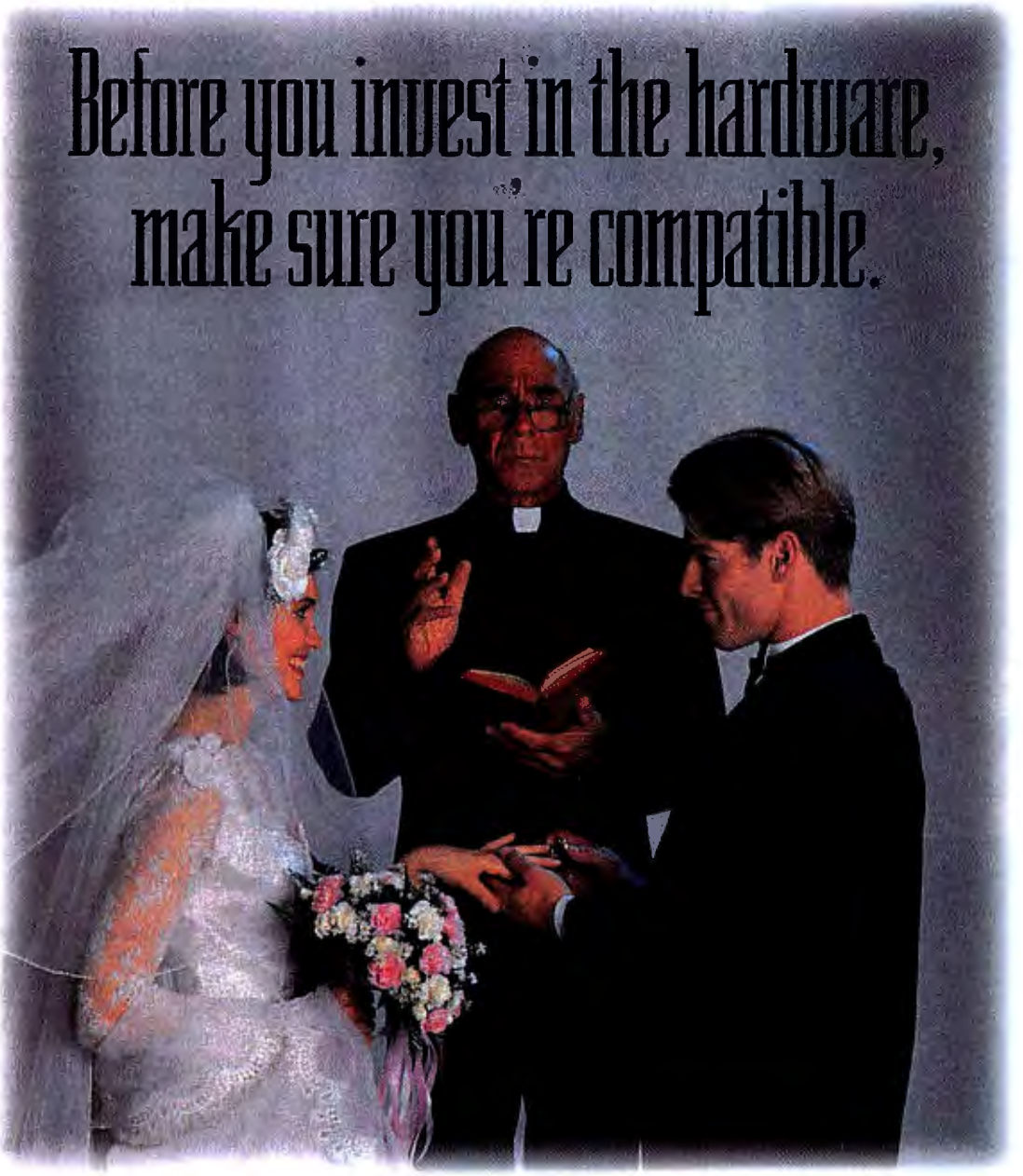

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If there's another book like this, I don't know of it. *Oracle: A Beginner's Guide* is on my reference shelf. Recommended.

You may recall I was recently the keynote speaker at a Canadian convention on technology in education. One of the awards given there was to SIR (for Simulations and Interactive Resources), a DOS VGA demonstration program that does chemistry experiments developed by Professor John Martin at the University of Alberta (John.Martin@ualberta.ca). The intended use is with a projector, so the program can function as a kind of animated blackboard. You can show Torricelli's mercury barometer, illustrate ideal gas laws, heat mercury without having the health physics people rush in to clean up your classroom, and show chemical reactions, including titrations. There's a neat periodic table from which you can extract information on demand. All told, it's like having an assistant drawing frantically with colored chalk as you lecture, and it's more legible.

Although it's meant for class use, SIR could be used as a lab supplement. I'd think every high school honors and college freshman chemistry teacher could make good use of this. SIR isn't fancy, but it will make a good teacher more effective, which is what electronic teaching aids are usually best at.

There's a new-and-improved version of Accent, the word processor that works in many languages. Accent Professional comes with a thesaurus in 11 languages, the ability to do bidirectional Arabic and Hebrew, 150 fonts, beaucoup keyboard layouts, spelling checkers in 16 languages, and the ability to import and export into popular word processing programs. The interface is good. There's really nothing like Accent Professional; if you need it, you need it bad.

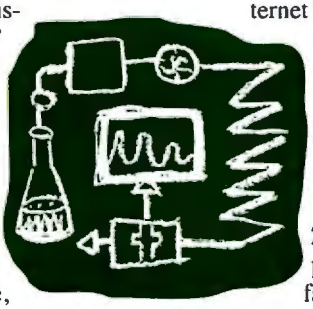
The UPS business is extremely competitive. It's also very hard to "review" a UPS without serious test equipment. For most of us, a UPS either works or it doesn't, and most of them do.

American Power Conversion has nifty software that monitors the status of your UPS and power line. This can be handy if you're in a location with bad power and you need to prove it to the local power company—or for that matter, to justify more UPS equipment to your bosses.

PowerChute Plus software works with Windows, NetWare, UnixWare, SCO Unix, and IBM LAN. It shows UPS status (including battery charge), gives remote

control of distant-site servers, and can make a full power-quality log.

The first book of the month is by Robert L. Forward, *Indistinguishable from Magic* (Baen Books, 1995). The title comes from Arthur Clarke's phrase, "Any sufficiently advanced technology is indistinguishable from magic." Dr. Forward is a former senior scientist at Hughes, an authority on gravitation, and one heck of an imaginative writer.



The second book of the month is by Richard Pipes, *Russia Under the Bolshevik Regime* (Random House, 1995). It's part of his history of the Seventy Years War (formerly called the cold war) and tells a grim tale of what happens when idealists and cynics fight over power.

The CD-ROM of the month is Microsoft's Composer Collection, three CDs on Mozart, Beethoven, and Schubert. I've written about these musical biographies before. They're a great and painless way to learn about composers, their times, and major works.

The game of the month is Interplay's Dungeon Master II: The Legend of Skullkeep. It's not as good a game as the original Dungeon Master, and the early parts get close to boring. However, it's different enough to be interesting if you like creature-bashing games and don't have the reflexes for the straight arcade variety.

We've received a new firewall box from Network Systems. It's called The Security Router. It's a lot more security than we'll ever need, but it will let us set up our own Internet interface with some confidence. A lot more another time, but if you need secure ways to the Internet, talk to Network Systems. They literally wrote the book on the subject.

We also just got the Zenith CruisePad, a portable pen-based radio-link interface to my network. It's not the pocket computer I invented for *The Mote in God's Eye*, but it's getting there. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

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Microsoft's **Composer Collection** ($54.95) is a great and painless way to learn about composers, their times, and major works. Contact **Microsoft Corp.**, Redmond, WA, (800) 429-9400 or (206) 882-8080; fax (206) 883-8101; http://www.microsoft.com. **Circle 1122.**

I recommend **Dr. Solomon's Anti-Virus Toolkit 7.5x** (single-user version for most OSes, $125). They have a good track record of early detection and disarming of new virus threats, and I like their approach. Contact **S&S International, Inc.**, Burlington, MA, (800) 701-9648 or (617) 273-7400; fax (617) 273-7474; http://www.us.drsolomon.com. **Circle 1123.**

Dungeon Master II: The Legend of Skullkeep (about $40) is different enough to be interesting if you like creature-bashing games and don't have the reflexes for the straight arcade variety. Contact **Interplay Productions, Inc.**, Irvine, CA, (800) 468-7752 or (714) 553-6655; fax (714) 252-2820; http://www.interplay.com. **Circle 1124.**

Inside the SAT (for Mac and Windows, $29.95; on CD-ROM, $54.95) provides practice in test taking, and the vocabulary and math coaching sections can help fill in gaps in specific knowledge and capabilities. Contact **Princeton Review Management Corp.**, New York, NY, (800) 955-3700 or (212) 874-8282; fax (212) 874-0775; chris.tprg@review.com. **Circle 1125.**

The **Norton Utilities for Windows 95** ($119) will help you tune up your system and avoid disasters. Contact **Symantec Corp.**, Cupertino, CA, (800) 441-7234 or (503) 334-6054; fax (503) 334-7474; http://www.symantec.com. **Circle 1126.**

PowerChute Plus 4.2 (Windows, $69; OS/2, Windows NT, and NetWare, $99; Unix, from $149) software monitors the status of your UPS and power line. Contact **American Power Conversion Corp.**, West Kingston, RI, (800) 800-4272 or (401) 789-5735; fax (401) 789-3710; http://www.apcc.com. **Circle 1127.**

I'd think every high school honors and college freshman chemistry teacher could make good use of **SIR** ($50). Contact **The Journal of Chemical Education: Software**, Madison, WI, (800) 991-5534 or (608) 262-5153; fax (608) 262-0381; http://www.jchemed.chem.wisc.edu. **Circle 1128.**

Tapedisk 6.4.0 ($249.95) is surprisingly fast and, once properly installed, easy to use. Contact **Tapedisk Corp.**, Oshkosh, WI, (800) 827-3372 or (715) 235-3388; fax (715) 235-3818; http://www.tesser.com/tapedisk/. **Circle 1129.**

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Circle 119 on Inquiry Card.

Not Just Another Free Unix

FreeBSD is fast and open, and it runs powerful tools and applications. And, yes, the OS is free.

JORDAN HUBBARD

The free-software world has attracted a growing army of highly talented engineers, many of whom turn out software that rivals or surpasses commercial products. Add to that the increased preoccupation with the Internet, which has led to a resurgence of interest in Unix and its strong networking abilities. These forces have helped produce a market for several free Unix-compatible OSes.

FreeBSD is one of them. We will show how it can be used for everything from providing commercial Internet service to a home-desktop solution, all with relatively inexpensive PC-based equipment.

A Brief History of FreeBSD

In 1974, an early release of Unix was distributed to the academic community, including the University of California at Berkeley. Students and faculty were quick to see its potential. They distributed a version of Unix called BSD, for Berkeley Standard Distribution. The first release was prepared by Bill Joy (later to gain fame as the author of the `vi` editor and a cofounder of Sun Microsystems). It came out in March 1978.

Under the auspices of the Computer Systems Research Group (CSRG), and funded by a Defense Advanced Research Projects Agency (DARPA) grant to develop networking for the ARPANET (later to grow into the Internet), BSD grew and flourished. The very foundations of modern TCP/IP networking were developed for BSD. The CSRG also added other important innovations: demand-paged virtual memory, job control, the fast file system (with long filenames), and 32-bit addressing.

The BSD releases had a strong influence on the commercial Unix world, as reflected by Sun's SunOS and Digital Equipment's Ultrix. Unix Systems Laboratories (USL) was quick to bring many features of BSD into its own System V version of Unix.

The CSRG also took what was then an unusual step in releasing two versions—BSD and BSD Lite. The latter version was BSD with all the AT&T-licensed code removed, making it legal to distribute it freely.

BSD releases from the CSRG ended in 1992, when the group disbanded. However, the spirit of what it tried to accomplish refused to die. Several groups began working where it left off, including the FreeBSD Project, which is composed of volunteers from industry and academia.

In July 1994, some former members of the CSRG came together briefly to release BSD 4.4 Lite, the last chapter in a successful saga. Many features (e.g., stackable file systems, 64-bit file-system sizes, and "portals") were added to 4.4 Lite. The FreeBSD Project was quick to adopt 4.4 Lite with FreeBSD 2.0, released in January.

There have since been two further releases of FreeBSD, 2.0.5 and 2.1. FreeBSD 2.1 represents a significant project milestone in terms of stability and overall systems integration. We will talk a little about using it in real-world applications and about what the future holds for the FreeBSD Project.

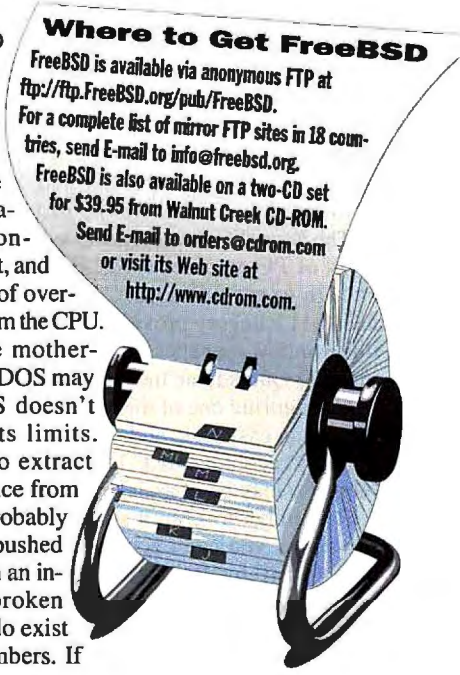
Installing FreeBSD

The installation of FreeBSD is fairly straightforward. It may nonetheless be useful to give some start-up tips to those who have never installed it before.

FreeBSD offers many kinds of canned installations aimed at beginners, power users, developers, and minimalists. If you don't like one of these canned options, you can create a custom installation of your own from the available pieces.

The equation gets slightly trickier when trying to tailor a FreeBSD machine to a specific application. Are you running a World Wide Web server? What kind of hardware should you get? How much memory do you need for a serious NFS server box? What sorts of Ethernet cards are appropriate for an IP router? These are all somewhat difficult questions to answer given that they're so broad, but you can follow some useful rules of thumb.

If you're using FreeBSD in an application where lots of I/O is involved, such as an NFS or Web server, go with SCSI peripherals. SCSI is more expensive than IDE, but for good reason. SCSI drives and controllers are more intelligent, and they off-load a good deal of overhead in transferring data from the CPU.



Don't buy a no-name motherboard. What works under DOS may work only because DOS doesn't push the hardware to its limits. FreeBSD will attempt to extract every ounce of performance from your hardware and will probably push it as it's never been pushed before. Motherboards with an inferior cache design or broken DMA invalidation logic do exist in depressingly large numbers. If

you own a motherboard (or system) certified for another version of Unix, you're likely to have far less trouble with it. If you're still unsure, ask a local Unix expert.

If you're going for serious packet routing, use Peripheral Component Interconnect (PCI) and PCI Ethernet cards. The latest PCI Ethernet cards based on Digital's DC21040 chip set are impressive and are offered by a number of manufacturers. Furthermore, they are available in both 10- and 100-Mbps (i.e., the DC21140) configurations. Therefore, you can go from warp 1 now to warp 10 later by swapping a card and hooking to the faster hub.

If you intend to support many simultaneous users or FTP sessions, don't skimp on memory. For every 10 users, add 16 MB. Configurations supporting up to several hundred on-line users with a simple 90-MHz Pentium machine are possible, but you need adequate memory for it.

Using FreeBSD for Internet Service Provision

It's no secret that FreeBSD is increasingly popular with Internet service providers (ISPs). One reason for this is the robust TCP/IP networking. A fundamental requirement for any ISP is the ability to route packets and provide TCP/IP-based services 24 hours a day, often under some of the most intense loads imaginable.

This means that the OS of choice not only needs to provide robust and reliable service, it also needs to scale well because an ISP's needs often exponentially increase. PCs are actually well suited to this given that they're comparatively cheap and powerful.

Providing Web service requires little more than installing a server and writing some content in Hypertext Markup Language (HTML). There are many good books on writing HTML, so we won't go into any detail here.

There are four popular Web (i.e., HTTPD) servers to choose from: European Laboratory for Particle Physics (CERN), National Center for Supercomputing Applications (NCSA), Apache, and Netscape Commerce server. The Apache server supports a number of advanced features, and it's free. The others will probably work just as well, and if you need encrypted transactions, the Netscape server is your only option.

Configuring the X Window System

Starting with a graphics card, a 17-inch (or larger) monitor, and the XFree86 software from the XFree86 Project, it is possible to build a reasonably high-quality graphics workstation for CAD, simulation, or 3-D-modeling purposes. Even with a 15-inch monitor and a 1-MB generic VGA card, X remains comfortable at resolutions of up to 1024 by 768 pixels.

The XFree86 package provided with FreeBSD supports a wide array of PC graphics cards. Because the X server alone is not enough to provide a truly comfortable environment, the packages/x11 category provides precompiled versions of many popular window managers and utility software for everything from viewing QuickTime movies to developing GUI applications.

Configuring one of the X servers for your graphics card is not always an easy task, and a thorough reading of the X documentation is recommended. The `xf86config` utility provided with XFree86 may be of assistance.

Remember to keep it simple when trying to configure the X server—if you can't achieve your initial target resolution, fall back to 640 by 480 pixels. See if you can get it to work there and then move up gradually. Also, do not start the X server and clients until the server is known to work. Run the X binary by itself, first, and then move on to use the `xinit` or `startx` scripts.

Using FreeBSD as a Software Developer

FreeBSD comes with a rich set of compilers and debugging aids, with support for languages as diverse as Scheme, TCL, or Forth in the packages/lang subtree. Out of the box, FreeBSD supports ANSI C and C++ compilers, as well as FORTRAN 77.

Full source symbolic debugging is provided by the GDB debugger, and utilities such as `xxgdb` and `ddd` even provide a graphical interface for it. The industry-standard `vi` editor is provided, and favorites such as `emacs` and `jove` are readily available add-ons from the packages/editors collection.

Because FreeBSD is based on the same BSD code base that greatly influenced many commercial versions of Unix, porting software to FreeBSD is usually a painless exercise. Many software developers use FreeBSD at home to augment their development environments at work. Where many accounting departments balk at the thought of providing a developer with a $10,000 workstation for home use, a $2000 PC is often easier to justify.

Many other tools of interest to the software developer are provided in the packages/development collection. The software for FreeBSD is provided with a tightly integrated build environment that may be of interest to developers looking for existing models on which to base software-development methodologies.

Hardware Requirements

If you want to do this:	You should have this:
Basic installation	386 PC, 4 MB
Packet routing	PCI Ethernet cards (Digital DC21040- or DC21140-based)
Simultaneous FTP sessions	16 MB for every 10 users
Internet	ISP Pentium, SCSI, multiport modems

The Future of the FreeBSD Project

It's difficult to predict the future with any great degree of accuracy where any volunteer project is concerned. But if enthusiasm and drive have anything to do with it, the FreeBSD Project has a bright future indeed. Far from resting on its laurels, the team is looking for fresh challenges. Having split development into two branches, "-stable" (i.e., semifrozen) and "-current" (i.e., in flux), a large number of developers have been freed to concentrate on new solutions without sacrificing stability. Innovative work is being done in the areas of dynamically loadable device drivers, full PC Card support, support for more than one processor, distributed processing, and much more.

There are far more desired projects than there are people to do them, so volunteers are always welcome. Those interested in joining in the development of FreeBSD should send E-mail to hackers@freebsd.org, which is open to all. You can also subscribe to this mailing list, along with a number of others, by sending E-mail to majordomo@freebsd.org and saying "subscribe hackers" in the message body.

Free software has always been a powerful concept, but organized free software has proven considerably more powerful still. As long as there are people willing to pledge time and energy to keep the organized efforts alive, growth and quality in the free-software world will continue at a rapid pace. ■

Jordan Hubbard is a member of the FreeBSD Project. He can be reached on the Internet or BIX at editors@bix.com.

Two Turbocharged PowerPCs

IBM and Motorola rev up the 603e and 604 and reduce the chips' hunger for power

TOM THOMPSON

IBM and Motorola have cranked up the performance of the PowerPC 603e and 604 CPUs. The companies recently disclosed an enhanced version of the 603e, called the 166-MHz 603e, that sports a number of significant improvements. Its predecessor, the 100-MHz 603e, peaks at 120 MHz. The companies have also revealed an enhanced PowerPC 604, called the 166-MHz 604e. Its 100-MHz sibling tops out at 133 MHz. The new processors not only operate at higher clock rates—they also run certain operations faster.

IBM and Motorola have now exceeded the performance targets they set for themselves in February. Not only that, but they've accomplished this without approaching any limits in these processor designs.

Both chips are made with a 0.35-micron five-layer-metal CMOS process. A 0.5-micron version of this same process dramatically shrank the original PowerPC 601's die (which used a 0.65-micron four-layer-metal process) from 121 mm^2 to 74 mm^2 and enabled it to run at 120 MHz. While this process costs slightly more, the size reduction confers important benefits. Smaller circuits result in a smaller die, which raises the yields per wafer and can result in savings that more than offset the increased process cost. Or, the designers can pack more features on the same-size die.

Size reduction can also mean a boost in the processor's performance. The reduced size of the processor's circuits means that signals travel shorter distances between logic gates. It also lets the circuits operate at lower voltages. These lower voltage levels allow the logic gates to switch faster while consuming less power. Thus, the 166-MHz 603e and the 166-MHz 604e can run at higher frequencies yet dissipate less or the same amount of power as their predecessors. For more details on die size, check the table at right.

Despite operating at the higher clock rate, the 166-MHz 603e consumes only 3 W (typical) at 166 MHz, the same as a 100-MHz 603e running at 100 MHz. Simulations show a dramatic performance improvement: At its named clock rate, the 166-MHz 603e posts an estimated 3.0 to 4.0 SPECint95 and 2.5 to 3.3 SPECfp95—about the same as a 100-MHz 604. At its named clock rate, the 166-MHz 604e typically dissipates an estimated 10 W, significantly less than a 133-MHz 604. Preliminary estimates by IBM peg the 166-MHz 604e at 5.0 to 6.0 SPECint95 and 4.0 to 5.0 SPECfp95 when running at 166 MHz. On top of the capabilities bestowed by a new fabrication process, each chip has key features added to its design that also boost performance.

603e Little Endian

The 166-MHz 603e contains 2.6 million transistors, approximately the same as the 100-MHz 603e. The design reduces power consumption by running the processor core at 2.5 V, while the bus and I/O interface still operate at 3.3 V. It's pin-compatible with the 100-MHz 603e. The new chip, with its higher clock speed, supports a wider range of clock multipliers (2:1, 5:2, 3:1, 7:2, 4:1, 9:2, 5:1, 11:2, and 6:1). This enables PC designers to build notebook systems that use modest clock speeds (such as 25 or 33 MHz) to conserve power, while the CPU runs at 150 MHz or 166 MHz to meet performance goals.

A modification to the 166-MHz 603e's load/store logic provides better performance and support for little-endian addressing modes under Windows NT. Formerly, when the PowerPC operated in little-endian mode and software accessed misaligned data (such as when a 32-bit word straddled a 32-bit word boundary), an exception would occur and a millicode exception handler would field the access; see "What the Heck Is Millicode?" on page 210. Put another way, the processor first had to perform two accesses to read data crossing a word boundary. The chip would access the lower-address word first, regardless of the memory-addressing mode. The processor then spent additional cycles in a millicode handler that determines the endian order of the data.

With the 166-MHz 603e, the hardware keeps track of the data order. With the overhead of a millicode handler absent, misaligned data accesses complete several cycles faster. As a result, load/store operations now take the

THE POWERPC FAMILY: GETTING SMALLER, RUNNING FASTER

PROCESSOR	100-MHZ 603E	166-MHZ 603E	100-MHZ 604	166-MHZ 604E
Die size	98 mm^2	81 mm^2	196 mm^2	148 mm^2
Number of transistors	2.6 million	2.6 million	3.6 million	5.6 million
On-chip cache size	32 KB	32 KB	32 KB	64 KB
Current maximum clock speed	120 MHz	166 MHz	133 MHz	166 MHz
Voltage	3.3 V	2.5 V (core)	3.3 V	2.5 V (core)
Power dissipation (at max. speed)	3 W	3 W	14 W	10 W
SPECint95 (max. clock speed)	2.5-3.3*	3.0-4.0*	4.55	5.0-6.0*
SPECfp95 (max. clock speed)	2.1-2.8*	2.5-3.3*	3.31	4.0-5.0*

* estimated

same number of cycles regardless of the endian addressing mode.

166-MHz 604e: Faster Fetching

Even with its smaller die, the 166-MHz 604e packs additional transistors that not only add new features but also enlarge its on-chip cache size from 32 KB to 64 KB. The new 604e has 5.6 million transistors, of which 3.8 million implement the on-chip caches. The 166-MHz 604e has separate code and data caches, each 32 KB in size, while the 100-MHz 604 had two separate 16-KB caches. The caches are logically organized as four-way set associative using 256 sets, instead of the 128 sets on the 604. By keeping the cache organization as four-way, the 166-MHz 604e is pin-compatible with the 100-MHz 604. The processor core operates at 2.5 V, and it supports processor-to-bus frequency ratios of 1:1, 3:2, 2:1, 5:2, 3:1, and 4:1, which can simplify a system design.

The CPU designers beefed up the logic of the load/store unit to reduce the number of cycles spent fetching and writing data. The cache logic forwards a subsequent nonspeculative load operation immediately to the load/store unit, rather than waiting for the cache fill to complete (as it does on the 100-MHz 604). Like the 166-MHz 603e, the 166-MHz 604e provides improved hardware support for little-endian misaligned data accesses.

Room to Grow

These new processors offer performance benefits beyond just faster clock speeds. The reduction of a few clock cycles here and there on load operations might not seem like much of an improvement. However, because a processor spends its time either executing instructions or shipping data in and out, these faster operations add up to a significant performance boost.

The improved little-endian addressing support makes these processors capable of hosting any operating system, regardless of its addressing mode, without performance degradation. This is especially important for Windows NT, which operates in little-endian mode. You can expect to see the 166-MHz 603e and 166-MHz 604e at the heart of any system based on the PowerPC Common Hardware Reference Platform (CHRP).

For notebook computers, a 166-MHz 603e will mean 604-level performance but with longer battery time. (At BYTE we tested the battery life of an Apple PowerBook 5300 equipped with a 100-MHz 603e CPU, active-matrix color display, and lithium-ion battery. It ran for nearly 7 hours.)

A 166-MHz PowerPC 604e, armed with both the 604's speculative execution and branch prediction logic, and the improved load/store instruction performance, should endow a desktop system with processing power beyond that of any system based on Intel's new P6. It's important to note that the 166-MHz clock speed is only the starting point. IBM and Motorola engineers say these enhanced processors have the potential to reach a clock speed of 200 MHz. ■

Tom Thompson is a BYTE senior technical editor. He's the author of Power Macintosh Programming Starter Kit *(Hayden Books, 1994). You can contact him on the Internet at tom_thompson@bix.com.*

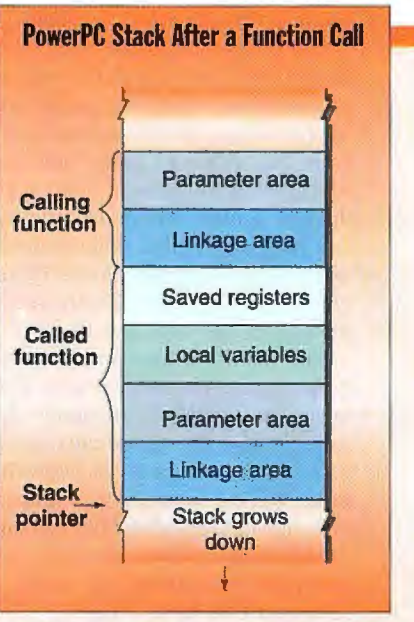
What the Heck Is Millicode?

Microcode, nanocode, and now millicode. What are these things?

Microcode is an on-chip program that decodes various processor instructions and operates the appropriate portions of the processor's logic to implement the requested action. Ergo, microcode is a sort of program embedded inside the processor. In very complex processors, separate programs—nanocode—operate sections of the processor, such as the floating-point unit or the integer unit.

Millicode, as its name implies, operates at a level outside the processor. It implements highly efficient routines for frequently called functions. Normally, when a program calls a function on a PowerPC system, it uses a set of rules that organize the target function's temporary storage into a region of memory known as a *stack frame*. (See the figure at right.) This stack frame serves as a container that preserves any nonscratchpad registers, the function's local storage, a parameter (or argument area), and a linkage area. One such rule places a number of the function's arguments into processor registers. Additional arguments (if any) spill over into the stack frame's argument area. Another rule adjusts the link register (LR) to point to the target function's address, while the LR's original contents get stored into the link area of the stack frame. Once the program sets up the stack frame, it executes a branch to the function, based on the address in the LR. When the function exits, it restores the LR (which effectively creates the return address) and executes another LR-based branch.

To reduce overhead, millicode doesn't follow these conventions. Instead, you place arguments in specific registers and use a branch absolute then link instruction (`bla`) to jump to the function. This convention reduces the function-call overhead to several register loads plus a single `bla` instruction. A register-based branch (using the LR) returns execution to your program when the function exits. Such unconditional branches typically take zero cycles to execute because the processor's branch unit can resolve them well in advance. Previous 603, 603e, and 604 processors used millicode to resolve little-endian addressing. As efficient as millicode is, it can add substantial overhead if the routine gets called frequently. The 166-MHz 603e and the 166-MHz 604e now handle these addressing issues in hardware, thus boosting the efficiency of the load/store instructions, which in turn increases the speed of the processor.



A typical PowerPC function stores temporary data in a structure called a stack frame. Millicode function calls don't use a stack frame.

How to Build an Internet App

A little Visual Basic code, a connection to the Internet, and you've got your own weather channel

BRETT GLASS

Have you been thinking about writing software for the Internet? Perhaps you're worried that the conventions and protocols would require years to master. As it turns out, programming for the Internet is quite simple. I'll demonstrate that fact in this article. In the process, with just a bit of pointing and clicking and about a page-and-a-half of code, you'll learn how to create a potentially life-saving Internet application. First, I should explain how Internet programming got to be so simple.

Multiplatform Simplicity

In the early days of wide-area networking, research institutes wanted to connect hundreds of different brands of micros, minis, and mainframes to what was then the ARPANET, an experimental research network (which is now the Internet). At that time, far more hardware architectures and operating systems were in use than today. For example, the time-sharing system of choice at many colleges and laboratories was the DECSystem-20 superminicomputer (DEC-20 for short). This unusual machine had a 36-bit word size, ran several powerful operating systems, and processed text as 7-bit ASCII characters.

Other machines on the Net included mainframes, Unix boxes, VAXen running VMS, Macs, IBM PCs, Apple IIs, and even CP/M machines. To minimize the effort required to bring networking to all these platforms, no Internet protocol could make many assumptions about the underlying architecture of the machine. Each Internet protocol was designed to be so simple that a capable graduate student could reimplement it on a new type of machine in a matter of days or weeks.

The Internet standardization process was also unique. Today, standards are established largely by fiat: A big company (say, Microsoft) introduces a product whose file format or communication protocol is adopted by other companies.

This was not true on the ARPANET, whose population of scholars and computer hackers had little to gain from the promotion of complex, proprietary standards. A new protocol's author would first implement and test the protocol, then write a descriptive paper known as a Request for Comment (RFC). This paper was "posted" on the network, where other programmers could comment on it. Only after many sites had implemented the protocol, found it useful, and provided their input would the protocol become—by consensus—a true standard. (You can obtain RFCs via FTP from the Internet site NIC.DDN.MIL. Or you can get them on CD-ROM from Walnut Creek; phone (800) 786-9907.)

TCP/IP and the OSI Reference Model

The protocol suite that emerged from the ARPANET standards process is TCP/IP (every other standard created through ARPANET, in one way or another, is connected with TCP/IP). TCP/IP has "layers" ranging from the physical signals that travel along wire or fiber to the messages or commands sent to one another by application programs. The International Standards Organization's Open Systems Interconnect (OSI) Reference Model, a generic set of protocol layers, helps to put the parts of TCP/IP into perspective (see the table below).

IP, the Internet Protocol, implements the network layer, which handles routing of information between networks. TCP, the Transmission Control Protocol, implements the transport layer, which paces transmissions, keeps the data in order, and ensures that it arrives without errors. UDP, the User Datagram Protocol (and another part of the TCP/IP suite), sends "raw" datagrams, or messages without error checking. In a sense, it's a "null" implementation of the transport layer, which is why it's sometimes called the Unreliable Datagram Protocol.

The TCP/IP suite contains many application-layer protocols—conventions that applications use to talk to other applications. These include the Simple Mail Transfer Protocol (SMTP), Telnet (terminal emulation), FTP (file transfer protocol), network news transfer protocol (NNTP), Gopher (the University of Michigan's distributed, text-based menu system), and the Hypertext Transport Protocol (HTTP) that, together with the Hypertext Markup Language (HTML), implements the World Wide Web.

Since many computers already come with complete implementations of TCP, UDP, IP, and Berkeley Sockets (a handy API that makes it easy to establish sessions with remote hosts), the application layer is where the action is. Virtually all the innovative new Internet programs work with existing application-layer protocols or create new

OSI Layers

Physical	Network and communications hardware
Data link	Reliable data transmission across physical link
Network	Establish and maintain connections across networks
Transport	Transfer of data between endpoints
Session	Establish and maintain connections between applications
Presentation	Transform data to provide application interface
Application	Actual services for users of the OSI environment

ones. Most Internet application-layer protocols are very simple and send messages in formats easily readable by humans, making them a joy, rather than an ordeal, to implement. I'll use one of the simplest protocols of all—Gopher—to retrieve information in the sample application that follows.

Where's Felix?

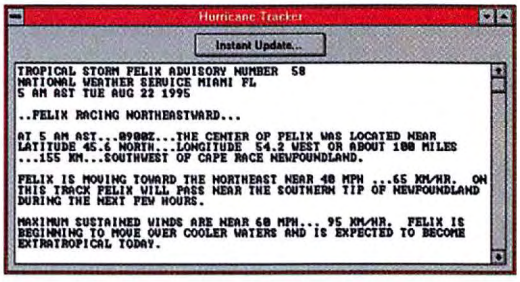
To demonstrate how easy it is to write Internet software, I recently developed a timely Internet application in 30 minutes in front of a live audience at One BBSCon in Tampa, Florida. At the time, Hurricane Felix was raging in the Atlantic, and southeasterners from the Carolinas to Florida were concerned that it might be headed their way. So, to allow them to track the hurricane easily, I developed a Windows program that would display information about the storm, with updates every 15 minutes. The application included an "instant update" button, which the user could click to retrieve the absolute latest information.

Because I had only about an hour for my entire lecture, I used Microsoft's Visual Basic 3.0 in conjunction with a shareware VBX (Visual Basic control) called IPPort, published by devSoft Inc. (Research Triangle Park, NC). You can get this and other VBXes from devSoft's Web site at http://www.dev-soft.com. IPPort interfaces to WinSock, the Windows variant of the Berkeley Sockets API, and in doing so insulates you from the complexity of dealing directly with WinSock. (WinSock and Berkeley Sockets are session-layer APIs for TCP/IP.)

The source code for the hurricane tracker, including copious comments and subroutine headings (generated by Visual Basic), is only 90 lines long. (You can download the complete source from the BYTE Web site at http://www.byte.com.) The application starts by establishing a connection to a Gopher server at the University of Indiana that contains frequently updated hurricane information. Making the connection requires only three lines of code, which set properties in the `IPPort` control:

```
IPPort1.HostName = "wx.atmos.uiuc.edu"
IPPort1.Port = 70 'Gopher
IPPort1.Connected = True
```

A property is a variable associated with a Visual Basic component or control. Usually, when you assign a new value to a control's property, it has side effects: For example, setting a button's property might cause it to change color. In the above listing, assigning a host's domain name to the `IPPort` control's `HostName` property causes the control to look up the name, determining its IP address in preparation for a connection.



The second statement assigns an IP port number for the connection. In TCP/IP lingo, the word *port* has an unusual meaning: It specifies the process or application with which you'd like to communicate on the remote host. Opening a connection with port number 70 indicates that your program would like to talk to the host's Gopher server (if one is running), while connecting to port numbers 23 and 79 invoke Telnet and Finger, respectively. The numbers which, by convention, invoke standard TCP/IP applications are known as "well-known ports."

The third statement starts the conversation with the remote machine. When the `Connected` property is set to `True`, the custom control "makes it so" by attempting a connection to the remote machine. The program can read the `Connected` property to determine whether a connection actually has been established; a trappable run-time error occurs if there is a problem.

The first three statements in the box below watch for a successful connection (yielding control to other Windows apps in the interim), place a message in the text box to indicate that a connection has been made, and request data from the Gopher server.

Asking a Gopher server for information is as simple as setting one other property—the `IPPort` control's `DataToSend` property—to a string containing the text of the request. To retrieve information from a Gopher server, the client just sends a text string indicating what it wants. (Most often this string is in the form of a filename.) The server delivers the data and ends the connection.

```
'Wait until we are connected
Do Until IPPort1.Connected: DoEvents: Loop
tResponse.Text = "Polling gopher server...." &
  Chr$(13) & Chr$(10)
'Send request
IPPort1.DataToSend =
 "0/Hurricane Advisories and Images/Atlantic-Discussion" &
 Chr$(10)
```

When data begins to flow in, it triggers a Visual Basic event handler—a procedure that responds to events such as mouse movements, keystrokes, and incoming network data. The event handler, a subroutine with the name `IPPort1_DataIn`, places the incoming data in the text box:

```
Sub IPPort1_DataIn (Text As String, EOL As Integer)
If EOL Then Text = Text & Chr$(13) & Chr$(10)
tResponse.SelStart = Len(tResponse.Text)
tResponse.SelText = Text
End Sub
```

If the `EOL` parameter has the value `True`, it indicates that the data was followed by an end-of-line character (an ASCII 10) and causes the program to start a new line in the text box. The insertion point is moved to the end of the text, and the new text is added to the contents of the box.

When the incoming data stops, the user can manipulate the scrolling text box to review the hurricane information (see the screen shot). No code is required to provide this feature, since this functionality is already built into the text-box control. Another control, a Visual Basic timer, causes the process to repeat every 15 minutes. The button at the top of the window starts the polling process again and lets the user get an instant report.

All Done

That's all there is to it. Development tools like Visual Basic make building the GUI side of Internet applications a snap; devSoft's IPPort VBX takes care of the rest. Armed with some easy-to-use tools and some basic knowledge of the Internet, you can sit down and quickly write nontrivial programs for the Net. ■

Brett Glass (rogue@well.com), a 15-year resident of the Internet, is a writer, computer consultant, and teacher in Laramie, Wyoming.

Untangling Fast Ethernet Cables

The Fast Ethernet standard specifies support for a wide variety of media

PAUL CUNNINGHAM

Fast Ethernet, also known as IEEE 802.3u or 100Base-T, has the potential to quickly become the successor to Ethernet as the networking topology of choice. This year about 1 million Fast Ethernet network interface cards (NICs) will ship, according to market-research firm International Data (Framingham, MA). And next year, the number is expected to increase to about 4 million, about four times as many NICs as is predicted for the other 100-Mbps Ethernet alternative, 100VG-AnyLAN.

The reason for Fast Ethernet's popularity is that it offers 10 times the speed of Ethernet for a small premium in price over today's 10Base-T adapter cards and hubs. In addition, Fast Ethernet is compatible with traditional Ethernet, using the same CSMA/CD method to arbitrate access to the cable. However, questions still remain in the minds of many about how to implement Fast Ethernet—and what type of cables to use with it.

With such concerns in mind, the IEEE standard for Fast Ethernet details cabling specifications for a wide range of copper cabling, as well as optical fiber. The Fast Ethernet standard provides for three distinct cabling systems (see the table "100Base-T Fast Ethernet Cabling Guide" below). Each of these systems has its merits and is appropriate for different situations. In addition, each standard specifies the use of cabling types, which are themselves based on industry-approved definitions.

The standards for twisted-pair copper cabling are called 100Base-TX and 100Base-T4; the standard for fiber-optic cabling is called 100Base-FX. These standards can be intermixed within an organization, and in combination they address virtually all cabling needs.

There are two general sources of specifications for twisted-pair cabling: the Telecommunications Industry Association (TIA) branch of the Electronic Industries Association (EIA), which is referred to as the EIA/TIA (or simply the EIA), and IBM. The EIA is responsible for the "Category" cable standards (see the table "EIA/TIA Cable Specifications" on page 214). It's important to note that the terms *Category* and *Level* are sometimes used interchangeably. IBM is responsible for the "Type" cable standards, such as Type 1, Type 2, and so forth.

Strictly speaking, a cable specification does not include the connector used to terminate the cable; however, both IBM and the EIA define specific connectors for use with twisted-pair cable. For example, with Category 3, Category 4, and Category 5, the connector standard is EIA-568, which specifies an RJ-45 connector. For Type 1 cable, the connector type is DB-9.

Most Ethernet installations use cable based on EIA standards, and most installations of IBM or Token Ring equipment tend to use cable that meets IBM cable standards. The notable exception to this is that many Token Ring installations use Category 4 unshielded twisted-pair (UTP) cable. The 100Base-FX standard specifies the use of the same type of fiber-optic cabling system that's used by the fiber-optic Ethernet standard (10Base-FL) and Fiber Distributed Data Interface (FDDI).

Flexibility Is the Key

The 100Base-TX method requires two pairs of high-quality, data-grade twisted-pair wiring, one for transmission and one for reception. This cable type can be either UTP or shielded twisted-pair (STP), provided it meets the required performance specifications. The most common examples of cable that meet these requirements are Category 5 UTP and IBM Type 1 STP.

The 100Base-T4 method requires four pairs of ordinary-quality twisted-pair wiring: one dedicated to transmission, one dedicated to reception, and two bidirectional pairs. Essentially, the 100-Mbps data signal is divided over three pairs of cable. Thus, the effective data rate remains the same as with other methods, but the cable frequency is much lower.

continued

100BASE-T FAST ETHERNET CABLING GUIDE

Cabling specification	Cable type	Advantages	Disadvantages
100Base-TX	Category 5 UTP (uses two pairs) or IBM Type 1 STP	Full-duplex mode offers 200-Mbps transfer rate; requires only two pairs of cable.	Category 5 cabling might not be installed; patch panels and jumper blocks must be rated for Category 5.
100Base-T4	Category 3, 4, or 5 UTP (uses four pairs) or IBM Type 1 STP	Operates on virtually any existing twisted-pair cabling; adapters are less expensive.	Requires four pairs of cabling; cannot support full-duplex operation.
100Base-FX	Multimode fiber (uses one pair of 62.5-/125-micron fiber)	Allows for extended distances between devices; immunity to electromagnetic interference; added security; uses same cabling as FDDI.	Connectors are more expensive than copper alternatives.

This means that you can use a less sophisticated cable with this method. This type of cable is sometimes referred to as *voice-grade cable*. Most often, this means Category 3 UTP. It's important to note, however, that 100Base-T4 is not limited to voice-grade cable. It can also be used with better-quality cable, including Category 4 UTP, Category 5 UTP, and Type 1 STP.

EIA/TIA CABLE SPECIFICATIONS

Cable type	Common uses
Category 1	Telephone service and low-speed data
Category 2	ISDN and T1/E1
Category 3	Data up to 16 MHz (including 10Base-T at 10 Mbps and 100Base-T4 at 100 Mbps)
Category 4	Data up to 20 MHz (including Token Ring at 16 Mbps and 100Base-T4)
Category 5	Data up to 100 MHz (including 100Base-TX and 100Base-T4 at 100 Mbps)

Pluses and Minuses

Each of the cabling specifications has advantages and disadvantages. The advantages of 100Base-T4 are that it will operate on virtually any preexisting twisted-pair cabling, its adapters are about 10 percent less expensive than those for other specifications, and it can use less-expensive Category 3 cabling. Meanwhile, 100Base-TX uses only two pairs of twisted-pair cabling and supports full-duplex mode for up to 200-Mbps rates into the servers.

The disadvantages of each of these two specifications are virtually the strengths of the other. For instance, 100Base-T4 cannot support full-duplex mode (which might be desirable for servers but is unneeded in workstations) and requires four pairs of wiring. Meanwhile, 100Base-TX suffers from a temporary shortage of Category 5 cabling, which was caused by a resin-supply problem. Additionally, for 100Base-TX to be used, all patch panels and jumper blocks must be rated Category 5.

There's no clear right or wrong in choosing between 100Base-TX and 100Base-T4. The right system for a given network depends on several factors, the first of which is the installed cable type. If properly installed Category 5 or Type 1 cable is not available, you must use 100Base-T4 or install new twisted-pair wiring. If the quality of the installed cable is unknown or questionable, 100Base-T4 is a better choice because it offers the flexibility of running on more cable types.

A second consideration is budget. You can save a substantial amount of money if you can use 100Base-T4 adapters and Category 3 cabling. (A quick survey of cable costs shows four-pair Category 3 plenum cable priced at 9 to 25 cents per foot, and four-pair Category 5 plenum cable at 23 to 37 cents per foot.)

Finally, you must take your future needs into account. If you must have full-duplex mode now, or if there's a chance that you might want it in the future, you'll need 100Base-TX.

Meanwhile, 100Base-T4 is best suited for use in workstations, where cost is an important issue. 100Base-T4 also runs over the more commonly installed types of cabling, and workstations are not likely to need full-duplex connections. 100Base-TX, on the other hand, is more desirable for network servers, which can take advantage of full-duplex mode, and in situations where it's easier to control the quality of the cabling.

The Fiber Alternative

The 100Base-FX fiber-optic option for Fast Ethernet offers the same types of advantages in traditional Ethernet and FDDI networks as fiber does. Namely, 100Base-FX offers extended distances, electromagnetic immunity, and increased security.

Like 10Base-T, 100Base-T allows a maximum distance of 100 meters between a repeater (i.e., a hub) and a node. Using fiber-optic cable, 100Base-FX increases this distance to a maximum of 185 meters. Between a server and a workstation, the maximum distance (with no repeater) is increased to 400 meters, and it can be as much as 2 kilometers when full-duplex mode is used.

The standard cable type for 100Base-FX is multimode fiber with a 62.5-micron core and 125-micron cladding. Only one pair of fibers is required—one for transmission and one for reception. This is the same type of cable that's commonly used in 10Base-FL Ethernet networks with ST bayonet-style connectors.

However, the new EIA-preferred connector is the SC-plug style. An SC connector has the advantage of being a push-on/pull-off connector (with no twisting required). Since it's keyed, there's no possibility of incorrectly connecting the transmit and receive cables. If your installed fiber-optic cable is already terminated with FDDI-compatible MIC connectors, then you can use an inexpensive MIC-to-ST converter.

The 100Base-FX standard will find its primary niche in the interconnection of repeaters to form a fiber-optic backbone. A typical company using this standard will have Fast Ethernet repeaters on each floor or in each department. Each of these repeaters will support 100Base-TX or 100Base-T4 workstations. The repeaters will then be interconnected using 100Base-FX links. When repeaters on different floors are connected, the fiber-optic cabling will provide protection from the electromagnetic noise often associated with elevators, and it will also enable longer cable runs between buildings.

Migration Strategies

Today there are many networks based not only on twisted-pair cabling, but also on thin-coaxial cabling with BNC connectors. Clearly, there must be a strategy that will allow today's networks to smoothly migrate to Fast Ethernet.

Many companies want to protect their investment in the cabling and connectors they've already installed. These companies should consider auto-sensing network adapters for their workstations. Such adapters can be used today for 10-Mbps Ethernet (either coaxial or UTP), and they can be used in the future for 100-Mbps Fast Ethernet. Such auto-sensing cards allow workstations to automatically switch to Fast Ethernet (when, for example, the servers and repeaters are upgraded) without the need for a LAN administrator to pop open each PC on the network and reconfigure DIP switches on the adapter card.

For those who are ready to install Fast Ethernet today—and need to do so gradually and keep some 10-Mbps devices—a number of options exist. Perhaps the simplest is to install a Fast Ethernet adapter in the existing server, alongside the 10-Mbps Ethernet adapter, and use this connection to support a Fast Ethernet repeater and workstations.

The Fast Ethernet standard is designed to provide flexible solutions for a wide variety of cabling situations. With the availability of 10/100 adapters, 10/100 adapters with BNC/coaxial support, and 10/100 switches, organizations should be able to migrate in a manner of their choosing. ■

Paul Cunningham is director of product marketing for Cogent Data Technologies, Inc. (Friday Harbor, WA). He can be reached on the Internet at paul@cogentdata.com or on BIX c/o "editors."

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Circle 88 on Inquiry Card.

WHAT'S NEW Hardware

PREVIEW MULTIFUNCTION MACHINES

HP Combines Color Copying with Printing

Color images are an integral part of business documents, but for many businesses, buying both a color copier and a color printer has been too expensive. Now, Hewlett-Packard has designed a combination color ink-jet printer and digital color copier for departments that use one or more color printers and have occasional need for color copies. The first-of-its-kind CopyJet is based on an enhanced DeskJet 1200C color-printing engine and the ScanJet 3C scanning engine.

You use the CopyJet's copier function like a traditional copier. On the top, it has a double-hinged removable document cover and a full-size flatbed copy surface, which can handle documents of up to 8.5 by 14 inches. The front panel, which has print settings grouped on the left side and copy settings grouped on the right side, lets you adjust color, reduce originals by 50 percent or enlarge them by up to 400 percent, adjust lightness and darkness, and make up to 99 copies. The front-loading paper tray holds up to 180 sheets of plain or glossy paper or 50 sheets of transparency film. The output tray, which is located on the front of the unit, holds 100 sheets of paper. The standard CopyJet has 5 MB of memory. The unit BYTE tested had 8 MB of extra memory.

CopyJet Color Printer-Copier
Base price, $2949;
as configured for testing with 8 MB of extra memory, $3074

Hewlett-Packard Co.
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Call local HP dealer
fax: (800) 333-1917
http://www.hp.com
Circle 998 on Inquiry Card.

The CopyJet makes copies at a resolution of 300 dpi. We copied a color document in normal mode and found it to be near-photographic quality, which should be more than adequate for most businesspeople. The CopyJet offers buttons for Original Is Photo, Emphasize Light Colors, and High Quality, so you can make adjustments for better-quality copies. Next, we printed a bit-map screen capture, which included a color bar graph, monochrome text, and four scanned color photographs; an eight-page Excel spreadsheet; and a document with monochrome text—all in normal mode. The CopyJet took 1 minute and 52 seconds to print the screen capture, 8 minutes and 34 seconds for the eight-page spreadsheet, and 19 seconds for the one-page document.

The CopyJet provides high-quality color copies and color ink-jet printing for companies that now take their color copying jobs to service bureaus or for individual departments who want more color capability.

—Martha Hicks

133-MHZ PENTIUM NOTEBOOK

Tadpole's P1300 (from $6995) features 8 to 128 MB of RAM, a 256-KB secondary write-back cache, a 64-bit memory interface, up to 1.2 GB of removable SCSI-2 disk storage, a high-bandwidth PCI local bus, an 800- by 600-pixel 10.4-inch active-matrix TFT color screen, a PC Card slot supporting one Type III card or two Type I or II PC cards, a pointing stick, an external 3½-inch floppy drive, and an internal NiMH battery. A mini-docking station ($1695) provides the direct I/O ports and additional interfaces for SCSI, stereo audio I/O, an external keyboard, and a serial port. A full docking station ($2995) offers multiple mass-storage options, network connectivity, and add-in-card expandability.

Contact: Tadpole Technology, Inc., Austin, TX, (800) 232-6656 or (512) 219-2200; http://www.tadpole.com.

Circle 1001 on Inquiry Card.

COMPUTER-TO-TV ADAPTER LINE

With Presenter TView ($449), you can display Mac- and PC-generated images on standard TVs and, with a VCR, record presentations directly to videotape. The external adapter is compatible with RGB, multisync, and VGA monitors. It produces a stable and clear image in composite and S-Video signal modes. The Electronic Marker software lets you highlight computer-generated presentations as you would overhead transparencies.

Contact: Consumer Technology Northwest, Inc., Beaverton, OR, (800) 356-3983 or (503) 643-1662.

Circle 1002 on Inquiry Card.

300-MIPS WORKSTATION

Powered by a 64-bit, 275-MHz Alpha 21064A microprocessor, the Viper 275 delivers 347 MIPS and runs under Windows NT, OSF/1, and VMS. The workstation includes 512 MB of RAM, 2 MB of static cache memory, PCI video with 1600- by 1280-pixel graphics, up to 28 GB of internal disk capacity without RAID, two PCI and three ISA expansion slots, 10 internal storage bays, and a 450-W power supply (from $28,000).

Contact: National Computers Plus, Tulsa, OK, (800) 522-2910 or (918) 664-0690; http://www.ncpi.com.

Circle 1003 on Inquiry Card.

TWO FLAT-PANEL LCD MONITORS ▼

The 10.4-inch M104 active-matrix color monitor ($2850) allows you to simultaneously access 262,144 colors for true-color display and photo-realistic full-motion video. The M104m, which is a 10.4-inch monochrome monitor ($735), uses STN technology for a high-speed refresh rate and display clarity with 28 levels of gray scale.

Contact: Qume, Inc., San Jose, CA, (800) 457-4447 or (408) 473-1500; http://www.qume.com/qume/.

Circle 1007 on Inquiry Card.

WINDOWS 95 TRACKBALL

The WinTrac 95 ($139) system combines a MicroSpeed trackball and software. The hardware includes a trackball, a trackwheel, and three buttons. For drag-and-drop operations, an auto-drag feature lets you drag-lock any button when holding it down for a fixed time interval. The software includes the MicroSpeed Protected Mode Windows 95 32-bit device driver, the WINTRAC.CPL control panel for Windows 95, and the WinTrac applications interface software for Windows 95.

Contact: MicroSpeed, Inc., Fremont, CA, (800) 438-7733 or (510) 490-1403; http://www.microspeed.com.

Circle 1017 on Inquiry Card.

MULTIMEDIA PENTIUM NOTEBOOK

The ChemBook Model 5400 and 5d Model 4100 notebooks (from $3450) come with double-speed or optional quad-speed CD-ROM drives, an 11.3-inch dual-scan or 10.3-inch TFT active-matrix screen, a touchpad, a joystick, a Microsoft Sound System– and Sound Blaster Pro–compatible 16-bit stereo sound system with a microphone and speaker, 1 MB of VRAM (expandable to 2 MB), and a 32-bit PCI video bus and Windows accelerator. Standard features include a 75-, 90-, 100-, or 120-MHz Pentium processor; 256 KB of L2 cache memory; 8, 16, or 32 MB of RAM; removable 340-MB, 500-MB, 810-MB, or 1-GB hard drives; a removable 1.44-MB floppy drive (to exchange an MPEG Plus video module); a high-speed serial port; PC Card slots; and power management.

Contact: Chem USA Corp., Hayward, CA, (800) 866-2436 or (510) 785-8080; fived@hoked.net.

Circle 1004 on Inquiry Card.

▲ RUGGEDIZED HAND-HELD COMMUNICATOR

Operating on Motorola's 800-MHz Private DataTAC network using MDC or RD-LAP protocols, the Forte Wireless CommPad (about $5500) provides real-time access to information when and where you need it. The 4-pound device includes a 486 CPU; a VGA-compatible LCD screen; an internal radio modem, communicating at up to 19.2 Kbps; support for two PC Card Type II slots or one Type III slot; a microphone; a voice-quality speaker; and Windows 3.1 with Pen Extensions. An optional vehicle docking station simultaneously charges the battery and a spare battery and provides a serial port.

Contact: Motorola, Inc., Schaumburg, IL, (800) 247-2346 or (708) 576-1000; http://www.mot.com.

Circle 1006 on Inquiry Card.

NUMERIC KEYPADS FOR PORTABLES

The Micropad 627 (about $85) offers 21 keys, three of which you can assign as the Windows 95 special-access keys, and a pass-through serial interface. GenCalc, an included pop-up 10-key adding-machine program, provides the functionality of a paper-tape adding machine on-screen.

The AddPoint combines the Micropad 627 with a GlidePoint trackpad. In addition to high-speed numeric input, you can move, click, drag, and highlight by simply moving your finger across the high-resolution surface. The AddPoint 628 is for PCs (about $120); the AddPoint 629 is for Macs (about $128).

Contact: Genovation, Inc., Irvine, CA, (800) 822-4333 or (714) 833-3355; http://www.genovation.com.

Circle 1005 on Inquiry Card.

PROGRAMMABLE TRACKBALL FOR THE MAC

Turbo Mouse 5.0 ($109.99) offers four programmable buttons, which you can program independently to perform common tasks and to group together frequently used commands. You can adjust the movement of the mouse on-screen, instantly jump to predefined hot spots on the screen, automatically move the cursor to the default button in any dialog box, and monitor mouse and keyboard use to remind yourself to take a break at specified intervals.

Contact: Kensington Microware, Ltd., San Mateo, CA, (800) 535-4242 or (415) 572-2700; info@kensington.com.

Circle 1008 on Inquiry Card.

DESKTOP Z-STATIONS

The Z-Station VP systems support Windows 95, Plug and Play technology, and DDC1. The machines include a 66-MHz 486DX2 or a 75- or 90-MHz Pentium; 256 KB of cache memory; 8 MB of RAM; a 540-MB, 850-MB, or 1.2-GB hard drive; 1 MB of video DRAM; and a standard desktop, space-saver desktop, or mini-tower cabinet (from $1585). You can add a quad-speed CD-ROM drive, 16-bit Sound Blaster audio, speakers, a microphone, a write-back cache, and memory, CPU, and video-DRAM upgrades.

Contact: Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000; http://www.zds.com.

Circle 999 on Inquiry Card.

COLOR PRINTERS FOR SILICON GRAPHICS WORKSTATIONS

Two color printers provide dye-sublimation and thermal-wax printing technologies for Silicon Graphics workstations. The Professional ColorPoint 2 RSF Models 4 and 14 include high-speed SCSI connectors, raster controllers, and Silicon Graphics' Iris Impressario 1.2 driver plug-in to optimize the workstation's output capabilities. The Model 4 ($6999) prints up to A-size bleed, and the Model 14 ($12,499) prints up to B-size bleed. Some key features include high-resolution 300 dpi in both modes and single-sheet bypass.

Contact: Seiko Instruments USA, Inc., San Jose, CA, (800) 888-0817 or (408) 922-5900.

Circle 1009 on Inquiry Card.

PC CARD HARD DRIVES FOR POWERBOOKS

Compatible with System 7.5, two PC Card hard drives for Apple PowerBooks offer 12-ms access times, an MTBF rating of 250,000 hours, and data transfer rates of 3.5 MBps for the MI PocketDrive 170MB ($429) and 5.7 MBps for the MI PocketDrive 260MB ($649).

Contact: Memory International, Irvine, CA, (800) 266-0488 or (714) 453-8008.

Circle 1010 on Inquiry Card.

PUT PAPER TO WORK

PaperPort Vx for Windows and the Macintosh offers business-card management with Corex CardScan software, copy-machine functions with PictureWorks Copier, document editing with Caere OmniPage Lite, and auto-launch technology that configures PaperPort Vx to move scanned documents instantly into the programs you use most. It also includes more than 20 new links to fax, word processing, OCR, copy, E-mail, spreadsheet, forms, document management, business-card, contact management, and image-editing software. The AnyPort interface allows you to connect PaperPort Vx ($369) to serial or parallel ports, and the SharpPage technology improves fax quality.

Contact: Visioneer, Inc., Palo Alto, CA, (800) 787-7007 or (415) 843-3999.

Circle 1011 on Inquiry Card.

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WHAT'S NEW

A MOUSE/TRACKBALL ALTERNATIVE

Designed to conquer the problem of repetitive-stress injuries, Felix ($119) is an input device that has a finger-activated handle that moves within a 1-inch-square tracking system. Felix automatically adjusts to any size screen or screen resolution, and it requires no mouse pad or special surface.

Contact: Altra, Rawlins, WY, (800) 726-6153 or (307) 328-1342.

Circle 1015 on Inquiry Card.

QUAD-SPEED SEVEN-DISC JUKEBOX

The CDJ 7004 ($399) supports CD-ROM, CD-DA, CD-ROM XA, and Photo CD (multisession) discs. It features push-button loading, a 128-KB buffer, a data transfer rate of 600 KBps (sustained quad-speed) or 2.8 MBps in burst mode, and an average access time of 340 ms. The front panel sports controls for audio CDs and a stereo headphone jack; the rear panel has RCA-type phono jacks. The unit automatically selects discs without requiring you to know the slot number.

Contact: Smart and Friendly, Chatsworth, CA, (800) 959-7001 or (818) 772-8001; 75162,2367@compuserve.com.

Circle 1013 on Inquiry Card.

8-MM TAPE BACKUP KIT FOR LANS

A tape-drive kit for NetWare and Windows NT users contains the EXB-8700, an external 8-mm tape drive with 14 GB of compressed capacity (7 GB native) and a transfer rate of 60 MBpm (compressed, 30 MBps native); a CD-ROM that lets you select backup software from a choice of Arcada Backup Exec for NT, Arcada Backup Exec for NLM, Cheyenne ARCserve for NetWare (Windows edition), and Palindrome Backup Director for NLM; an Adaptec SCSI-2 host-adapter card and Adaptec EZ-SCSI software; Adaptec CI/O software, which allows system administrators and network managers to remotely profile performance and diagnose problems of SCSI devices from a Windows-based client; an Exabyte 12c cleaning cartridge; Exabyte's Exatape 160mXL 8-mm data cartridge; cables; and media ($2695).

Contact: Exabyte Corp., Boulder, CO, (800) 392-2983 or (303) 442-4333.

Circle 1021 on Inquiry Card.

6-PPM LASER PRINTER

Up to three users running Windows for Workgroups 3.11 can share the KX-P6500 ($595), a 2400- by 600-dpi laser printer. Up to 25 users can share it via an optional software upgrade. You can adjust brightness and contrast, print on both sides of the page in book or report style, overlay an image on any document printed in GDI mode, print two or four pages on a single letter-size sheet, and enlarge or reduce the print page from 10 percent to 500 percent. The multipurpose paper tray accepts up to 100 sheets of 20-pound paper, 10 envelopes, 30 labels, or 30 transparencies.

Contact: Panasonic Communications & Systems Co., Secaucus, NJ, (800) 742-8086 or (201) 348-7000.

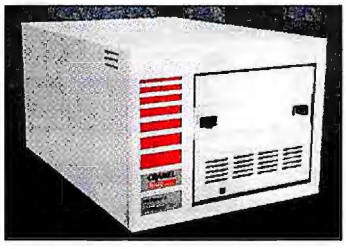
Circle 1000 on Inquiry Card.

FULL-MOTION/FULL-SCREEN DIGITAL PLAYBACK

Powered by S3's Trio64V+ chip, which provides GUI acceleration, video scaling, signal mixing, RGB/YUV conversion, synchronization, and DAC output to the CRT, the Powergraph 64 Video PCI controller displays video output from NTSC/PAL tuners or decompressed CD-ROM video on SVGA monitors. In the 2-MB DRAM configuration ($229), the controller supports 64-bit graphics resolutions at refresh rates of up to 160 Hz. The Powergraph 64 is available in an upgradable 1-MB version ($189). It supports a daughtercard option for MPEG-1 audio/video hardware playback.
Contact: STB Systems, Inc., Richardson, TX, (214) 234-8750; http://www.stb.com.
Circle 1020 on Inquiry Card.

FAST ETHERNET STARTER KIT

First-time 100Base-T users can evaluate the technology for $995. The Fast Ethernet Starter Kit includes Grand Junction's FastHub 100 VL four-port 100Base-TX repeater and two 100Base-TX Intel EtherExpress Pro/100 PCI adapters.
Contact: Grand Junction Networks, Inc., Fremont, CA, (800) 950-3365 or (510) 252-0726; info@grandjunction.com.
Circle 1014 on Inquiry Card.



RAID SUBSYSTEM ▲

Providing up to 20 GB of magnetic storage, the RAIDworks 1000 subsystem mounts its IDE drives in frame-based carriers that connect to the hardware controller through a PCB-based slot connector. The only cable necessary is the one from the subsystem to the SCSI host adapter. There are two models.

The C510-xx (from $5616) is an internal or external five-drive model with drive capacities ranging from 850 MB each up to 1.624 GB each, resulting in 6.4 GB of total drive capacity. The C1010-xx (from $8274) is an external 10-drive unit.
Contact: Cranel, Inc., Columbus, OH, (800) 288-3475 or (614) 431-8000; http://www.cranel.com.
Circle 1016 on Inquiry Card.

RUGGEDIZED RACK-MOUNT TOUCH MONITOR

The TruePoint IC-20 ($3850) combines MicroTouch's capacitive touchscreen technology with a 20-inch Intecolor E02154 monitor. The unit is optically bonded for added strength and gasket-sealed for water tightness. It has a protective glass overcoat for scratch and wear protection. The capacitive analog touch technology is immune to interference from factors such as dirt, vibration, and ambient light. The monitor has a maximum video resolution of 1024 by 864 pixels, a video bandwidth of 75 MHz, a vertical scan frequency of 45 to 90 Hz, a horizontal scan frequency of 30 to 56 kHz, and a touchscreen resolution of 1024 by 1024 pixels.
Contact: MicroTouch Systems, Inc., Methuen, MA, (800) 642-7686 or (508) 659-9000; touch@MTS.compuserve.com.
Circle 1012 on Inquiry Card.

DATA STORAGE AND RETRIEVAL

For simultaneous multiuser drive access to information, the Hot-Swap SCSI TowerDrives come in three models. Seven drives are in the MiniTower range, up to 16 drives in the TowerDrive range, and up to 32 CD-ROM drives in the TwinTower range (call for prices). In addition to CD-ROM drives, the systems are able to house 1- and 2-GB hard drives, 2-GB MO drives, and 4-mm DAT and 8-mm tape drives.
Contact: TAC Systems, Inc., Huntsville, AL, (205) 721-1976; http://www.tacsys.com.
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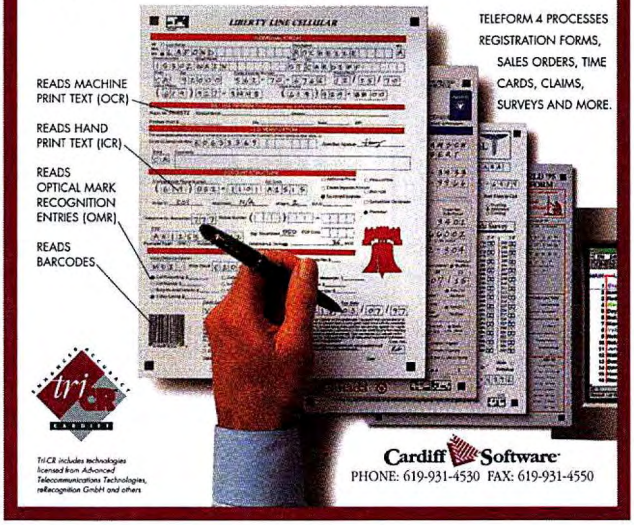

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WHAT'S NEW Software

PREVIEW **WINDOWS 95 FAX SOFTWARE**

WinFax Pro 7.0 Delivers More-Reliable Faxing

Windows fax programs have many advantages over stand-alone fax machines. With fax software, you can easily schedule fax broadcasts for off-peak hours, maintain multiple phone books, and create fax cover pages. However, too many times when I used Windows 3.1–based fax programs, a fax operation that was running in the background (e.g., sending a big fax) would interrupt an application running in the foreground (e.g., a word processor). As the fax program monopolized my system, I found myself staring at the dreaded hourglass as I tried to use my foreground application.

WinFax Pro 7.0 . . . . . $129
Delrina Corp.
Toronto, Ontario, Canada
(800) 268-6082
(416) 441-3676
fax: (416) 441-0333
http://www.delrina.com
Circle 1024 on Inquiry Card.

Delrina's WinFax Pro 7.0 for Windows 95 changes that. Thanks to support for Windows 95's improved multitasking, the beta version of WinFax Pro 7.0 that I previewed, which should be released this month, had no problem sending a fax in the background without interrupting me as I checked spelling on my word processing document in the foreground. Version 7.0's improved multitasking is good news if you use a PC as your primary fax device.

Version 7.0 also makes use of multithreading for smoother operation. Many tasks such as file I/O, printing, and compression are now performed on separate threads. For example, the program can print a hard-copy confirmation of a successful fax transmission seamlessly in the background, a feature that makes it easier to track faxes for billing purposes than the two-step process of cutting and pasting from WinFax's send log. The same is true for WinFax Pro 7.0's support for MR compression, a standard for sending faxes up to 30 percent faster.

Other new features include consistent support for gray-scale faxing; integration of Xerox's TextBridge 3.0 OCR engine, for better fax-to-text conversion; and integration with other messaging software through MAPI, which lets mail-centric users access WinFax capabilities through Microsoft Exchange.

If you send a lot of faxes from your PC, WinFax Pro 7.0 provides a compelling reason to upgrade to Windows 95.

—Dave Andrews

FINANCIAL FORECASTING FOR WINDOWS

With Cashe ($1995), you can analyze common business issues, such as preparing a strategic business plan, evaluating an acquisition/merger, understanding how much debt or equity you can raise, or analyzing a price or product mix change. You can produce pro forma statements, sensitivity analyses, and valuation models, graphs, and reports to obtain a clear picture of the future course of your business and to adjust plans and resources to achieve desired targets.
Contact: Business Matters, Inc., Waltham, MA, (800) 993-3600 or (617) 899-8700; info@bmatters.com.
Circle 1038 on Inquiry Card.

MANAGE WORK FLOW OVER THE INTERNET

With Track-It and a World Wide Web browser, team members from remote sites can complete, assign, negotiate, collaborate on, communicate about, and participate in various work processes through the Internet. Track-It ($800 per license) is available for DOS/Windows, OS/2, and Unix platforms.
Contact: UES, Inc., Dublin, OH, (614) 792-9993; http://www.columbus.ues.com/.
Circle 1027 on Inquiry Card.

DESKTOP-TO-UNIX CONNECTIVITY

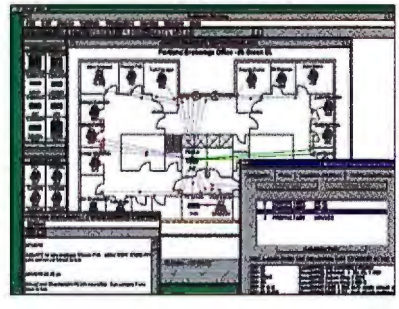
Fully X Window System 11 release 6–compliant, XoftWare 4.0's ($395 for a single-user license) user interface transforms the Unix desktop into a Windows 95–like application. Remote file management and connectivity applications include Network File Manager with drag and drop, OLE 2.0 compliance, and improved printing, sorting, file transfer, and messaging capabilities; remote-access utilities; NFS; VT320 terminal emulation; and VxD-based TCP/IP software.
Contact: AGE Logic, Inc., San Diego, CA, (800) 742-5243 or (619) 755-1000; http://www.age.com.
Circle 1028 on Inquiry Card.

COMPUTER/TELEPHONE INTEGRATION KIT

Show N Tel 3.0 (two-line version, $995; with support for four lines or more, $2995) helps you build voice, fax, call-processing, E-mail, speech-recognition, call-center, and multimedia-messaging applications under OS/2 and Windows NT. New graphical program design objects provide tighter PBX and switch control, in-chassis switching, text-to-speech messaging, and interactive fax functions. Version 3.0 provides support for more than 25 desktop, server, and mainframe databases; a graphical debugger, with break and watch points; a graphical navigation utility; advanced event handling; a graphical voice recorder; and message-storage and retrieval facilities.
Contact: Technically Speaking, Southborough, MA, (508) 229-7777.
Circle 1030 on Inquiry Card.

NETWORK DESIGN TOOL FOR WINDOWS

Using object-oriented technology, NetSuite::Professional Design ($495) builds intelligent models of your organization's network devices and media. The package supports logical and physical representations of LANs, WANs, and MANs; allows real-time validation of designs from topology to transceivers, and connection and domain validation for major network protocols; and prepares work-order activity logs and bills of materials. You can easily query the design database or use it to prepare asset management and other reports. NetSuite::Library (per year, $295) contains over 50 vendor product families and over 2500 devices, adapters, and accessories.



Contact: NetSuite, Wayland, MA, (508) 647-3100; http://www.netsuite.com.
Circle 1032 on Inquiry Card.

VISUAL INFORMATION MANAGEMENT FOR WORKGROUPS

Vineyard 2.0 (single-user version, $295) transforms a LAN into a repository of shared information for all members of your workgroup. You can manage contacts, projects, and documents; send and receive E-mail; write letters and memos; perform calculations; and manage files produced with Windows applications. Three levels of protection determine access privileges for users, and Vineyard 2.0 can grant privileges in any combination. In addition, Vineyard 2.0 encrypts all messages sent over the network.

Contact: Data Fellows, Inc., San Jose, CA, (408) 244-9090; http://www.DataFellows.com/.

Circle 1033 on Inquiry Card.

BACKUP AND RESTORE FOR SILICON GRAPHICS USERS

FalconFastBack can back up multiple file systems concurrently on 8-mm and DAT tapes at a rate of 45 MB per minute. The backup is portable to most Unix systems. In addition, you can access FalconFastBack ($2499) locally or remotely.

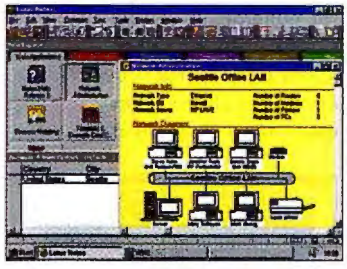
FalconFastBack can restore crashed drives with automatic drive reconfiguration, automatic drive recovery, automatic boot-disk set construction, automatic snapshot of drive geometry, and hands-free recovery after crash/drive replacement.

Contact: Falcon Systems, Inc., Sacramento, CA, (800) 326-1002 or (916) 928-9255; http://www.falcons.com.

Circle 1034 on Inquiry Card.

ENTERPRISE-WIDE DRAWING AND DIAGRAMMING

Visio 4.0's ($249) and Visio Technical 4.0's ($399) optimization for Windows 95 includes Quick View previews of Visio drawings and diagrams and true preemptive multitasking. Visio 4.0 includes perspective block diagrams and mind-mapping charts as well as flowcharts, organizational charts, project time lines, network diagrams, office layouts, quality management diagrams, geographic maps, database connectivity, and the ability to associate detailed data with shapes in a diagram.



Visio Technical 4.0 lets you create and share 2-D drawings and technical schematics with enhanced AutoCAD integration. An append option allows you to add information on top of an imported DWG file. New drawing tools include a fixed grid for increased accuracy, object-snap capabilities for exact placement of geometry, new intersect and subtract commands, and a B-spline tool.

Contact: Visio Corp., Seattle, WA, (800) 248-4746 or (206) 521-4500; http://www.visio.com.

Circle 1037 on Inquiry Card.

INTERFACE OPTICAL DRIVES UNDER SUNOS

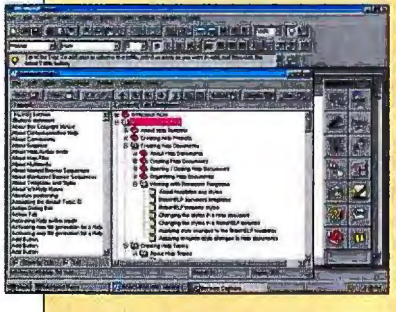
With MO-SOL 5 and a host PC running Solaris 2.x or SunOS, you can access gigabytes of information stored on one or more optical disks using erasable media. The package ($450) includes a device driver, operation and diagnostic utility programs, and a GUI. An optional developer's package includes C libraries for building applications that need to closely interact with the optical drive.

Contact: Instar Corp., Calgary, Alberta, Canada, (403) 264-7274; sales@instar.com.

Circle 1039 on Inquiry Card.

HELP AUTHORING FOR WINDOWS 95

Whether you are creating help systems for Windows 95, 3.x, and NT or moving your current Windows 3.x help systems to Windows 95, WinHelp Office 95 may interest you. The package ($599) includes RoboHelp 95, SmartHelp OLE Control, the WinHelp Video Kit, the WinHelp Tool Kit, Mastering WinHelp, the WinHelp HyperViewer, and the Moving to WinHelp 95 Kit (also available separately for $199).



RoboHelp 95 supports such Windows 95 help engine features as Contents Tab, What's This?, Context Help, A-links, K-links, multimedia, authorable buttons, 27 new macros, secondary windows, and secondary window startup macros. The WinHelp Video Kit includes a software videocamera that lets you capture on-screen actions and create "live" video product demonstrations and tutorials.

Contact: Blue Sky Software Corp., La Jolla, CA, (800) 459-2356 or (619) 459-6365; http://www.blue-sky.com.

Circle 1025 on Inquiry Card.

Software Update

Available in English, French, German, and Japanese, **StatView 4.5 for the Macintosh**, a data-analysis program, includes survival analysis, quality control, Excel read/write capabilities, data management, more than 20 new analysis and graphing templates, criteria labels, importing and speed enhancements, and an implementation of Apple Guide. $595.

Contact: Abacus Concepts, Inc., Berkeley, CA, (800) 666-7828 or (510) 540-1949; info@abacus.com.

Circle 1042 on Inquiry Card.

The Boxer/DOS, Boxer/TKO, and Boxer OS/2 text editors are now available in version 7.0. They include a macro-list interface for simultaneously loading and accessing up to 100 macros, an anchor-list interface for defining and accessing up to 20 text anchors, file locking, a paragraph reformat command, an undo granularity command, previous change and next change commands, a reset changes command, and a save-as command. Boxer/DOS, $50; Boxer/TKO and Boxer OS/2, $89 each.

Contact: Boxer Software, Peterborough, NH, (800) 982-6937 or (603) 924-6602; http://www.boxersoftware.com/users/dhamel.

Circle 1043 on Inquiry Card.

Able to read single-page forms with unlimited zones and up to 255 data fields, as well as multilingual text, handwritten numerals, bar codes, and check marks, **Recognita Form 2.0** lets you scan and process/proof at separate workstations within a network, with three methods for correcting recognition results. $2500.

Contact: Recognita Corp. of America, Sunnyvale, CA, (800) 225-4627 or (408) 241-5772.

Circle 1049 on Inquiry Card.

WHAT'S NEW Software

TRITEAL ENTERPRISE DESKTOP

An implementation of the Common Desktop Environment, TED 4.0 ($425) has features such as TEDvision, an Internet browser; TEDsecure ($200), an optional NSA Fortezza–based security solution; TEDfax; and GWM, a graphical workspace manager. Version 4.0 includes WinTED, which lets you run a Unix session and a Windows session concurrently at native speed on a PC, and LocalTED, which runs TED clients locally on X Window System terminals, optimizing speed and communication between an X terminal and a host system running TED.

Contact: TriTeal Corp., Carlsbad, CA, (800) 874-8325 or (619) 930-2077; info@triteal.com.

Circle 1035 on Inquiry Card.

32-BIT DISTINCT TCP/IP SDK

The 32-bit version of Distinct TCP/IP SDK Visual Edition contains OLE controls for Windows Sockets, telnet, FTP, TCP server, SMTP, POP2/POP3, NNTP, RCP, Rlogin, Rshell, Rexec, and VT220. Therefore, you can quickly integrate Internet-type activities into your applications. The package ($295) provides a networking solution for building customized 32-bit TCP/IP and Internet applications for Windows 95 and NT.

Contact: Distinct Corp., Saratoga, CA, (408) 366-8933; http://www.distinct.com.

Circle 1040 on Inquiry Card.

32-BIT VIDEO SPECIAL EFFECTS ▲

With PhotoMorph 2 for Windows NT, you can utilize RISC workstations to produce videos. The program provides such effects as video transitions and distortions, morphing, chroma keying, blue screening, alpha-channel overlays, and video colorizing. PhotoMorph 2/NT ($399) includes support for symmetric multiprocessing, support for digital video in all effects, nonlinear video editing, 256,000 combinations of transitions and wipes, titling of video clips with support for TrueType and PostScript fonts, multiple layering of image effects, and storyboarding and composition of multiple clips.

Contact: North Coast Software, Inc., Barrington, NH, (603) 664-6000; http://cbix.unh.edu/ncs.htm.

Circle 1036 on Inquiry Card.

COLLABORATIVE DEVELOPMENT FOR WINDOWS 95 AND NT

A collaborative development system for Windows 95, NT, and 3.11, StarTeam (call for price) integrates version-control, defect-tracking, electronic-conferencing, auditing, and reporting systems that include charting capabilities. In addition, StarTeam integrates into Microsoft Visual C++, so you can access version control, defect tracking, and electronic conferencing within Visual C++.

Contact: StarBase Corp., Irvine, CA, (714) 442-4400; http://www.starbasecorp.com.

Circle 1041 on Inquiry Card.

GROUP CONNECTION FOR NETWORK WINDOWS USERS

Multiple Windows users can share screens and keyboards across Novell LANs or WANs and still retain that same group-connection capability in DOS. One Close-Up/LAN Pro (basic package for two users, $399) user simply selects from a pull-down menu to initiate connection to an entire group. All users can then view and control the same Windows and DOS applications running on a host PC. A modem version lets you access your network from home or when you're on the road.

Contact: Norton-Lambert Corp., Santa Barbara, CA, (805) 964-6767; 72662.327@compuserve.com.

Circle 1029 on Inquiry Card.

VISUAL SPECIAL EFFECTS FOR WINDOWS

An image-editing and visual special-effects program, Sentfactor Paint ($149.99) offers drawing, painting, and cropping tools. It also features image-manipulation capabilities, modification of image attributes, and special effects (e.g., emboss, pixelate, color wash-out, and stain). You can input live video capture from boards and scanners, copy one area of your image to another, expand or compress irregularly shaped sections of an image, and create tiled backgrounds out of bit-mapped images.

Contact: Sentfactor, Inc., Lakeland, FL, (941) 647-3220; 74774.3465@compuserve.com.

Circle 1026 on Inquiry Card.

Software Update

The **Disk Manager 7.0** disk-installation utility supports Windows 95, Windows NT, and OS/2 Warp; configures disk drives larger than 528 MB; eliminates the need to manually select drive models and parameters; automatically configures drives for the highest performance setting allowed by the drive controller; and enables IDE disk drives to read and write multiple sectors of data at one time. $124.95.

Contact: Ontrack Computer Systems, Eden Prairie, MN, (800) 752-1333 or (612) 937-1107; http://www.ontrack.com.

Circle 1046 on Inquiry Card.

A browser companion tool for Windows and the Mac, **GrabNet 2.0** provides a hierarchical list of folders and objects. It lets you export GrabNet objects as HTML, rearrange the initial order of folders and objects from the browser, and paste text or images into existing GrabNet objects. $19.95.

Contact: The ForeFront Group, Inc., Houston, TX, (800) 867-1101 or (713) 961-1101; info@ffg.com.

Circle 1045 on Inquiry Card.

Kurzweil Voice for Windows release 1.5 is a voice-recognition system that allows you to run your Windows-based PC using voice. It comes with a continuous digit recognizer running simultaneously with an enhanced discrete speech-recognition engine, on-line knowledge (including acoustic recognition models), and spellings for up to 200,000 words. With an Mwave WindSurfer sound board and a Shure VR 230 headset microphone, $995.

Contact: Kurzweil Applied Intelligence, Inc., Waltham, MA, (800) 380-1234 or (617) 893-5151; http://www.kurz-ai.com.

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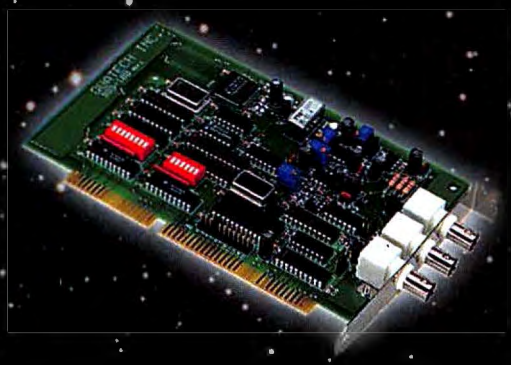

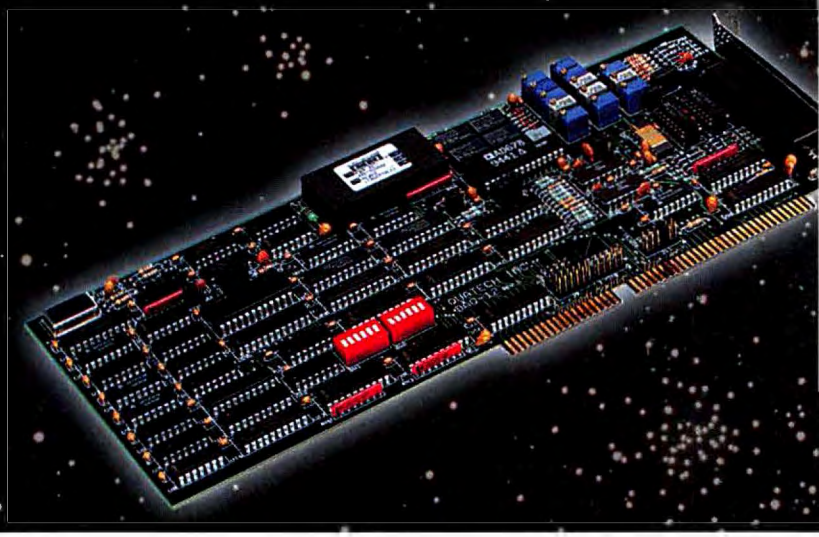

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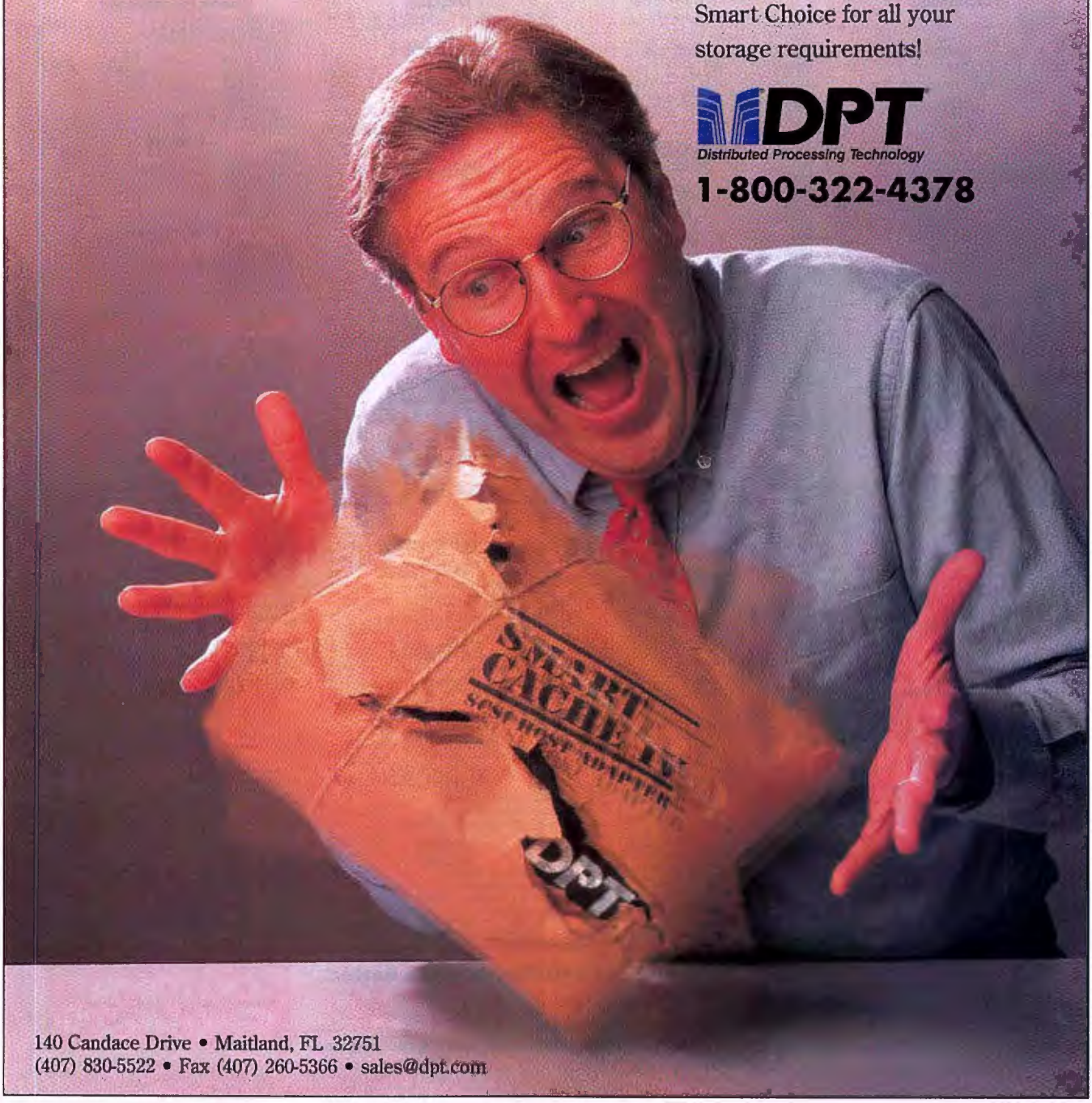

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90MHz Pentium

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Portégé 610CT

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- Accupoint stick for easy control

Processor	Screen	HD	Price
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- Built-in infrared for wireless communications

Satellite Pro 400

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	772MB	$3479
Pentium 75	10.4" Active	772MB	4359

Satellite Pro 410

Processor	Screen	HD	Price
Pentium 90	11.3" Dual Scan	772MB	CALL
Pentium 90	11.3" Active	772MB	CALL

Satellite 2110/2130

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	330MB	$1979
486DX4/75	10.4" Dual Scan	500MB	2339
486DX4/75	10.4" Active	500MB	3059

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Versa 2000

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Processor	Screen	HD	Price
486DX4/75	9.5" Active	350MB	$2299*
486DX4/75	9.5" Active	350MB	2599
486DX4/75	9.5" Active	540MB	2799

*14.4 fax/modem not built-in

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NEC Versa 4000

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Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	540MB	$3499
Pentium 75	10.4" Dual Scan	540MB	3799*
Pentium 75	10.1" Active	540MB	3999
Pentium 90	10.1" Active	810MB	4649*
Pentium 90	10.4" High Res.	810MB	4799

* Features built-in CD-ROM drive standard

TEXAS INSTRUMENTS

Extensa 550CD

Extensa 550/550CD

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- Integrated touchpad pointer
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- Built-in infrared for wireless communications

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	524MB	$2449*
Pentium 75	10.4" Dual Scan	524MB	2939
Pentium 75	10.4" Active	524MB	3519

*CD-ROM Drive is an optional accessory on this model

Extensa 450

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Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	340MB	$1769
486DX4/75	9.5" Active	340MB	2039

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Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	500MB	$2969
Pentium 75	10.4" Active	772MB	3999
Pentium 90	10.4" Active	1.2GB	4649

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Processor	Screen	HD	Price
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Pentium 75	10.4" Dual Scan	800MB	2879
Pentium 75	10.4" Dual Scan	1.2GB	3249
Pentium 75	10.4" Active	800MB	3799
Pentium 75	10.4" Active	1.2GB	4199
Pentium 90	10.4" Dual Scan	800MB	3259
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Processor	Screen	HD	Price
486DX2/50	10.4" Active	360MB	$2199
486DX2/50	10.4" Active	540MB	2399
486DX4/75	10.4" Dual Scan	360MB	2649
486DX4/75	10.4" Dual Scan	540MB	2949
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486DX4/75	10.4" Dual Scan	720MB	3299
486DX4/75	10.4" Active	720MB	3879

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- SoundBlaster-compatible audio & telephony
- Lithium Ion battery technology

Processor	Screen	HD	Price
Pentium 90	10.4" Active	720MB	$5349
Pentium 90	12.1" Active	720MB	6049
Pentium 120	12.1" Active	720MB	6599
Pentium 90	12.1" Active	1.2GB	7449*

*Features built-in CD-ROM drive

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486DX4/75	10.4" Dual Scan	420MB	$2459
486DX4/75	10.4" Active	420MB	3029
486DX4/100	10.4" Dual Scan	720MB	2839
486DX4/100	10.4" Active	720MB	3499

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LTE 5000

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Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	510MB	$3799
Pentium 75	11.3" Dual Scan	810MB	4439
Pentium 75	10.4" Active	810MB	4729
Pentium 90	10.4" Active	810MB	5289
Pentium 90	10.4" Active	810MB	5549*
Pentium 120	10.4" Active	1.35GB	6329

Features Built-In CD-ROM drive

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Processor	Screen	HD	Price
Pentium 90	10.4" Active	1.2GB	$5579
Pentium 90	10.4" Active	1.2GB	6239*

*16MB RAM standard

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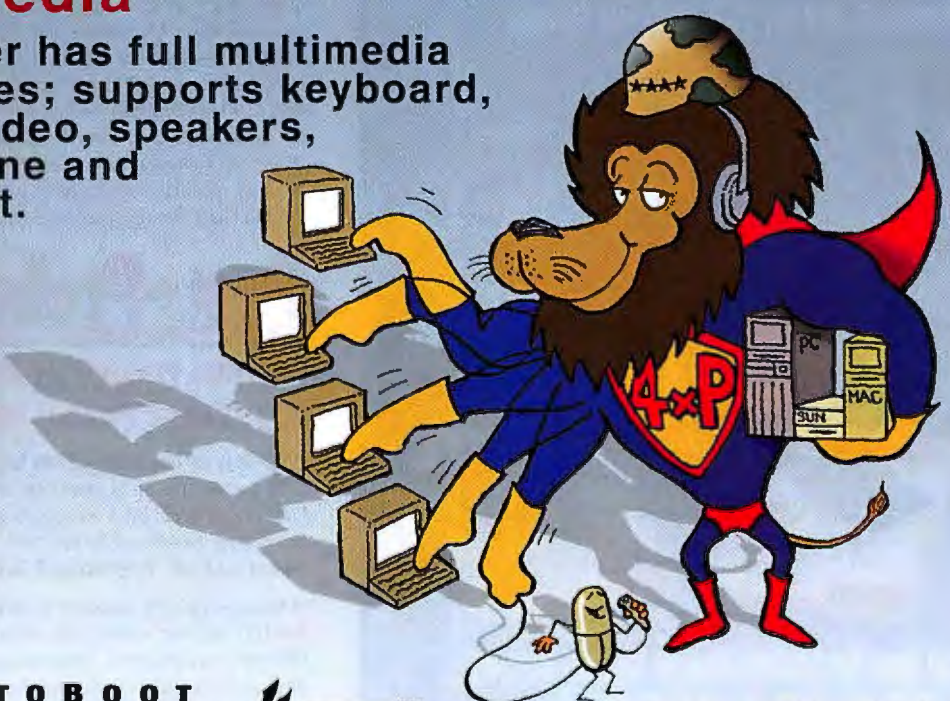

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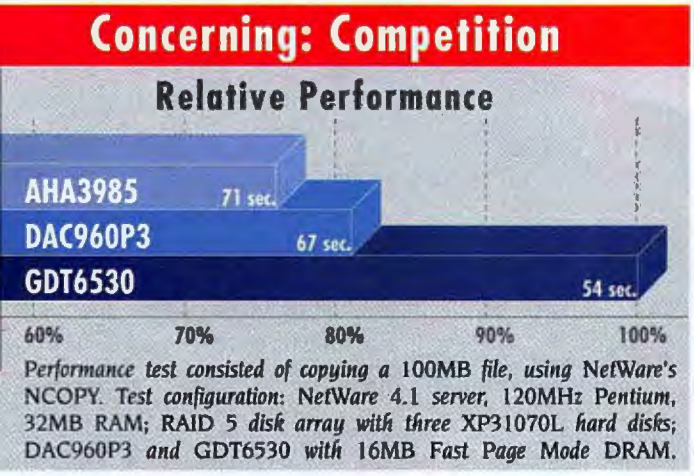

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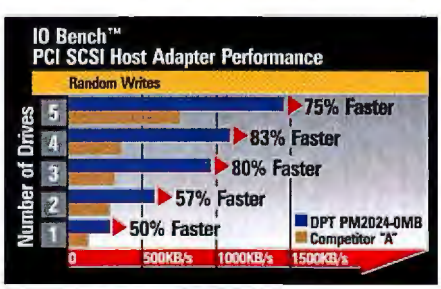

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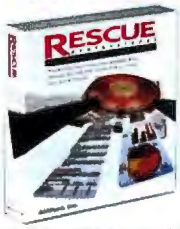

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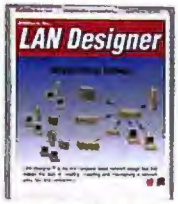

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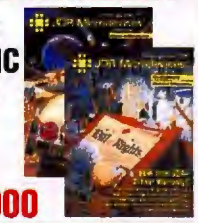

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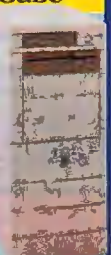

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80387-33	169	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73
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AM287-25	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73
AM287-33	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73
AM287-40	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73	80387SX-33	73	80387SX-16	73	80387SX-20	73	80387SX-25	73

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2C87-8 4MHZ	84	2C87-16 12MHZ	84	2C87-20 16MHZ	84	2C87-25 20MHZ	84	2C87-33 25MHZ	84	2C87-40 33MHZ	84	2C87-16 12MHZ	84	2C87-20 16MHZ	84	2C87-25 20MHZ	84	2C87-33 25MHZ	84	2C87-40 33MHZ	84	2C87-16 12MHZ	84
2C87-12 10MHZ	84	2C87-20 16MHZ	84	2C87-25 20MHZ	84	2C87-33 25MHZ	84	2C87-40 33MHZ	84	2C87-16 12MHZ	84	2C87-20 16MHZ	84	2C87-25 20MHZ	84	2C87-33 25MHZ	84	2C87-40 33MHZ	84	2C87-16 12MHZ	84	2C87-20 16MHZ	84

INTEL																							
80387-16	183	80387-20	183	80387-25	183	80387-33	183	80387-40	183	80387-16	183	80387-20	183	80387-25	183	80387-33	183	80387-40	183	80387-16	183	80387-20	183
80387SX-16	183	80387SX-20	183	80387SX-25	183	80387SX-33	183	80387SX-16	183	80387SX-20	183	80387SX-25	183	80387SX-33	183	80387SX-16	183	80387SX-20	183	80387SX-25	183	80387SX-33	183
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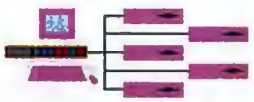

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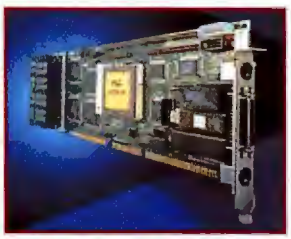

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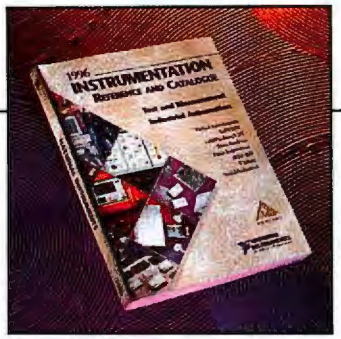

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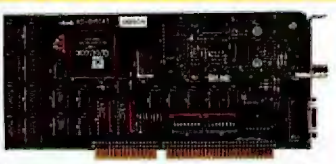

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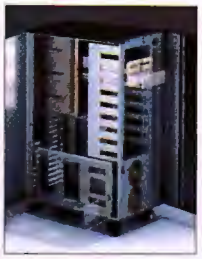

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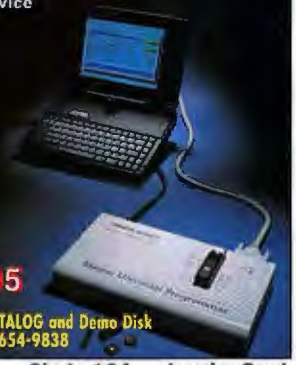

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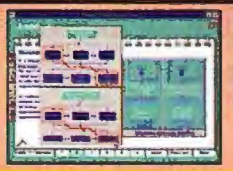

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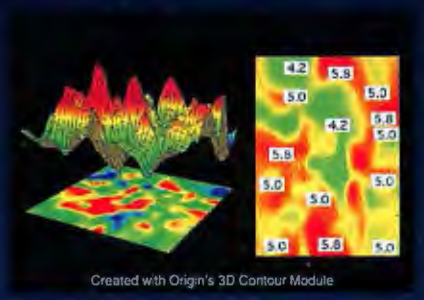

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•	GLOBAL NETWORK NAVIGATOR	40A-B	800-533-9933 451-4999
199-200	GLOBETEK	249	800-229-4640
172-173	GRANITE DIGITAL	252	510-471-6442
	H		
155	HOOLEON CORP	252	520-634-7515
	I		
•	IBM APPLICATIONS DEVELOPMENT	31	
•	IBM CLIENT SERVERS	154-155	800-IBM-3333 ext JA110
•	IBM DATA MANAGEMENT	108-109	800-IBM-3333 ext GA061
•	IBM OS/2	12-13	800-IBM-3333 ext EA100
•	IBM PPC CHIP	42-43	800-POWER PC ext 1401
•	IBM PPC CHIP	44-45	800-POWER PC ext 1402
•	IBM PPC CHIP	46-47	800-POWER PC ext 1403
•	IBM RS6000	128-129	800-IBM-3333 ext FA130
120-121	ICL (EMBLA)	74	703-648-3326**
•	IDT	256	800-743-4343
156	INTEGRAND RESEARCH	251	209-651-1203
207	INTEGRIX INC	137	800-300-8288
•	INTEL CORP	28-29	800-538-3373
611	INTERCON / PSINET	125	800-INTRCON
77-78	INTERGRAPH CORP	114	205-730-5499
157	IO TECH	251	216-439-4091
219-220	IXOS SOFTWARE GMBH	134	+49-89-46005-199**
	J		
•	JDR MICRODEVICES	247	800-538-5000
	K		
79-80	KINGSTON TECHNOLOGY	77	714-438-1850
208-209	KINGSTON TECHNOLOGY	152	714-435-2600
	L		
145-146	L A TRADE	240	800-433-3726
	M		
215-216	MAG INNOVISION	133	800-827-3998
613	MANCHESTER EQUIPMENT CO	240NE 2-3	516-435-1199
606-607	MAXTECH CORP	101	201-586-3008
605	MEGAHERTZ CORP	95	800-LINKING ext 4324
142	MICRO 2000	234-235	800-864-8008
138-139	MICRO SOLUTIONS COMP PROD	243	800-285-1214
168-169	MICROCAL SOFTWARE INC	256	800-969-7720
144	MICRO-INTERNATIONAL INC	241	800-967-5667
110	MICRON COMPUTER	CII-1	208-465-3434
•	MICROSOFT CORP	15	800-899-0435 dept YU6
•	MICROSOFT CORP	39	800-719-5577 dept 7FQ
•	MICROSOFT CORP	93	800-228-6139 dept XVH
•	MICROSTAR LABORATORIES	251	208-453-2345
•	MICROWAY	159	508-746-7341
86-87	MINUTEMAN	78	214-446-7363
•	MOTOROLA	80-81	
•	MOTOROLA	82-83	
242-243	MRT	62	603-465-2830
	N		
158	NATIONAL INSTRUMENTS	252	512-794-0100
81	NOBLENET	219	508-460-3456**
82	NSTL	203	610-941-9600
83	NU-MEGA TECHNOLOGIES	61	603-889-2386
	O		
185	OBJECT MANAGEMENT LABORATORY	255	800-6789-OML
223-224	OMNICOMP GRAPHICS CORP	141	713-464-2990
•	OPEN COMPUTING	188	
84-85	OPTIQUEST	75	909-468-3750
•	OSBORNE MCGRAW-HILL	176-177	800-822-8158
	P		
204	PANELIGHT	254	800-726-3599
210	PASSPORT DESIGNS INC	130	415-726-0280
147	PC'S COMPLEAT	230-231	508-624-6400
88	PERSOFT INC	215	800-TCP-3130
175-176	PIKA TECHNOLOGIES	249	613-591-1555
89-90	PINNACLE MICRO	16-17	714-727-3300
211-212	PIONEER NEW MEDIA TECHNOLOGIES	151	800-444-OPTI
91	PKWARE INC	120	414-354-8699
92	PKWARE INC	199	414-354-8699
•	POLLUTION SOLUTION	240NE 4	
•	POLLUTION SOLUTION	240SO 4	
615	POLYWELL COMPUTERS INC	240PC 1	800-999-1278
612	POLYWELL COMPUTERS INC	240SO 1	800-999-1278
127	POWERQUEST	103	800-379-2566
213-214	PROXIMA CORP	138	800-447-7694

ADVERTISER CONTACT INFORMATION

Inquiry No.		Page No.	Phone No.
	Q		
159	QUALSTAR CORP	254	800-468-0680
93-94	QUARTERDECK OFFICE SYSTEMS	105	310-392-9851
95-96	QUATECH INC	224	800-553-1170
	R		
237	RAINBOW TECHNOLOGIES	89	800-852-8569
123	RAVE COMPUTER ASSOCIATES	198	800-966-RAVE
179-180	RCI	250	800-RCI-8090 ext 71
160	RHETOREX INC	250	408-370-0881
140-141	ROSE ELECTRONICS	246	800-333-9343
	S		
114	SAG ELECTRONICS	165	508-682-0055
602-603	SAMTRON DISPLAYS INC	96NA 8	310-537-7000
217-218	SCEPTRE TECHNOLOGIES	131	800-788-2878
203	SCI TRAN PRODUCTS	252	412-357-7063
201-202	SERMAX	253	800-209-7126
177-178	SHAFFSTALL CORP	254	800-248-3475
170-171	SIGMA TECH SOFTWARE	250	818-368-6132
*	SILICON GRAPHICS	117	800-636-8184 D440
188	SILICONRAX	251	800-700-8560
*	SOFTWARE PUBLISHER'S ASSOC	246	
97	SOFTWARE SECURITY	201	203-656-3932**
231-232	SOLID COMPUTER GMBH	143	+49-89-3159146**
195	STARTECH COMPUTER PRODUCTS	249	800-265-1844 ext 231
98	STATSOFT	69	918-583-4149
617	SUPRA CORP	111	800-727-8647
108	SYMANTEC	2-3	800-628-4777 9AP13
105	SYMANTEC	53	800-628-4777 9AP9
106	SYMANTEC	55	800-628-4777 9AP11
107	SYMANTEC	57	800-628-4777 9AP12
	T		
191	TALKIE	255	800-TALKIE-4
161	TALKING TECHNOLOGY INC	250	800-685-4884
181	TAPEDISK CORP	254	800-827-3372
99	TEKTRONIX	91	800-835-6100 ext 1240
*	THE BOSTON COMPUTER MUSEUM	146	
100	TOSHIBA AMERICA INC	84-85	800-457-7777
165	TRI VALLEY TECHNOLOGY INC	251	510-447-2030
174	TTI TECHNOLOGIES INC	253	800-541-1943
	U		
124-125	UNIDIRECT	104	800-755-UNIX
190	UNITED EDUCATION CENTERS	255	800-877-4889 ext 28
	V		
162	VIDEX INC	249	503-758-0521
101-102	VIEWSONIC	71	800-888-8583
149-150	VORTEX COMPUTER-SYSTEMES GMBH	237	+49-7131-255063**
	W		
103	WATCOM C/C++ 10.5	27	519-886-3700
225-226	WAVETEK CORP	148	800-854-2708
229-230	WIBU	150	800-986-6578
604	WINBOOK	11	800-725-3469
235-236	WITCHDESK INC	149	800-544-4756
*	WORLDWIDE TECHNOLOGIES	248	215-922-0116**
	Z		
104	ZEOS INTERNATIONAL	162-163	800-554-5226
163	Z-WORLD ENGINEERING	254	916-757-3737

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INDEX TO ADVERTISED PRODUCTS

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Inquiry No.		Page No.
	HARDWARE	
	1 ACCESSORIES/SUPPLIES	
•	ANTHRO CORP	96
197-198	COMPUTER GATE	249
	2 ADD-IN BOARDS	
192-193	CAMELEON TECHNOLOGY INC	253
199-200	GLOBETEK	249
•	MICROWAY	159
223-224	OMNICOMP GRAPHICS CORP	141
85-86	QUATECH INC	224
161	TALKING TECHNOLOGY INC	250
149-150	VORTEX COMPUTERSYSTEMES GMBH	237
	3 BAR CODING	
205	BLUE QUETZAL	249
162	VIDEX INC	249
	4 COMMUNICATIONS/ NETWORKING	
221	ALTEX ELECTRONICS	142
238-239	BAY NETWORKS	64-65
208-209	KINGSTON TECHNOLOGY	152
606-607	MAXTECH CORP (N.A.)	101
605	MEGAHERTZ CORP (N.A.)	95
175-176	PIKA TECHNOLOGIES	249
179-180	RCI	250
160	RHETOREX INC	250
140-141	ROSE ELECTRONICS	246
170-171	SIGMA TECH SOFTWARE	250
231-232	SOLID COMPUTER GMBH	143
195	STARTECH COMPUTER PRODUCTS	249
161	TALKING TECHNOLOGY INC	250
225-226	WAVETEK CORP	148
	5 COMPUTER SYSTEMS	
166-167	APPRO INTERNATIONAL INC	250
113	BADGER COMPUTER	99
•	COMPAQ PORTABLES (N.A.)	22-23
222	DATALUX CORP	147
•	DELL COMPUTER CORP (N.A.)	CIII
•	DELL COMPUTER CORP (N.A.)	CIV
•	DELL COMPUTER CORP (N.A.)	58-59
•	DELL COMPUTER CORP (F1000) (N.A.)	CIII
•	DELL COMPUTER CORP (F1000) (N.A.)	CIV
734-735	DIGICOM (INT'L)	109
736-737	DIGICOM (INT'L)	111
233-234	ELSNER TECHNOLOGIOES (U.S.)	140
•	GATEWAY 2000	72A-X
•	GATEWAY 2000	72-73
•	IBM CLIENT SERVERS (N.A.)	154-155
•	IBM RS6000 (N.A.)	128-129
156	INTEGRAND RESEARCH	251
207	INTEGRIX INC	137
•	INTEL CORP	28-29
233-234	LIGHTSTONE SYSTEMS GMBH (INT'L)	140
110	MICRON COMPUTER	CII-1
82	NSTL	203
147	PC'S COMPLEAT	230-231
615	POLYWELL COMPUTERS INC	240PC 1
612	POLYWELL COMPUTERS INC	240SO 1
123	RAVE COMPUTER ASSOCIATES	198
114	SAG ELECTRONICS	165
•	SILICON GRAPHICS	117
188	SILICONRAX	251
231-232	SOLID COMPUTER GMBH	143
165	TRI VALLEY TECHNOLOGY INC	251
104	ZEOS INTERNATIONAL	162-163
	6 DATA ACQUISITION	
153	AMERICAN ADVANTECH	251
157	IO TECH	251
•	MICROSTAR LABORATORIES	251
158	NATIONAL INSTRUMENTS	252
85-86	QUATECH INC	224
203	SCI TRAN PRODUCTS	252
	53 DIAGNOSTIC EQUIPMENT	
142	MICRO 2000	234-235
	7 DISK & OPTICAL DRIVES	
151-152	ADVANCED MICRO ELECTRONICS	245
119	ARTECON	206
148	ASHTEK INC	233
172-173	GRANITE DIGITAL	252
•	IBM OS/2 (INT'L)	46-47
79-80	KINGSTON TECHNOLOGY	77
138-139	MICRO SOLUTIONS COMP PROD	243
89-90	PINNACLE MICRO	16-17
114	SAG ELECTRONICS	165
	9 FAX BOARDS/MACHINES	
617	SUPRA CORP (N.A.)	111
	11 KEYBOARDS	
222	DATALUX CORP	147
246-247	ELMA ELECTRONIC	252
155	HOOLEON CORP	252
	12 LAN HARDWARE	
196	ANTEC	253
703-704	COMPEX INC (INT'L)	101
130-131	CYBEX CORP	229
132-133	CYBEX CORP	236
706-707	CYBEX CORP (INT'L)	CIII
•	DATA COMMUNICATIONS	240PC 2-3
•	DATA COMMUNICATIONS	240SO 2-3
•	DATA COMMUNICATIONS (INT'L)	22-23
•	DATA COMMUNICATIONS (INT'L)	154-155
233-234	ELSNER TECHNOLOGIOES (U.S.)	140
136-137	FIRST SOURCE INT'L	244
233-234	LIGHTSTONE SYSTEMS GMBH (INT'L)	140
231-232	SOLID COMPUTER GMBH	143
149-150	VORTEX COMPUTERSYSTEMES GMBH	237
225-226	WAVETEK CORP	148
	13 LAPTOPS & NOTEBOOKS	
742-743	CHICONY (INT'L)	86
•	COMPAQ SYSTEMS (N.A.)	186-187
•	DELL COMPUTER CORP (N.A.)	168-169
•	DELL COMPUTER CORP (N.A.)	96NA 3
723	FIRST INTERNATIONAL COMPUTER	40IS 2
•	JDR MICRODEVICES	247
606-607	MAXTECH CORP (N.A.)	101
144	MICRO-INTERNATIONAL INC	241
726	MITAC INTERNATIONAL CORP (INT'L	93
714-715	OLIVETTI S.P.A. (INT'L)	35
147	PC'S COMPLEAT	230-231
217-218	SCEPTRE TECHNOLOGIES	131
100	TOSHIBA AMERICA INC	84-85
604	WINBOOK(N.A.)	11
104	ZEOS INTERNATIONAL	162-163
	14 MAIL ORDER	
221	ALTEX ELECTRONICS	142
129	COMPUTER DISCOUNT WAREHOUSE	226-227
614	COMPUTERLANE UNLIMITED	240PC 4
613	MANCHESTER EQUIPMENT COMPANY	240NE 2-3
147	PC'S COMPLEAT	230-231
	15 MEMORY/CHIPS/UPGRADES	
•	ADVANCED MICRO DEVICES	96NA 6-7
151-152	ADVANCED MICRO ELECTRONICS	245
192-193	CAMELEON TECHNOLOGY INC	253
136-137	FIRST SOURCE INT'L	244
•	IBM PPC CHIP (N.A.)	42-43
•	IBM PPC CHIP (N.A.)	44-45
•	IBM PPC CHIP (N.A.)	46-47
•	INTEL CORP	28-29
208-209	KINGSTON TECHNOLOGY	152
145-146	L A TRADE	240
201-202	SERMAX	253
174	TTI TECHNOLOGIES INC	253
•	WORLDWIDE TECHNOLOGIES	248
	16 MISCELLANEOUS HARDWARE	
115-116	CALIFORNIA PC PRODUCTS INC	94
•	MOTOROLA	80-81
•	MOTOROLA	82-83
	17 MODEMS/MULTIPLEXORS	
•	JDR MICRODEVICES	247
606-607	MAXTECH CORP (N.A.)	101
605	MEGAHERTZ CORP (N.A.)	95
617	SUPRA CORP (N.A.)	111
	18 MONITORS & TERMINALS	
222	DATALUX CORP	147
215-216	MAG INNOVISION	133
720	PHILIPS MONITORS (INT'L)	11
602-603	SAMTRON DISPLAYS INC	96NA 8
101-102	VIEWSONIC	71
	19 MULTIMEDIA/CD-ROM	
186-187	BOXLIGHT CORP	253
109	CREATIVE LABS INC	21
•	DATADSIC (N.A.)	35
242-243	MRT	62
204	PANELIGHT	254
210	PASSPORT DESIGNS INC	130
211-212	PIONEER NEW MEDIA TECHNOLOGIES	151
213-214	PROXIMA CORP	138
•	SILICON GRAPHICS	117
181	TAPEDISK CORP	254
	20 PRINTERS/PLOTTERS	
613	MANCHESTER EQUIPMENT COMPANY	240NE 2-3
716-717	OLIVETTI S.P.A. (INT'L)	12-13
99	TEKTRONIX	91
	21 PROGRAMMABLE HARDWARE	
244-245	ALADDIN SOFTWARE SECURITY INC	102

INDEX TO ADVERTISED PRODUCTS

Category No. / Inquiry No.		Page No.
164	AMREL TECHNOLOGY INC	254
•	DATA ACCESS CORP	232
710-711	FAST SECURITY AG	40IS 7
•	JDR MICRODEVICES	247
237	RAINBOW TECHNOLOGIES	89
229-230	WIBU	150
163	Z-WORLD ENGINEERING	254

56 RAID DRIVE ARRAYS

134	DISTRIBUTED PROCESSING TECH	238
135	DISTRIBUTED PROCESSING TECH	228
114	SAG ELECTRONICS	165
149-150	VORTEX COMPUTERSYSTEMES GMBH	237

22 SCANNERS/OCR/DIGITIZERS

732-733	MDI SYSTEMS LTD	40IS 17

52 SECURITY

189	ADVANCED ENGINEERING CONCEPTS	254
62-63	ALADDIN SOFTWARE SECURITY INC	66
244-245	ALADDIN SOFTWARE SECURITY INC	102
710-711	FAST SECURITY AG	40IS 7
237	RAINBOW TECHNOLOGIES	89
229-230	WIBU	150

23 TAPE DRIVES

730-731	COMBYTE INC (INT'L)	CIV
122	DATASONIX	76
73-74	EXABYTE CORP	19
138-139	MICRO SOLUTIONS COMP PROD	243
159	QUALSTAR CORP	254
177-178	SHAFFSTALL CORP	254
181	TAPEDISK CORP	254

24 UPS/POWER MANAGEMENT

•	AMERICAN POWER CONVERSION	32A-B
64	AMERICAN POWER CONVERSION	32-33
65-66	BEST POWER TECHNOLOGY	119
86-87	MINUTEMAN	78
84-85	OPTIQUEST	75

SOFTWARE

25 BUSINESS

112	CARDIFF SOFTWARE	219
740-741	FINSON (INT'L)	125
•	IBM APPLICATIONS DEVELOPMENT	31
213-214	PROXIMA CORP	138
235-236	WITCHDESK INC	149

27 COMMUNICATIONS/NETWORKING

227-228	AGE LOGIC	145
703-704	COMPEX INC (INT'L)	101
128	DIGIPHONE (CAMELOT)	175
728-729	DISTINCT CORP	40IS 8
136-137	FIRST SOURCE INT'L	244
75-76	FRONTIER TECHNOLOGIES	204
120-121	ICL (EMBLA)	74
81	NOBLENET	219
88	PERSOFT INC	215
738-739	SOFT & NET DSTIBUTION SA	40IS 14
191	TALKIE	255
•	WALKER, RICHER & QUINN (INT'L)	39

29 DATABASE

154	COMPUTERWISE	255
•	IBM DATA MANAGEMENT (INT'L)	42-43
•	IBM DATA MANAGEMENT (N.A.)	108-109
•	IBM STORAGE SYSTEMS (INT'L)	44-45

30 EDUCATIONAL

190	UNITED EDUCATION CENTERS	255

31 ENGINEERING/SCIENTIFIC

718-719	LOGIC PROGRAMMING ASSOCIATES	40IS 19

33 GRAPHICS

69	COREL CD-ROM	7
70	COREL DRAW 6	37
206	COREL TOYMAKER	122
184	EMATEK GMBH	255
210	PASSPORT DESIGNS INC	130
213-214	PROXIMA CORP	138
235-236	WITCHDESK INC	149

35 MAIL ORDER

151-152	ADVANCED MICRO ELECTRONICS	245
129	COMPUTER DISCOUNT WAREHOUSE	226-227
705	COMPUTER QUICK	40IS 10
712	GREY MATTER LTD	40IS 13

36 MATHEMATICAL/STATISTICAL

98	STATSOFT	69

37 MISCELLANEOUS SOFTWARE

740-741	FINSON (INT'L)	125
724	ON TIME MARKETING	40IS 19

38 ON-LINE SERVICES

450	BIX	267
68	COMPUSERVE	113
•	GLOBAL NETWORK NAVIGATOR	40A-B
•	IDT	256
611	INTERCON/PSINET (N.A.)	125

39 OPERATING SYSTEMS

233-234	ELSNER TECHNOLOGIOES (U.S.)	140
233-234	LIGHTSTONE SYSTEMS GMBH (INT'L)	140
93-94	QUARTERDECK OFFICE SYSTEMS	105

54 OS/2

•	IBM OS/2 (N.A.)	12-13

40 PROGRAMMING LANGUAGES/TOOLS

•	COPIA INTERNATIONAL LTD	201
184	EMATEK GMBH	255
712	GREY MATTER LTD	40IS 13
713	HUMMINGBIRD COMM LTD (INT'L)	95
718-719	LOGIC PROGRAMMING ASSOCIATES	40IS 19
•	MICROSOFT CORP	15
•	MICROSOFT CORP (N.A.)	39
•	MICROSOFT CORP (N.A.)	93
81	NOBLENET	219
83	NU-MEGA TECHNOLOGIES	61
165	OBJECT MANAGEMENT LABORATORY	255
724	ON TIME MARKETING	40IS 19
721-722	RAIMA CORP	40IS 11
108	SYMANTEC	2-3
•	WALKER, RICHER & QUINN (INT'L)	39
103	WATCOM C/C++ 10.5	27

41 SECURITY

62-63	ALADDIN SOFTWARE SECURITY INC	66
244-245	ALADDIN SOFTWARE SECURITY INC	102
708-709	EUTRON	40IS 16
710-711	FAST SECURITY AG	40IS 7
237	RAINBOW TECHNOLOGIES	89
97	SOFTWARE SECURITY	201
229-230	WIBU	150

45 UNIX

227-228	AGE LOGIC	145
•	COPIA INTERNATIONAL LTD	201
728-729	DISTINCT CORP	40IS 8
713	HUMMINGBIRD COMM LTD (INT'L)	95
120-121	ICL (EMBLA)	74
77-78	INTERGRAPH CORP	114
219-220	IXOS SOFTWARE GMBH	134
81	NOBLENET	219
721-722	RAIMA CORP	40IS 11
738-739	SOFT & NET DSTIBUTION SA	40IS 14
124-125	UNIDIRECT	104
•	WALKER, RICHER & QUINN (INT'L)	39

46 UTILITIES

143	ALLMICRO	239
142	MICRO 2000	234-235
91	PKWARE INC	120
92	PKWARE INC	199
127	POWERQUEST	103
93-94	QUARTERDECK OFFICE SYSTEMS	105
105	SYMANTEC	53
106	SYMANTEC	55
107	SYMANTEC	57
181	TAPEDISK CORP	254

47 WINDOWS

•	COPIA INTERNATIONAL LTD	201
728-729	DISTINCT CORP	40IS 8
75-76	FRONTIER TECHNOLOGIES	204
712	GREY MATTER LTD	40IS 13
168-169	MICROCAL SOFTWARE INC	256
738-739	SOFT & NET DSTIBUTION SA	40IS 14
105	SYMANTEC	53
106	SYMANTEC	55
107	SYMANTEC	57
604	WINBOOK(N.A.)	11
235-236	WITCHDESK INC	149

48 WORD PROCESSING/DTP

117-118	ACCENT SOFTWARE INTERNATIONAL	200

GENERAL

49 BOOKS/PUBLICATIONS

•	AVIATION WEEK (INT'L)	58-59
•	BUSINESS WEEK (INT'L)	169
67	BYTE ON CD ROM	223
•	OSBORNE MCGRAW-HILL	176-177

51 MISCELLANEOUS

•	BYTE CIRCULATION FIELD REPS	40IS 20
•	BYTE EURODECK (INT'L)	168
•	BYTE PUBL STATEMENT	202
•	BYTE REPRINTS	187
•	BYTE SUB MESSAGE	205
•	BYTE WEARHOUSE	242
•	BYTE WEB SITE	204
•	BYTE WEB SITE (INT'L)	128
•	BYTE WEB SITE (N.A.)	86
•	CANON	96NA 5
•	CONSUMER INFORMATION	240NE 1
•	DCI	185
72	DIGITAL WINDOWS NT	8-9
•	MCGRAW-HILL CORPORATE I.D. (INT'L)	186
•	POLLUTION SOLUTION	240NE 4
•	POLLUTION SOLUTION	240SO 4
•	SOFTWARE PUBLISHER'S ASSOC	246
•	THE MCGRAW-HILL COMPANIES (INT'L)	108

EDITORIAL INDEX

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on the response card. Each page number refers to the first page of the article or section in which the company name appears.

Inquiry No.		Page No.
	A	
1042	Abacus Concepts	221
1121	Accent Software International	197
990	Accolade	207
	Accurate Information	87
106	acp	40IS 15
109	Adept Scientific	40IS 20
	Adobe Systems	129
	Advanced Micro Devices	30
	Advanced RISC Machines	40IS 9
1028	AGE Logic	220
	AIB Software	48
	Aldus	129
1104	All Computer Warehouse	166
1015	Altra	218
	American Management Systems	36
1127	American Power Conversion	197
	Analog Devices	34
	Andyne	193
	Antares Alliance Group	26
	Apple Computer	129, 195
1120	Arbor Software	193
1080	Arcom Control Systems	40IS 17
1105	AT&T Global Information Solutions	166
	AT&T Wireless Services	96NA 1
	Atria Software	48
1085	Autodata	40IS 18
	Autodesk	129
	Autodesys	129
1073	Aydin Controls	40IS 15
	B	
	Badger Computers	87
991	BBN Hark Systems	97
1075	Blue Chip Technology	40IS 17
1025	Blue Sky Software	221
	Borland International	183
1043	Boxer Software	221
1132	Brooklyn North Software Works	170
987	Bungie Software Products	126
1038	Business Matters	220
	C	
	Cabletron Systems	40IS 4
	Centerline Software	48
1004	Chem USA	217
	Cognos	193
1070	Colorgraphic Communications	40IS 15
1106	Compaq Computer	166
	Computer Boards	87
	Compuware	26
1136	Connectix	191
1002	Consumer Technology Northwest	216
1101	Contemporary Software	40IS 20
1016	Cranel	219
	Cyrix	30
	D	
1033	Data Fellows	221
	Dataquest	25
	Datastorm Technologies	25
1074	Data Translation	40IS 16
1089	Datech	40IS 18
1107	Dell Computer	166
1024	Delrina	25, 220
	devSoft	211
	Digidesign	129
1108	Digital Equipment	24, 40, 166
1040	Distinct	222
992	Dragon Systems	97
	Dynasty Technologies	26
	E	
1093	Editor Software	40IS 19
	Electric Image	129
	Electronic Data Systems	87
1088	Ematek	40IS 19
	Encore Consulting Group	87
	Envisioneering Group	34
1102	Esker	40IS 18
1021	Exabyte	218
	F	
1034	Falcon Systems	221
	Fore Systems	40IS 4
1045	The Forefront Group	222
	Forte Software	26
	Four Seasons Software	26
	G	
979	GameTek	139
1109	Gateway 2000	166
	GEC Plessy	40IS 9
	GemStone Systems	67
	General Datacomm	40IS 4
1005	Genovation	217
	Gensyn	79
	Georgetown Systems	67
1014	Grand Junction Networks	219
1110	GST/Microcity	166
	GTE Personal Communications	96NA 1
	H	
	Hagenuk	40IS 9
1134	Helix Software	191
998	Hewlett-Packard	40, 48, 216
	Hilco Technologies	67
1084	HP Customer Information Centre	40IS 20
	HSC Software	129
1077	Husky Computers	87, 40IS 16
	I	
993	IBM	97, 209
978, 988	id Software	139, 207
1133	InContext Systems	170
	Infinite Technologies	24
	Infotech	38
	Insignia Solutions	195
	Insitu	24
1039	Instar	221
	InSync Software	26
	Intel	30, 40
1130	Interleaf	170
	International Data	207
1124	Interplay Productions	197
	Intersolv	48
1111	IPC Technologies	166
	J	
1095	John Walker Graphics	40IS 18
1128	The Journal of Chemical Education: Software	197
	K	
	Kalidor	87
1072	Kassen-Dietrich Data	40IS 15
1008	Kensington Microware	217
1079	KK Systems	40IS 16
994, 1048	Kurzweil Applied Intelligence	97, 222
1094	KWG Software	40IS 19
	L	
	LANcity	40
	Lotus Development	24
986	LucasArts Entertainment	126
	M	
1086	Macromedia	40IS 19
981	Maxis	139
1010	Memory International	217
	Metrowerks	183
	Micro Focus	36
985, 989, 1052, 1062, 1103, 1122	Microsoft	41, 106, 126, 129, 179, 181, 183, 197, 207, 211
1017	MicroSpeed	216
1012	MicroTouch Systems	219
1067	Mitac Europe	40IS 15
1006	Motorola	40, 209, 217
1066	MRT Micro	40IS 15
1068	MultiTech Computers	40IS 15
	Mustang Software	25
	N	
1003	National Computers Plus	216
	Netscape Communications	24
1032	NetSuite	220
	Neural Applications	79
	NeuralWare	79
	NeuroLogix	79
	NexGen	30
1087	Nexus	40IS 18
1036	North Coast Software	222
1029	Norton-Lambert	222
1063	Novell	106
	Nu-Mega Technologies	48, 183
	O	
1051	ObjecTime	189
1046	Ontrack Computer Systems	222
1081	Opti International	40IS 17
	Opto 22	67
982	Origin Systems	139
	OSC Media Products	129
	P	
1000	Panasonic Communications & Systems	218
1082	Pegasus Technologies	40IS 17
	Performix	48
	Philips	38
995	Philips Dictation Systems	97
	Philips Key Modules	38
	Philips Semiconductors	40IS 9
1112	Polywell Computers	166
1071	Portable Add-ons	40IS 15
	Praxis	36
1125	Princeton Review Management	197
	Progress Software	26
977	Psygnosis	139
	Pure Software	48
	Q	
1064	Quadbase Systems	106
1135	Quarterdeck Office Systems	191
1007	Qume	216
	R	
1099	Radcom	40IS 20
	RadioMail	96NA 1
	RAM Mobile Data	96NA 1
1113, 1114	Reason Technology	166
1049	Recognita Corp. of America	221
	S	
1123	S&S International	197
1115, 1116	S.A.G. Electronics	166
983	Sanctuary Woods	129
1009	Seiko Instruments USA	217
	Semico Research	34
996	Sensory Circuits	97
1026, 1092	Sentfactor	222, 40IS 18
	Siemens	40IS 9
	Siemens Nixdorf	40IS 3
984	Sierra On-Line	129
1013	Smart and Friendly	218
1131	SoftQuad	170
1096	Software AG	40IS 20
1083	Software Compatibility Center	40IS 18
	Sony	38, 129
980	Spectrum HoloByte	139
997	Speech Systems	97
1076	Spider Systems	40IS 17
1023	Stac Electronics	153
1041	StarBase	222
1020	STB Systems	219
976	Strategic Simulations	139
	Sun Microsystems	207
1050, 1126	Symantec	183, 197
1137	Syncronsys Softcorp	191
	Synetics	106
	T	
1018	TAC Systems	219
1001	Tadpole Technology	216
1129	Tapedisk	197
1117	Tatung Co. of America	166
1030	Technically Speaking	220
	Telecom Finland	40IS 4
	Telxon	87
	Texas Microsystems	38
1091	Toplevel Computing	40IS 18
	Trinzic	193
1035	TriTeal	222
1069	Tulip Computers	40IS 16
	Tusk	87
	U	
1027	UES	220
	Unify	28
1118	USA Flex	166
	USData	67
1090	Utopia Technology Partners	40IS 18
	V	
1037	Visio	221
1011	Visioneer	217
	VLSI Technology	40IS 9
	Voyetra Technology	129
	W	
	Walnut Creek	211
	Warman	40IS 4
	White Pine	24
	World Market Strategies	87
	Y	
	The Yankee Group	25
	Z	
999, 1119	Zenith Data Systems	166, 217
	Zenith Electronics	40

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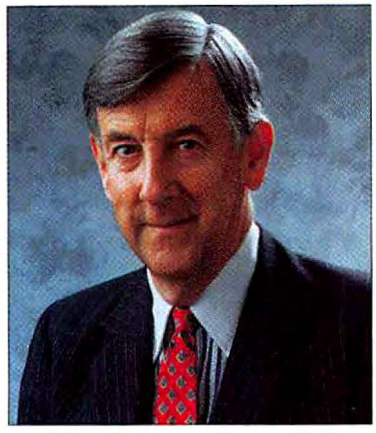
COMMENTARY James Martin

CyberDavid Rocks Goliath

In today's business world, the technology-smart newcomer can topple the stodgy giant



The cybercorp revolution will bring many David-and-Goliath stories. Small and nimble companies can attack old and arthritic corporations and win. The old corporation, like Goliath, often reacts with scorn to the newcomer rather than with appropriate caution. There are many opportunities for entrepreneurial Davids.

In the Bible, David took a major risk that would not have looked good in the strategy meetings. A cybercorp newcomer needs less raw heroism than that exhibited by the biblical hero; it can use new ideas to exploit an old company's weaknesses. It can use newer technology, virtual mechanisms, and electronic marketing. Because of its size, it can build a cozier relationship with customers. David can win in many corporate situations because Goliath is loaded down with the baggage of an earlier era.

Old corporations often have old cultures, inappropriate to the mercurial cybercorp age. They have cumbersome structures and politics. Their computers are snarled up in spaghetti-like software that is murder to change. They pay lip service to reengineering themselves but make only mechanical changes within the present structure—when that structure ought to be scrapped.

Is there a better Goliath analogue than IBM in the 1980s? That was when IBM was confronted with a fabulous opportunity. Personal computers would be on every desk and linked with networks. OSes and office software would sell in huge numbers. Customers needed a leader to set the standards. We know how the story turned out. Goliath was outmaneuvered and outmarketed by David: Bill Gates and Microsoft.

Some corporations in the 1990s have grown at a rate that's never seen before. Netscape, which makes the popular Internet browser software, went public when the company was only 16 months old, with a valuation of $2 billion. Marc Andreessen, the 24-year-old who originally programmed the software, had shares worth $58 million.

New corporations are evolving with radically new types of organization. They grow from the start with virtual-office space, E-mail—not snail-mail, a boundary-less culture, Internet connections, World Wide Web pages, and electronic links to trading partners. They are cybercorps from the beginning.

Today's technology makes possible virtual space and virtual operations. A small company does not need expensive offices; some employees can work at home. Key players may live in different cities but be linked electronically. A small company can be a virtual company.

A start-up may want to build something unique and interesting but cannot do it all. It may outsource part of the design; it may work jointly with component suppliers; it may use students to create brochures or software. The founders try to hire only the brightest, most dedicated people, with unique talents, and outsource everything that does not need much skill. The company focuses on what it is brilliant at. It should have a policy of owning everything with a high return on investment and outsourcing everything with a low return on investment.

Start-ups often have a turbulent ride. They don't do the right thing first time and may need to switch direction fast. They may plan for this by avoiding fixed or expensive resources.

The David corporation may be a start-up or a spin-off of an old corporation. Where an established corporation is proving resistant to business reengineering, its best chance of moving into the cybercorp age is to start new units. The dog may be too old to learn new tricks—but it can have puppies. A spin-off sometimes has major advantages that a start-up does not have, including access to money, services, specialized skills, and existing customers.

In his 1993 book *Managing to Survive*, Sir John Harvey-Jones, ex-chairman of the giant chemical company ICI, reflects on a lifetime of beating organizations into shape: "Although everyone complains of overmanagement and obsolete controls, it is extraordinarily difficult to fight free. Over time a sort of cat's cradle is devised, so that as one frees oneself from one entanglement, it is only to find oneself in another."

It is much easier to start new David operations than to change Goliath. ■

James Martin is a consultant and writer on information technology. He spent 19 years working for IBM and then went on to found James Martin and Co. Known as "the father of CASE," he has written more than 80 books, including The Wired Society. *You can reach him on the Internet or BIX at editors@bix.com.*

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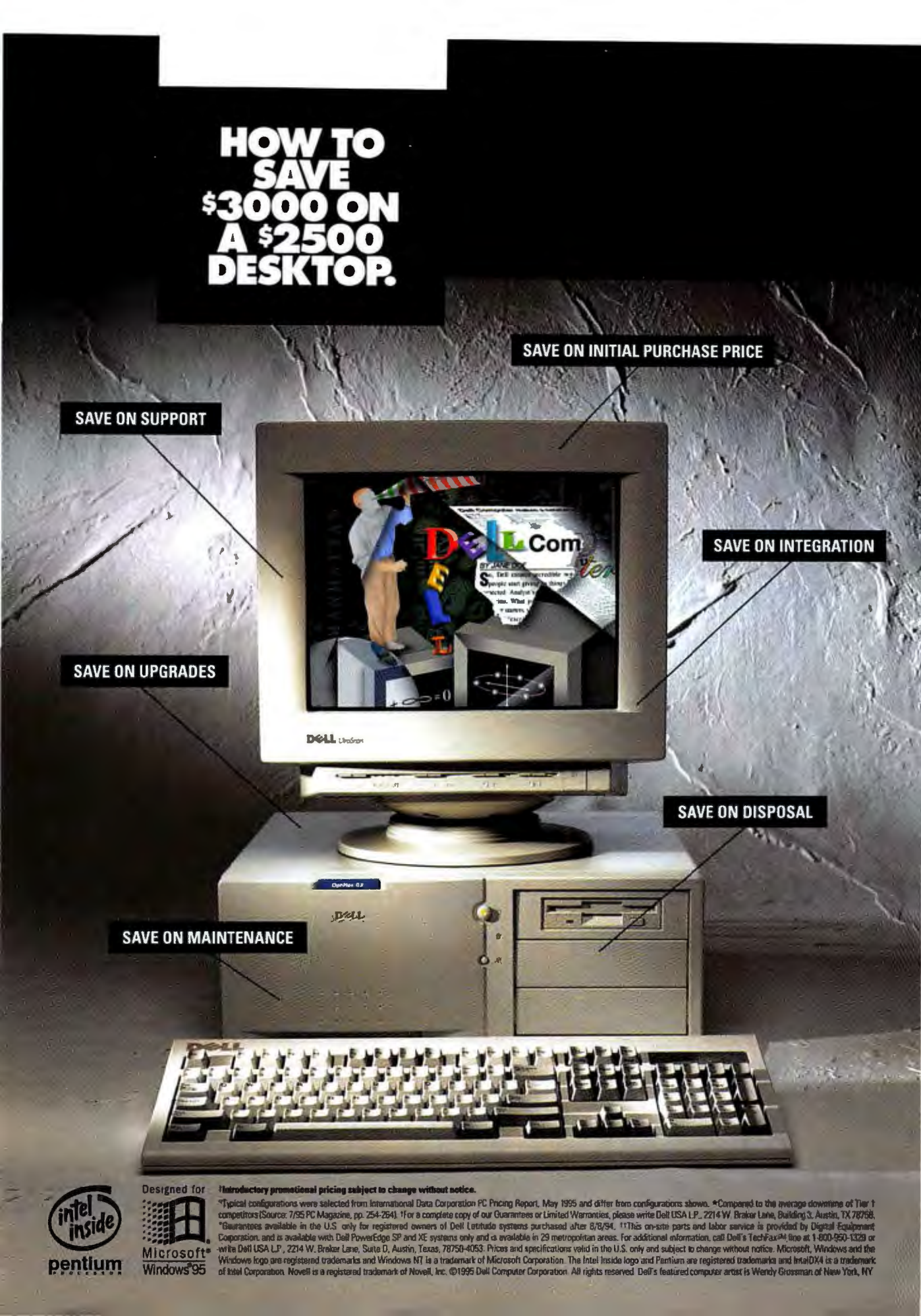

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^ΔIn Cross-Country™ tests conducted by VeriTest, inc., a leading independent test lab, the Dell Latitude LX 4100D lasted 3 hours 39 minutes with one battery, 7 hours 36 minutes with two batteries. That's LA to New York, no problem. The VeriTest Cross-Country v2.0 test simulates typical executive use of Microsoft Office® applications in Microsoft Windows® v3.11 during an airplane flight. Power management was enabled and 8MB of RAM was installed. VeriTest, inc. is located in Santa Monica, CA.