31 NO-COMPROMISE PORTABLES

BYTE

OCTOBER 1994

20 Years 1975-1995

Watcom C/C++ Gets a New Face

Unix at 25

Add Shared Fax Capability to Your Mac Network PAGE 169

THE MAGAZINE OF TECHNOLOGY INTEGRATION

Smart Networks

AT&T and IBM are working on a new generation of intelligent networks using agent-based technology.

PLUS

- **Porting Unix Programs to Windows NT** PAGE 203
- **DEC'S NEW ALPHA: The World's Fastest Microprocessor** PAGE 197

10

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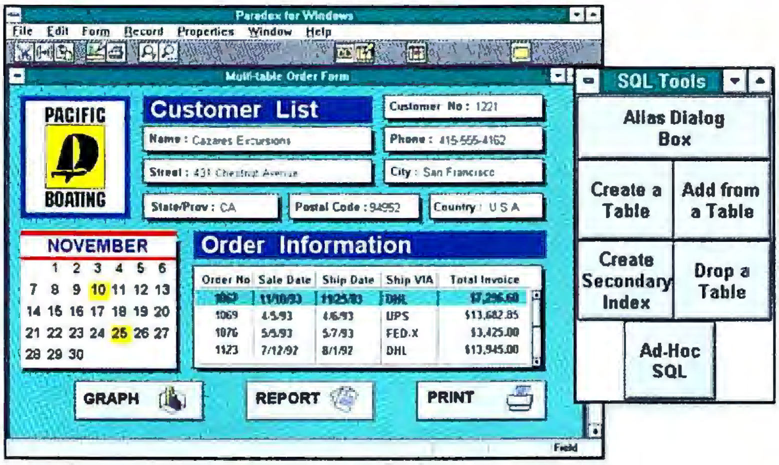

Look what you get!

SpeedBar icons provide push-button access to frequently used commands

Object Inspectors let you click on any object to reveal or change its properties

Desktop Folders organize tables, forms, reports, and queries

Visual Form and Report Designers are drawing tools that rival graphics packages

Style Sheets offer instant formats and lets you save your own templates

Graphical Query By Example lets you get answers to questions quickly and easily

Productivity Experts show you the easiest way to complete any task

Multiple data formats use data from Paradox for DOS and Windows, dBASE and FoxPro tables

Instant SQL connectivity for upsizing to client/server applications

Workgroup Desktop to share tables, queries, and complete applications with others

ObjectPAL programming language makes it easy to create Windows and client/server applications

Windows—using standardized training and familiar applications.

Upsize to client/server with instant SQL connectivity

Instant plug-in connectivity to popular SQL servers like Borland InterBase,® Sybase/MS,® and Oracle give you immediate client/server capability. So, as your information needs grow, Paradox lets you "upsize" your familiar desktop and network applications, while maintaining the familiar, easy-to-use look and feel. And Paradox is also the only database with a Workgroup Desktop, allowing you to send tables, query results, or even complete applications to anyone, anytime, anywhere in the world. No wonder more client/server applications already use Paradox than any other PC database.

Paradox is the best Windows database

	Paradox	Access
Visual data modeling for forms and reports	Yes	No
Object-oriented development environment	Yes	No
Supports SQL pass-through	Yes	No
Built-in workgroup support	Yes	No
Complete Paradox and dBASE file support	Yes	No

The future is built in

No other Windows database makes so many powerful features so instantly accessible. And with its unique object-oriented design, Paradox for Windows can handle all your expanding information needs, now and in the future.

For power, ease of use and complete connectivity, Paradox works for you, and for corporations everywhere. Get Paradox today, and you'll see why it's the world's #1 selling database.

Borland

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Get a look at the #1 selling database in the world

Real tools for the real world

Every day, people like you are putting Paradox® for Windows to work, and accomplishing a variety of tasks in record time. That's because no other Windows database gives you this much control of your information, and makes it so easy to use. Whether you're managing customer mailings, coordinating inventories, shipping orders, tracking reservations, or providing secure desktop access to corporate data, Paradox helps you get the job done fast.

Database power starts with ease-of-use

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PC Magazine Editors' Choice
Paradox for Windows May 11, 1993

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Paradox for Windows November 1993

1994 Win Award Windows 100
Paradox for Windows February 1994

1993 BYTE Readers' Choice Award
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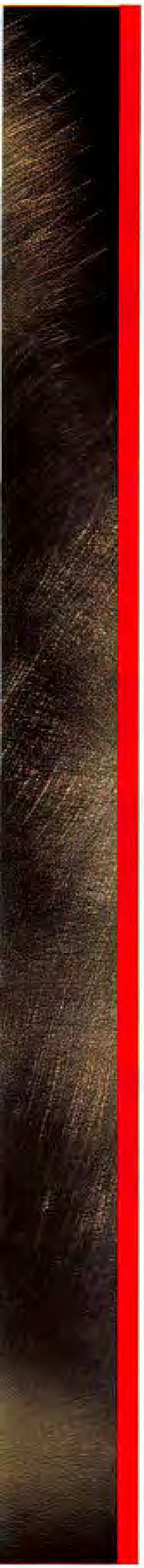
RISC
CISC
Performance
Time



At a certain point, everyone understands the benefits of RISC over CISC.

In the debate over which microprocessor technology is best for today's emerging computing needs, there's one point on which everyone can agree.

It's the one in the middle of the chart to your left. And what it illustrates is that, over time, microprocessors powered by RISC technology will outperform those driven by 15-year-old CISC architecture.

> ***Update***
>
> *In July, we shipped our one millionth PowerPC 601 microprocessor, after just ten months of production.*

That's vital news for everyone who makes or uses personal computers. Because the fact is, it takes the extraordinary processing power of RISC chips like our PowerPC™ family to drive today's and tomorrow's leading-edge computers and software. Which makes possible such innovative applications as realtime voice dictation, wireless networks, voice and handwriting recognition, and full-screen, full-motion multimedia, to name a few.

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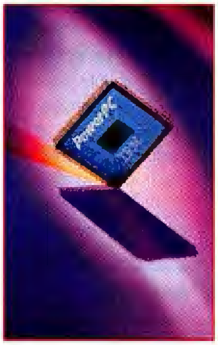
Of course, all these advantages are hardly accidental. The fact is, because RISC (Reduced Instruction Set Computing) processors carry only the most frequently used instructions, they offer streamlined performance levels that CISC (Complex Instruction Set Computing) chips simply can't match. Specifically, the simpler instructions implemented in RISC processors are typically executed in one system clock cycle, while CISC instructions often take five or even fifty system clock cycles to execute. The result is that the average number of system clock cycles per instruction in RISC typically eliminates advantages touted by CISC manufacturers.

And the best is yet to come. Since RISC-based PowerPC chips are built with IBM superscalar technology, we can all look forward to even greater performance benefits down the road. Right this minute, in fact, systems from palmtops to high-end workstations are under development utilizing IBM's PowerPC 603,™ PowerPC 604™ and PowerPC 620.™



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OCTOBER 1994 VOL.19, NO.10

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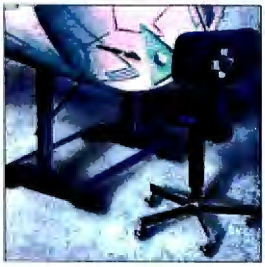

Opinions

PROGRAM LISTINGS

From BIX: Join "listings/frombyte94" and select the appropriate subarea (i.e., "oct94").

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

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

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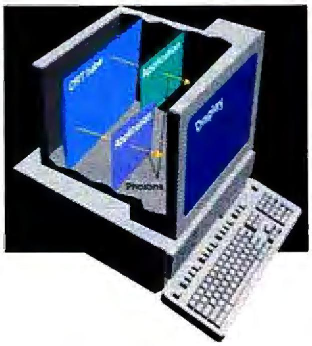

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BYTE Contents by Platform

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

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Of course, that was before the introduction of Microsoft Access® relational database system 2.0: the database that's as powerful as it is easy to operate.

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Have to add a functional button to a form? Use the Command Button Wizard. (Microsoft Access will even write the code for you.) Have to locate some hard-to-find data? Let the Query Wizard hunt it down. Have to set up a mail merge between Microsoft Access and Word? Click on – you guessed it – the Mail Merge Wizard.

What is it that makes this wonderful stuff so easy? Something we call IntelliSense™ technology: a feature unique to the Microsoft® Office family of programs, and one reason why Microsoft Access has garnered so much critical acclaim.

Suppose you're ready for something more adventurous. Like developing a database application of your own. Microsoft Access can help you do just that. Pose a query and its Rushmore™ query technology will provide an answer – not quickly, but immediately. Revise a piece of data and that revision will be reflected wherever your data is used – automatically. Plus, no matter where your data happens to be stored – Paradox™, Microsoft SQL Server™, you name it – with Microsoft Access you can, well, access it.

As if that weren't enough, even finding a helping hand is pretty easy. Microsoft Access comes with unlimited product support at no service charge.*

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Two Decades of BYTE

A celebration of what we've done for 20 years, and a look at a new way of getting BYTE

As you've already noticed from the logo on our cover and this page, BYTE is beginning its twentieth-anniversary celebration, and we are really excited about that. BYTE is the oldest and most widely respected general computing magazine published—a tribute to all the people who have worked for BYTE during the past 20 years and to all you readers and your insatiable hunger for technological information.

BYTE's twentieth anniversary is the celebration of a journey that started with the very beginning of microcomputers. It has been a journey filled with the trials and tribulations of ill-conceived standards, orphaned platforms, software bugs, and vaporware. But it's also been a journey filled with real solutions, increasingly faster systems, shrink-wrapped software, and the promise of a brighter tomorrow.

Each of us has a unique tale to tell of our computer experiences—the good, the bad, and the ugly. Through it all, though, we've traveled the same road in the pages of BYTE. So that we can commemorate—and sometimes even commiserate with—those experiences, we've devoted a page to "Blasts from the Past." In it are tidbits and memories found in the October issues of BYTE from five, 10, and 15 years ago. With the September issue in 1995, our one-page retrospective will go all the way back to September 1975, when the first issue of BYTE was published.

"Blasts from the Past" is essential reading. Taking license from Hollywood's copywriters: You'll laugh, you'll cry, and you'll relive the best moments of computer history when reading this regular feature in BYTE. Each month, these snippets from issues of yesteryear will highlight the most interesting moments of computing. It's on page 41; check it out.

The celebration will continue with each of the next 12 issues, and you will see the 20-year logo on each of those issues. You can also expect to see some very special articles in BYTE during that period. Everything culminates with our big anniversary issue in September 1995—an issue you won't want to miss.

For now, here's something that many of you have been asking for: BYTE articles on disk. We collected the text from all the significant articles on networking we've published since the beginning of 1993 and placed it onto disk. You can do a search—even with Boolean logic—on every word published to find precisely the information that will help you with your networking problems. The BYTE networking articles on disk are available at a small cost; call (603) 924-2625.

Let me know what you think of it. I would also like to know how you would prefer to see BYTE on disk. Please drop me a note on the Internet. Many readers say they have saved every issue of BYTE since they started subscribing—some of you have every issue back to September 1975. That says a lot about the unique relationship readers have had with BYTE.

I read my first copy of BYTE back in 1976—long before I started working for the magazine. (My first computer was a Radio Shack TRS-80 Model I, whose RS-232 connection contacts had to be frequently cleaned with a pencil eraser.) Likewise, every technical editor and writer at BYTE was a reader long before coming here. As readers, we appreciate BYTE's heritage. As editors and writers, though, we mostly appreciate you for reading BYTE.

For that reason, I'd like to hear about experiences you've had with computers over the last 20 years. What kind of interesting encounters have you had with computers and software? When did you read your first copy of BYTE? In which direction should the computer industry be headed? And what technology problems ought to be solved next?

Send me E-mail or a letter. It might be neat to share some of your experiences with all our readers as we celebrate BYTE's twentieth anniversary. In the meantime, thank you for being part of BYTE's history, and enjoy our little celebration during the next year. ■

DENNIS ALLEN, EDITOR IN CHIEF
(dallen@bix.com)

BYTE
One Phoenix Mill Lane
Peterborough, NH 03458
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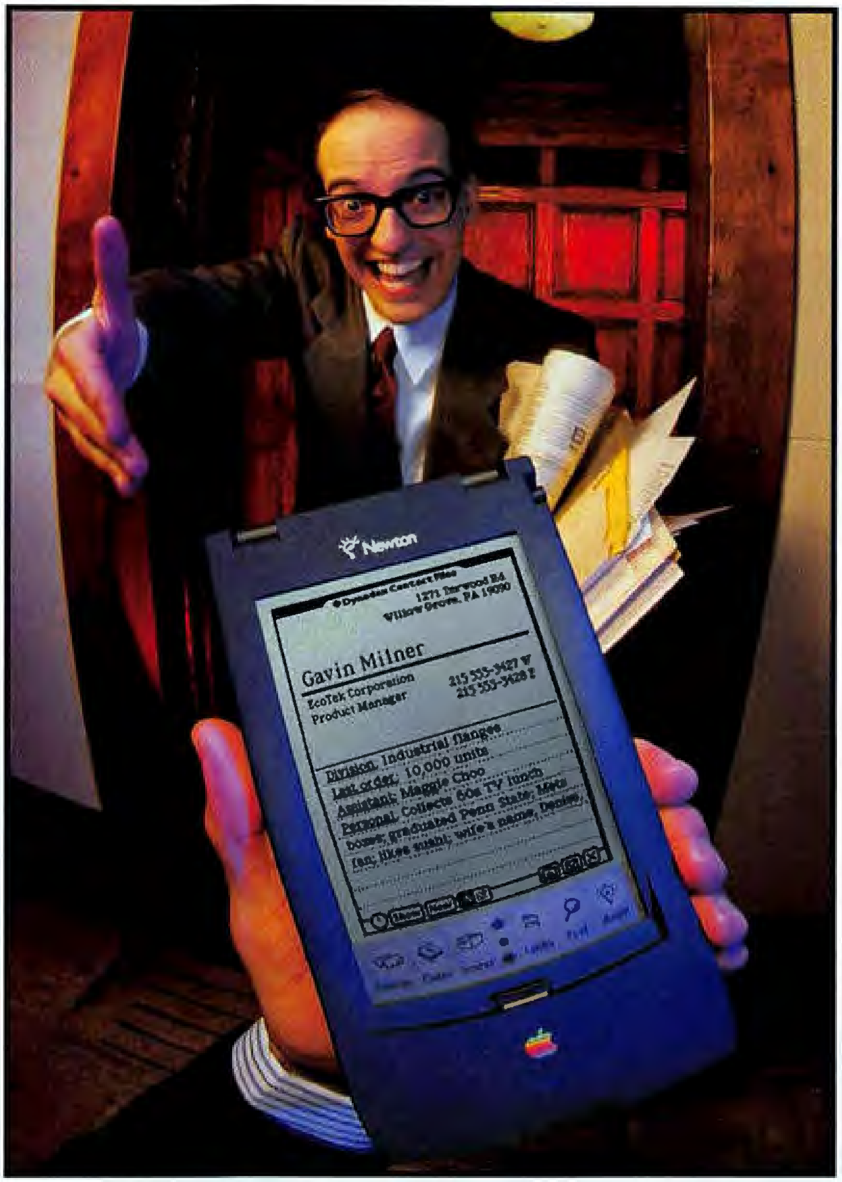
Newton connects. When you carry a MessagePad™ 110, the new Newton® communications assistant from Apple, you carry the power that comes from having information at your fingertips. Which means no matter where you go, you always have access to the facts you need, at the moment you need them.



With the Newton Connection Kit 2.0 for Windows, you can exchange information with a range of popular software on your Windows-equipped PC, such as ACT! contact manager, Lotus Organizer, Lotus 1-2-3, AmiPro and WordPerfect.*

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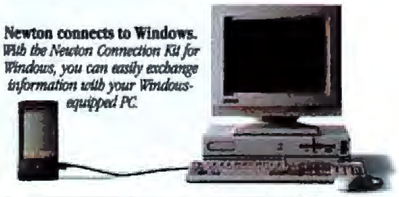
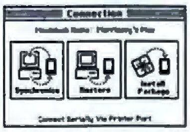
Newton. It's there when you need it.



Newton connects to Windows.
With the Newton Connection Kit for Windows, you can easily exchange information with your Windows-equipped PC.



Downloading, updating and backing up information between your Newton and your computer is as easy as plugging in.

Newton connects to Macintosh.
The Newton Connection Kit lets you work with your Macintosh via serial connection or your AppleTalk® network.


DEC 3000
"With these workstations based on Alpha AXP chip technology, Digital continues to lead in performance and price/performance."
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See listing on page 277.

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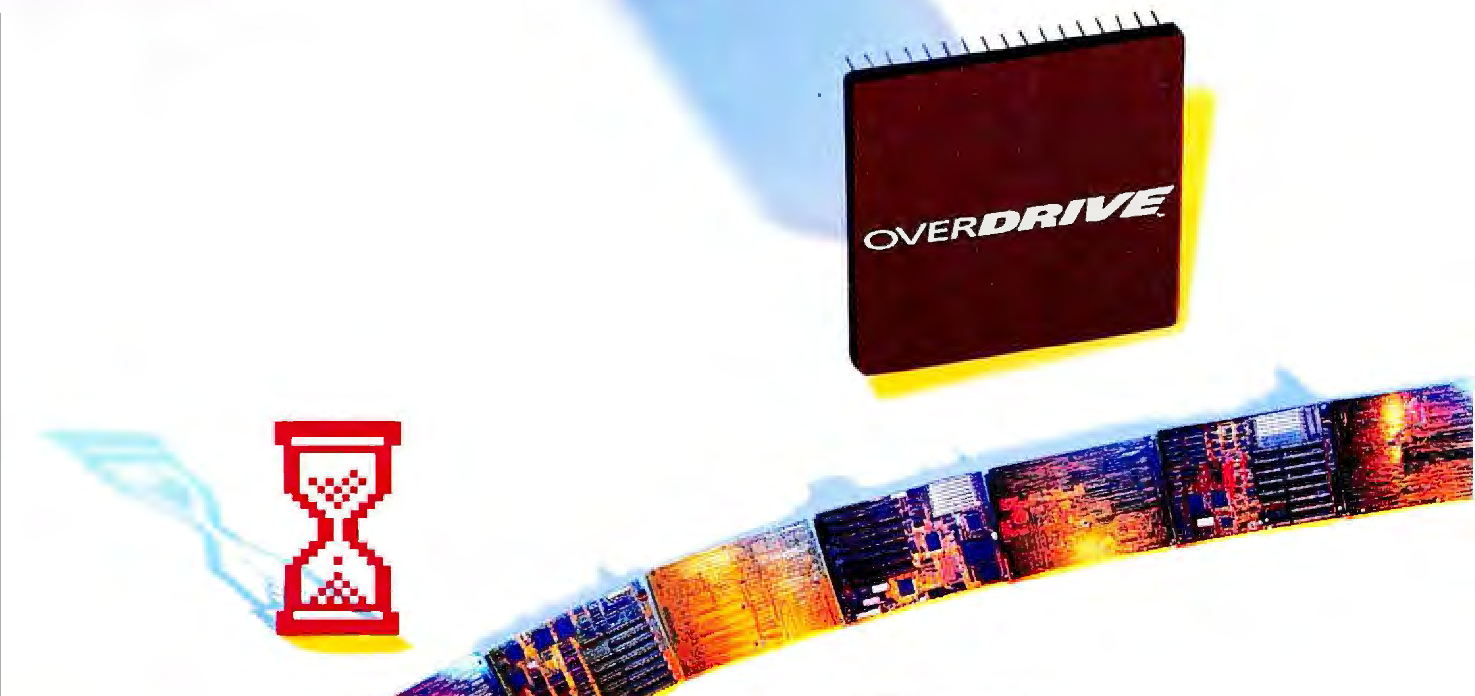

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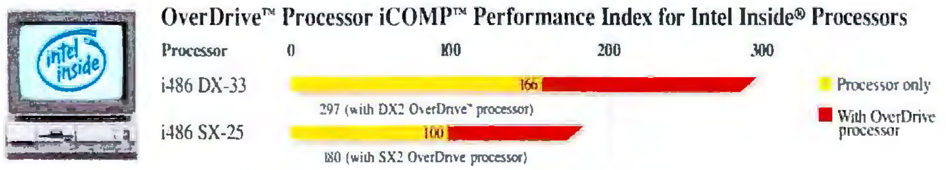

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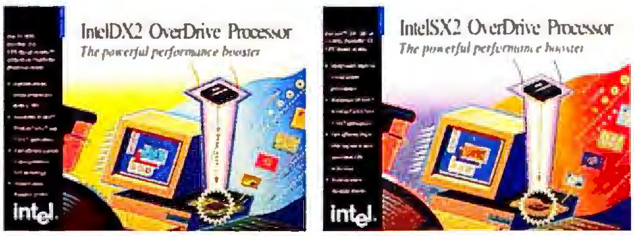

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Commodore—Thanks for the Memories

When my father bought our family a Commodore 64 (which I maintain is still the greatest personal computer ever produced), my life changed completely. I tore into it with a vengeance, and because of it, I will probably be involved with computer science as a career.

The first computer I bought for myself was an Amiga 1000, which I still have. Tom R. Halfhill's commentary "R.I.P. Commodore 1954–1994" (August) has inspired me to pull out my old system and hook it up once more. I can only say that it is a shame that the marketing division of Commodore didn't advertise more aggressively. Perhaps then we wouldn't have the tragedy of the world's greatest personal-computer producer going out of business.

Casey Connor
Columbus, OH

My first stride into programming was with a VIC-20. I dutifully stretched that machine to its 3-KB limit, writing what I thought were personal-productivity tools and file management programs. Of course, I was 10 years old at the time. When I finally moved up to the Commodore 128, I thought that I had hit the big time. I credit Commodore with my love of computers. Were it not for a computer that was accessible to a kid with less than $200, I might not have gone beyond the aging Apple computers collecting dust at my junior high school. As I type away on my Macintosh PowerBook, I can honestly say that I miss Commodore's quirky little VIC-20, with its jumbo-size characters and boxy keyboard. Rest in peace.

John Logan
Boise, ID

Tom R. Halfhill's eulogy for Commodore ("R.I.P. Commodore 1954–1994," August) was all the more poignant, because in the past, BYTE has never adequately covered Commodore products. Search your files for a comprehensive, timely review of the Commodore 64; you won't find it, because it was never written. Perhaps Halfhill's commentary would be different if BYTE had given Commodore more evenhanded treatment.

Rob Stengel
Princeton, NJ

Commodore PET

*Magazines don't have the power to change the direction of the market or to save companies from their own destruction. Commodore collapsed because of poor management, ineffective marketing, and the reluctance of users to buy anything that doesn't conform to established standards—not for lack of magazine coverage. In fact, from the earliest days, Commodore attracted plenty of coverage. BYTE published several timely articles on Commodore's most significant accomplishments (particularly on the Amiga), and there were many Commodore-specific magazines as well. In 1983, I helped launch the most successful of those magazines (*Compute!'s Gazette*), which quickly zoomed to more than 300,000 readers. But that magazine doesn't exist anymore.*

BYTE will continue to cover alternative platforms to the extent that they are launching pads for significant new technology. To devote major coverage to those platforms, however, would risk putting us in the same boat as the magazines that sink with those platforms.

—Tom R. Halfhill

I had to write and commend you on your excellent obituary of Commodore International (August). I still use an Amiga and have found it gives me a leg up on more advanced general operating systems, such as NetWare and Unix. I am currently a LAN administrator for the University of Wisconsin and would not have dreamed of getting to my present position had I not learned so much from Jay Miner and Commodore. Finally, thank you for including coverage of the Amiga in BYTE, especially in the early days. There were two multipart series on the kernel alone! I bought a secondhand bridgeboard without documentation, and a BYTE article on the bridgeboard told me enough to get it working. I feel I need to apologize for some of my fellow Amigans who attacked every magazine that did not do regular monthly praise of the machines. The industry as a whole went in another direction, and you had to follow.

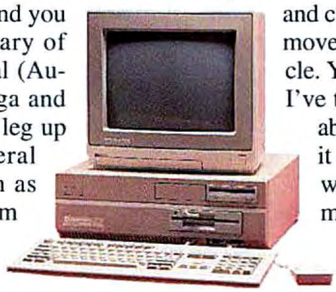
John Holt
Madison, WI

Shortly after I wrote my obituary, the Commodore community suffered another tragic loss—the death of Jay Miner in a Silicon Valley hospital. Miner was a brilliant engineer who played major roles in designing two computers that were ahead of their times: the Amiga (1985) and the Atari 800 (1979). He will be missed.

—Tom R. Halfhill

Commodore's death may very well be the best thing that ever happened to the Amiga, as no doubt some other company will realize the hidden treasure and give the machines the recognition they so richly deserve. Seeing a full-screen, 24-bit animation playing at 30 frames per second on an Amiga 4000 equipped with a Personal Animation Recorder from Digital Processing Systems is guaranteed to make any proponent of Windows animation or QuickTime suffer a violent hemorrhage. Commodore may be dead, but expect the Amiga to rise phoenix-like from its ashes.

Michael A. Prostka
Address unknown



Amiga 2000

The August commentary "R.I.P. Commodore 1954–1994" was an accurate, well-thought-out professional piece of journalism (something Commodore and the Amiga have lacked for a long time). As the past owner of an Amiga 1000, 2000, and currently 3000, I was almost moved to tears as I read the article. You pointed out "firsts" that I've told friends and colleagues about for a long time. It seems it is always the Amiga users who point out these achievements, while the company failed to articulate the true meaning of the Amiga and relay this to the masses. I sincerely hope the Amiga finds a new home before it's too late.

Nat Bowman
Redmond, WA

At least two companies and a group of former Commodore managers are interested in acquiring what's left of Commodore, but I fear the Amiga is doomed no matter what happens. Motorola's 68060 is probably the last generation in

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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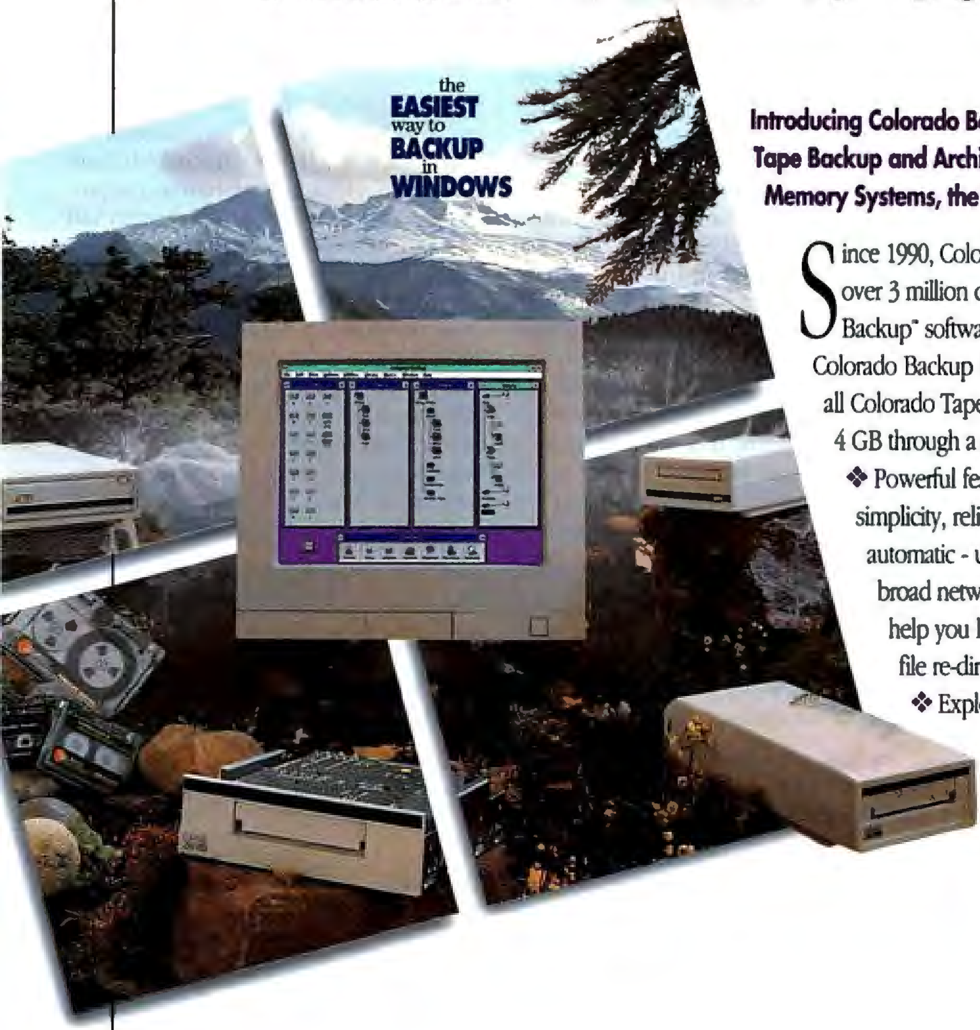

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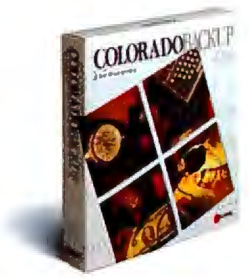

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the 680x0 line, and the task of adapting the Amiga's custom chips, operating system, and software base to another CPU architecture would be difficult and expensive. —*Tom R. Halfhill*

Thank you for the kind words you wrote for an underrated computer company. It's surprising enough to see the Amiga mentioned in a magazine like BYTE, but pretty darn cool to actually see nice things said about it. Two of the first PCs I ever used were the PET (Personal Electronic Transactor) and the VIC-20, but until your article, I had forgotten they were related to the 4000 on my desk at home.

Geoff Mark
Pasadena, CA

Satellite Savvy

Our company specializes in satellite communication, and I was pleased to see that your July Lab Report on modems included satellite channels. You were right about the fastest modem on impaired lines, the Motorola Codex 3265 V.Fast. However, to exploit its capabilities, you need special software.

We have found ZMODEM to be better than XMODEM on satellite channels, and to overcome the inherent limitations of ZMODEM, we have developed our own protocol. One of the characteristics of satellite channels is that the signal-to-noise ratio can be very good for 20 seconds and then drop sharply for 500 milliseconds and then bounce back. Normal software/modem combinations waste time when they react by falling back to a slower speed and then picking up at a faster speed.

Our software treats signal degradation as a "blank." It waits for the signal degradation to go away and then resumes at the initial speed. Our system also assumes that ACK (acknowledge) packets will take a while to reach their destination; it will continue to pump data and recover missing frames later. Modems must also be capable of supporting output-level adjustment. We achieve throughputs of 2000 characters per second; a V.32bis modem and XMODEM will not exceed 700 cps. With a fleet of five vessels, a shrewd shipowner can save $50,000 per year.

Frank Guinard
Arka Ltd.
London, U.K.

The Intricacies of SCSI Addressing

I am one of the "old" supercomputer folks who has become a regular reader of BYTE. In fact, my product development references currently include your magazine. The subscription has paid for itself a number of times in 1½ years. Dinah McNutt's article "SCSI and Beyond" (August) was excellent. At least 90 percent of BYTE articles have been outstanding—they are for the general audience of PC-o-philes but still do not "write down" and are therefore interesting and informative to me and mine.

Philip D. Tannenbaum
Director of Product Planning
HNSX Supercomputers, Inc.
The Woodlands, TX

In the article "SCSI and Beyond," Dinah McNutt writes, "SCSI uses a 3-bit addressing scheme." I just want to clarify that SCSI actually uses 8-bit addressing. Each device uses the bit number of its SCSI ID as its address line. This is extremely important to understand for the arbitration bus phase. A device will assert its address line if it wants to acquire the bus. If more than one device wants the bus, the device with the highest address will win. Multiple IDs are accommodated by the wired OR logic used on the SCSI bus.

Steven Krapp
Software Engineer, Motorola
Schaumburg, IL

I agree with you, and I did state that "SCSI is an 8-bit parallel I/O bus." Electrically, all 8 bits are being used. However, for the purposes of installing devices on the bus, you have a 3-bit address space. As you say, it is a matter of clarification (for the hard core).
—*Dinah McNutt*

Fixes

Regarding the text box "Software in Russia" (June, page 118), Corel licensed the spreadsheet for its CorelDraw 4.0 from Steepler, not from Microinforum. The programmers from Steepler have recently left to start a new company called Inzer.

The July Lab Report ("26 Modems: Faster than 14.4 Kbps") incorrectly represented two telephone-line types as if they were defined by the working papers of the EIA/TIA (Electronic Industries Association/Telecommunications Industry Association). NSTL (which provided testing for the report) created lines 17d and 25 based on composites of EIA/TIA draft specifications. ■

COMING UP IN NOVEMBER

- **STATE-OF-THE-ART CPUS**
  We examine new chips and architectures from AMD, Mips, Sun Microsystems, and more that will bring unprecedented power to PCs and workstations.
- **THE PROBLEM WITH PCMCIA**
  PCMCIA has been plagued by incompatibilities from its inception. Here's what the industry is doing to make the standard rock solid.
- **VISUAL PROGRAMMING**
  A U.K. company has come up with a new slant on visual programming. Is this the breakthrough needed to change the way you develop software?
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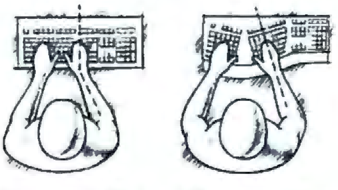

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forearm. Which then helps to relax the shoulder. All of which makes for a more natural typing position.

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And you won't even have to wait for a dressing room.

Microsoft

News & Views

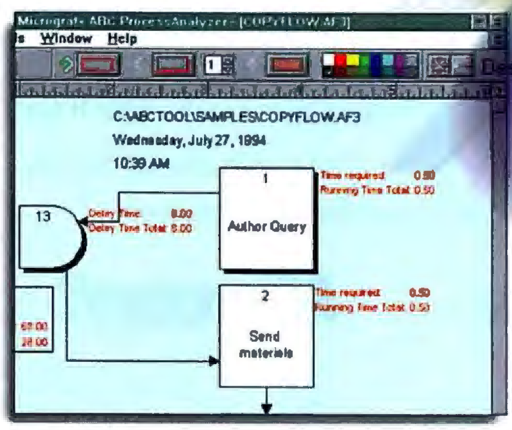
BUSINESS PROCESS REENGINEERING

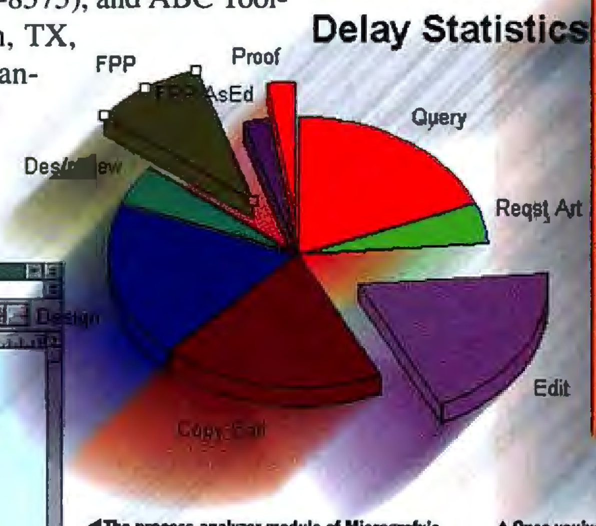
BPR Tools Help You Work Smarter

We've heard about business process reengineering for more than four years. A new breed of affordable applications can help managers analyze and automate businesses.

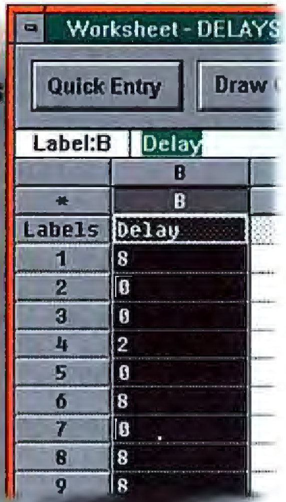
JOHN VACCA AND DAVE ANDREWS

Ever since Michael Hammer's article about BPR (business process reengineering) appeared in the July-August 1990 issue of *Harvard Business Review*, numerous articles, books, and seminars have discussed BPR's potential for reducing costs while increasing productivity and quality. Process-mapping applications for Windows, such as Analyst from Action Technologies (Alameda, CA, (510) 521-6190), Maxim from KnowledgeWare (Atlanta, GA, (404) 231-8575), and ABC Toolkit from Micrografx (Richardson, TX, (214) 234-1769), help business managers visualize an organization's work flow and quickly identify areas that need improvement.





◀The process-analyzer module of Micrografx's ABC Toolkit for Windows ($495) lets you map business processes and attach data such as cost and delay times for each operation. Micrografx officials say that version 1.1 of ABC Toolkit, slated for release this fall, will support ODBC (Open Database Connectivity) and OLE automation.

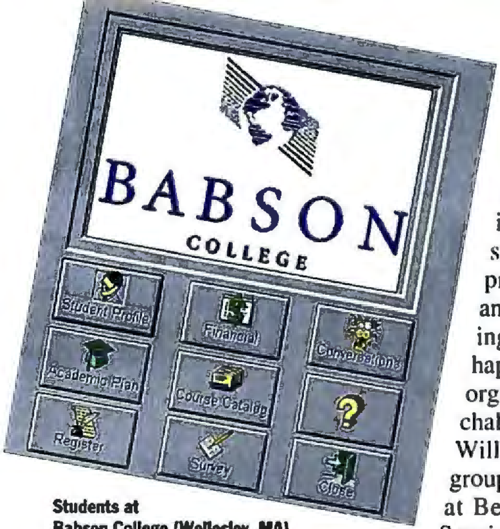


▲Once you've created a process map in ABC Toolkit, you can paste information into the program's data analyzer or an application like a Windows spreadsheet to visualize bottlenecks. Future versions of ABC Toolkit will add rules-based logic and will integrate with work-flow engines like Lotus Notes.

Process-mapping programs generate diagrams that resemble flowcharts. But unlike typical flowcharting programs, process-mapping programs let you attach data such as number of units processed, cost/resources consumed, required time, and other information associated with an activity. Once you map out the processes, the programs let you generate reports and charts that summarize the data captured in the process maps. These programs range from $250 to $500.

Programs like Maxim and Analyst that let you capture a business's process logic (e.g., central purchasing handles orders only above $500) also let a business manager deliver process maps to developers using higher-end development tools such as KnowledgeWare's Application Development Workbench or Action Builder to create actual work-flow applications. Logic captured at the up-front process-analysis stage can be preserved in a work-flow routing application.

"People are moving toward the integration of design and implementation," says Bob Flanagan, director of software services at the consultant firm WorkGroup Technologies (Hampton, NH). "Senior-level



Students at Babson College (Wellesley, MA) will soon be able to register for classes, pay tuition, and track financial-aid applications over their PCs, thanks to an application that Beacon Application Services is creating. Beacon developers spent several weeks assisting Babson managers in mapping out the college's business processes in Action Analyst before they used Action Builder to generate a working application.

managers using these tools may use some of the analysis tools just to see the impact of any changes. But it's still nice to have the process map and work-flow engine coupled."

Just creating the process map can provide useful insight into a business, however, and it's an essential first step in a proper BPR project, say analysts and developers. "Trying to figure out what happens in a complex organization is the big challenge," says Barrett Williamson, director of groupware development at Beacon Application Services (South Natick, MA), a consulting and development firm that helps companies automate their business. "Our goal is to help our clients satisfy their customers and do it for less money. But sometimes in a large organization, people don't even know who the customer is. Action's model forces you to ask these questions and makes everything explicit that you might not even think about in a business. Once you've done that, it's not a hard road to get from all those maps to automated business processes."

Where the Action products tie into Lotus Notes or SQL Server to provide their work-flow engines, KnowledgeWare tapped Object Design's ObjectStore database to provide Maxim's engine. The benefit of using an object database is it lets you reuse portions of a process map, says Mike Mandatto, product marketing director for Maxim at KnowledgeWare. As you modify processes in Maxim, you can save different views of the same process. "One of the things we're hearing is that an organization needs to constantly revisit its business process reengineering effort and hone it down. Maxim's semantic model lets you inherit processes and their attributes from one model and apply them to another model."

IBM uses ObjectStore as the engine for FlowMark, available currently for OS/2, and for AIX (server and client) and Windows (client) versions, which should be available now. Officials at IBM Software Solutions (Somers, NY, (800) 426-3333) say a benefit of FlowMark is that managers are creating the application as they map processes and don't have to transfer process maps to a developer. FlowMark starts now at $12,000, but IBM says it may unbundle FlowMark's process-mapping module and sell it separately at a lower price. Likewise, UES (Dublin, OH, (614) 792-9993), developer of the KI Shell work-flow process management program, also plans to make a process-mapping tool available as a stand-alone program.

In the past four years, BPR has become entrenched in the culture of many businesses. "The world of work is changing," says Marlene Martin, assistant vice president of Associates Corp. of North America (Dallas, TX), a financial services company. "Processes are expected to be of concern to everyone in the organization, and tools have to be in everyone's hands."

PC TRENDS

The Pentium Goes Mainstream

Pentium-based systems sporting high-capacity enhanced IDE hard drives, fast graphics, and integrated CD-ROM drives will highlight PC announcements this fall. PC vendors like AST Research, DEC, Dell Computer, Gateway 2000, and IBM are targeting value-conscious PC buyers with 90-MHz Pentium-based systems that sell for about $2500 and 60-MHz Pentium-based systems for under $2000. In July, Intel reduced the price of its 90-MHz Pentium chips from $849 to $707 (in quantities of 1000), and that's just the beginning. Like clockwork, Intel reduces the prices on its Pentium chips about every three months. The next price reduction should come in early October.

"If Intel can quickly move the [x86] world over to the Pentium, that means the company won't have any competition for a long time," explains Dan Sheppard, director of marketing for business desktop systems at AST Research. AMD, Cyrix, and NexGen are all working on Pentium-class processors, but only NexGen should have its processor available in volume before mid-1995. Thus, for the near future, Intel has the market to itself.

The latest round of PCs that target the value-conscious business buyer (e.g., DEC's 486- and Pentium-based Celebris line, AST's Bravo MS series, and Dell's OptiPlex series of Pentiums) offer more than just fast processors. Expect to see enhanced IDE hard drives; high-speed serial ports with a 16550 buffered UART (universal asynchronous receiver/transmitter); ECP/EPP (Extended Capabilities Port/Enhanced Parallel Port) ports; Plug and Play–compliant, upgradable flash BIOS; and 64-bit graphics acceleration offered as standard features. Also, the PCI (Peripheral Component Interconnect) bus will be a common architecture on these desktop systems. Less expensive Pentium-based PCs will eschew state-of-the-art components.

Despite the inexorable march toward Pentium, the 486 is by no means dead. Indeed, officials at Gateway 2000 say that Pentium sales in the second quarter accounted for only 26 percent of the company's total. "I think it will be three or four more quarters before the Pentium is entrenched as the desktop PC standard," says Jesse Parker, director of product management for DEC's PC business unit. "But the momentum for Pentium is increasing. Neither the home nor the business purchaser wants to buy a [486 or lower] system that will be obsolete in 12 to 18 months."

—Dave Andrews and Jon Pepper

Pentium Pricing Scorecard

Intel generally reduces the pricing on its processors approximately every three months. PC vendors say the 100-MHz Pentium is not yet available in large quantities, which would explain the minimal price decrease for that chip. An asterisk indicates the price as of August 1. Pricing is given in quantities of 1000.

Processor	April 1994 Price	July 1994 Price	Price Decrease (%)
100-MHz Pentium	$995	$964	3.1
90-MHz Pentium	$849	$707	16.7
66-MHz Pentium	$750	$525*	30.0
60-MHz Pentium	$675	$418*	38.1

He Grew Up With MTV. He
And, Unfortunately, He'll B

TV COMPUTING

TV Services Add Value to Desktop PCs

Computers from Apple, Packard Bell, and other vendors that combine PC computing and TV reception are now available in the $1500 price range. But the ability to receive regular TV programming is just the beginning of the PC/TV connection. New services and products will deliver PC-specific TV content. Cable and phone companies are also testing content delivery to set-top boxes running operating systems like OS-9-based DAVID (Digital Audio/Video Interactive Decoder) from Microware (Des Moines, IA).

NBC Desktop Video (New York City) has launched three TV financial services. NBC Professional provides live coverage of events such as congressional hearings and news conferences gathered by NBC companies like CNBC, NBC NewsChannel, and PFN. PFN/FirstCall offers video programming of analyst presentations, shareholder meetings, interviews, and brokerage conferences. NBC Desktop Video on Demand lets you call up recorded programming originally shown on other services.

Sold on a subscription basis, the programs target financial-service professionals. NBC Desktop Video and its partners developed a video network to deliver the services to corporate sites. Lenel Systems International created the custom software to produce and play the stories on a PC. The services are transmitted over MFS Datanet's ATM Fiber Network Service. Xing Technology provided the video-compression technology, and the GE Research and Development Center built the communications software. The services are expensive. For example, PFN/FirstCall costs $1750 a month for the first user plus another $250 per month for each of two to five additional users.

Team Software is developing a friendly Windows interface for CableLink.

On the consumer side, Intel will introduce next year a card that will link your PC to a cable TV system. Cable companies that provide special services for the PC will play a big role in Intel's service that's code-named CableLink. Intel has signed agreements with major cable players like Comcast, Rogers, TCI, and Viacom. And Redgate Communications is working with multimedia developer Medior (San Mateo, CA) to create a home-shopping service called Esplanade.

Services based on CableLink should be widely available by this time next year, and they will vary with each cable company. Sean Doherty, president of Team Software (Houston, TX), which is developing software for CableLink, says the service will turn your neighborhood cable feed into a giant LAN. Typical services could include on-line interactive chats between a town's residents and its officials, on-line commerce with local businesses, electronic classified ads, and remote education. The service could also provide links to the Internet and on-line services like Prodigy and Delphi

Users who currently lack the ability to make a local telephone call to access an on-line service could pay a fixed monthly fee to make the connection over CableLink. "Cable TV was started to provide clear TV reception to remote areas," Doherty notes. "CableLink could provide similar capability for computer users who don't want to pay long-distance charges to go on-line."

—Michael Nadeau

Did You Know...

- **Cable TV is available to 89 percent of the U.S. public**
- **64 percent of U.S. households subscribe to cable TV**
- **48 percent of cable subscribers are "very satisfied" with news programming**
- **32 percent of those without cable are "very satisfied" with news programming**
- **12 percent of U.S. households have a modem-equipped PC**

Source: *The Role of Technology in American Life*, Times-Mirror Center for the People & the Press

Apple's Affordable Audiovisual Macs

Apple's new 630 series of Macs features a modular design that makes audiovisual capabilities like watching TV in a window and recording live video as a QuickTime movie available in systems for under $1500. Two cost-cutting features help make this new Mac affordable.

First, Apple used 60-nanosecond DRAM (instead of the more expensive video memory) for the 630's built-in video. This DRAM is used in a 1-MB frame buffer that's separate from the Mac's memory subsystem and can't be expanded. Due to the frame buffer's 1-MB limit, the largest display the 630 supports is 800 by 600 pixels at 8 bits per pixel, with 256 colors. Smaller screens support 16-bit pixels, the pixel depth required to reproduce digital video accurately.

Second, Apple used a 250-MB IDE internal hard drive. Because IDE drives are a PC staple, this design choice reduces cost by $20 to $50 per system (a saving that is magnified by the time the system makes its way through the retail channel to the consumer).

Unlike Apple's Mac TV, which lets you toggle only between a full-screen TV session and a full-screen computing session, the 630 lets you use Mac applications as you watch a TV program in a window. A basic Quadra 630 with a 33-MHz 68040, 4 MB of RAM, and a 250-MB IDE hard drive costs $1279. You can then buy the components you need for your medium's requirements. A $149 Apple Video System lets you acquire 16-bit video in a 320- by 240-pixel frame, while a $249 Apple Video/TV System module supplies a cable-ready TV tuner that plugs into a dedicated slot. A $229 Apple Presentation System module lets you print the Mac screen (e.g., a software demonstration session) to video systems like a videotape or projection TV.

—Tom Thompson

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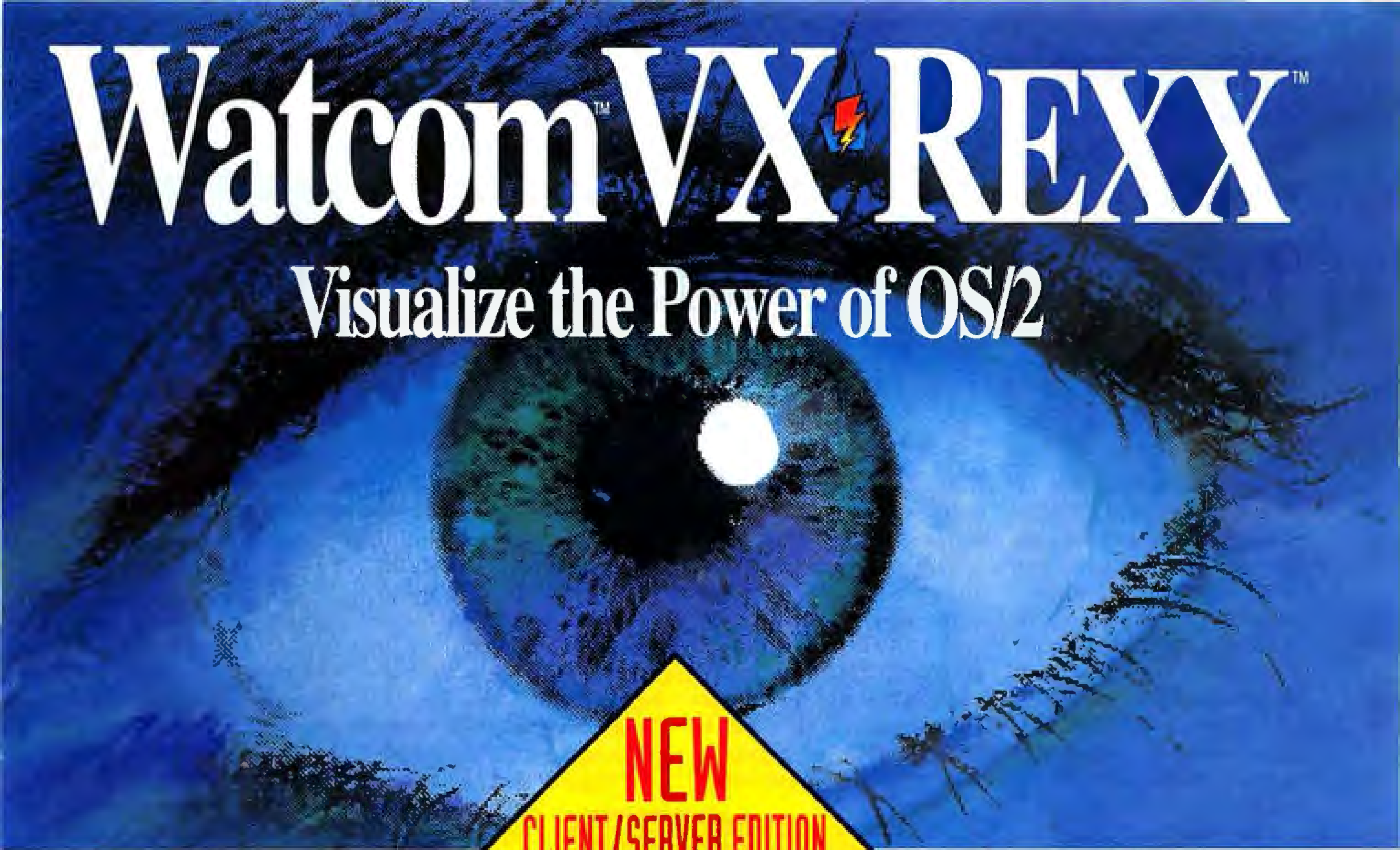

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PC Magazine, February 8, 1994.

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Software Development, November, 1993.

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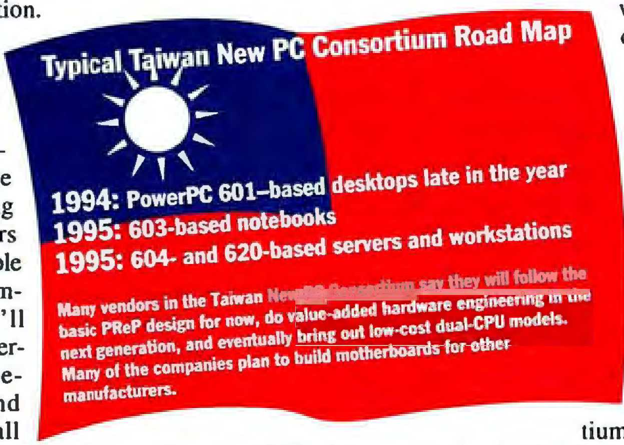
POWERPC SYSTEMS

Taiwanese Vendors Wait for Operating Systems

IBM is mum about when it will ship its next round of PowerPC machines—the ones that run something other than AIX—and major PC vendors are taking a wait-and-see attitude toward the chip. But major Taiwanese PC manufacturers such as Datatech Enterprises, Mitac, Tatung, and UMC stand poised to beat them all to market. However, software remains a big question.

The Taiwan New PC Consortium (TNPC) is a group of 24 companies that includes most of the country's leading PC manufacturers (Acer is the notable exception). Members claim they'll start selling PowerPC systems between now and next month's Fall Comdex. Some say they're already in limited production with PReP-compliant (PowerPC Reference Platform) machines; in other words, IBM PowerPC clones.



Datatech Enterprises (better known outside Taiwan as DTK Computer) intends to be one of the first to bring an IBM-type PowerPC system to market. The company showed a working prototype at the Computex show in Taipei in June; it was running a beta version of Windows NT. "We expect to be in mass production by October," says Alex Liu, an executive at the company's headquarters in Taoyuan, Taiwan.

DTK's system typifies what the other Taiwanese manufacturers plan to be selling soon: a 601-based system with a 240-MB hard drive, 16 MB of RAM, three PCI (Peripheral Component Interconnect) slots, five ISA slots, and a 15-inch color monitor. This system, with a 66-MHz CPU, will sell for about $2500. You can pick either NT or AIX for an operating system. DTK hopes to sell its systems as "high-powered personal workstations," Liu says. "We don't want to compete head-to-head with low-end Intel machines."

Power Macs have been available since last spring. Although Apple had sold about 345,000 Power Macs as of June, not a single Taiwanese company has yet confirmed that it's licensed the system software needed for Power Mac clones.

The Taiwanese do not expect that the PowerPC will be an overnight sensation. "The PowerPC in the first two or three years will have trouble with the Intel base," says Nerow Yang of consortium member Taiwan Auto-Design. "With a new system, it is hard to do much volume."

Yang leads the TNPC team dealing with software and porting issues and is aware of the problems associated with the PowerPC. Which operating systems will run on it and when, which operating system will be most popular, and when will native applications be ready? Leaders at other companies, like Chris Hsu at Tatung, see a lack of native applications as the platform's biggest deficit. Meanwhile, Tatung will continue to emphasize Intel machines. But "if a lot of software becomes available, the PowerPC market will mature," Hsu says.

Analysts think the $2500 price tag will be too high to compete with Pentium-based PCs, now selling for less than $2000 in some models. "The Taiwanese will have to take a workstation strategy—not in terms of just selling horsepower, but finding a niche and developing solution platforms," says John Donovan, an analyst with WorkGroup Technologies (Hampton NH), adding that vendors will have to work with VARs to design systems that solve specific problems (e.g., customer-service systems, high-powered publishing systems, or software-development stations). Says Donovan, "To just go out and say 'We've got this cheap hotbox' doesn't work anymore."

—Dennis Barker
(John Donovan, a reporter in Hong Kong, also contributed)

Whatever Happened to...?

The feud between Intel and Microsoft on how to improve video playback performance in Windows (see "Intel's VDI Speeds Up Video, Miffs Microsoft," November 1993 BYTE).

Intel and Microsoft have jointly developed the DCI (Display Control Interface) specification for accelerated video and graphics playback on PCs running multimedia applications under Windows. Microsoft planned to release a DCI development kit in September, and drivers that conform to the new specification are expected to arrive in force this fall.

DCI lets PCs play video clips at a faster rate and in bigger windows than previously. This happens thanks to a data path that provides a direct connection from the software video driver to the graphics display subsystem and frame buffer.

The DCI specification also defines a method to access the advanced video and graphics features that are designed into the latest generation of sophisticated graphics controllers. Among these features are color space conversion, image clipping, filtering and scaling, and overlaying.

DCI supplements the Windows GDI (Graphical Device Interface) drawing engine when sending movies to the screen. Bypassing the GDI for certain operations reduces call overheads and results in fewer dropped frames when a video is played back. DCI-compliant drivers will detect the presence of graphics accelerator boards to off-load video operations from the system CPU, resulting in even better performance.

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There are three types of computer users: those who have lost data due to a power problem, those who are going to, and those who have protected themselves against the inevitable surge, blackout or brownout with the most reliable UPS they can buy: Back-UPS by APC. In fact, editors and users alike agree that if your system demands absolute reliability, you can depend on APC Back-UPS.

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"All other brands of UPS die regularly in this lightning prone environment. My APC won't die!" said Paul Sisilli, Systems Analyst, City of Port St. Lucie. "With other brands, users don't find out until it is too late. The power interruptions here are very hard to live with. The other brands are dying off. Typically they last just beyond their warranty period. My Back-UPS is going on three years...no other brand is as reliable."

Don Truax knows first hand about Back-UPS reliability: "It ought to be against the law to buy a computer without an APC Back-UPS 250. I recently had a direct lightning hit right outside the house...my computer never blinked. Each morning I get a surge down the line and both APC's hate it - they simultaneously 'holler 'n clamp' while my 'Brand T' quietly sleeps in. I've relegated that unit to non-critical household stuff like my VCR."

Andrew Wargo, Manager at Baxter Land Company, tried two other brands before Back-UPS. "One lasted a few days, a second one went up in smoke after 48 hours, a third lasted less than 24 hours! I then bought my Back-UPS for less than half of what I had paid for the others. We've purchased three more Back-UPS and for the past 14 months they've been just hummin' away on the same power line that was eating the other brands alive!"

If you're protecting a network server, a communications interface port (on models Back-UPS 400 and higher) provides the security of an automatic shutdown to all major OS including NetWare, Windows, Windows NT, LAN Server, LAN Manager, LANtastic, SCO Unix, OS/2, Banyan Vines, AppleShare/System7 and more, so your data is safe whether the system is attended or not. (PowerChute software and interface kits sold separately.)

And since data processed on networked clients needs protection too, the $139 Back-UPS 280 provides an economical solution for all your LAN workstations. And if you have a new green PC, the price is even better at $119 for the new Back-UPS 200.

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600	Heavily configured systems, CAD/ CAM workstations	$399
900	Multiple systems, longer runtime applications	$599
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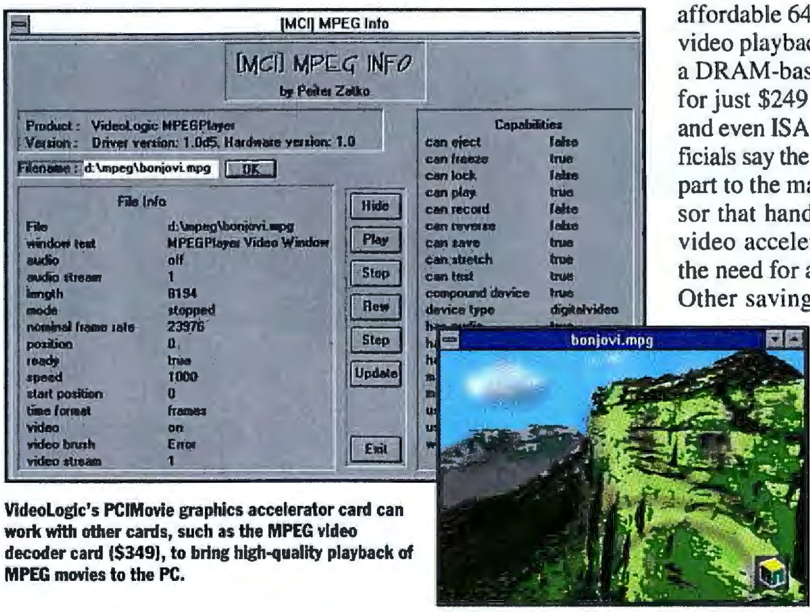
PC GRAPHICS CARDS

Low-Cost Video Acceleration Arrives

New graphics cards that deliver Windows acceleration and improved full-motion video playback are starting to hit the market for less than $500. Some of them are available for as little as $249. The cost savings are achieved by integrating or sharing graphics, video, and memory subsystems, thus reducing component duplication.

VideoLogic (Cambridge, MA, (617) 494-0530) has two cards that provide multimedia and Windows acceleration. They are 928Movie, available in ISA and VL-Bus versions ($349 for a card with 1 MB of video memory), and PCI-Movie, for PCI-bus (Peripheral Component Interconnect) systems ($499 for a card with 2 MB of video memory). PCI-Movie provides Windows graphics acceleration and assists video playback by supporting full-screen playback (at up to 1280- by 1024-pixel resolution) with up to 30-frames-per-second playback on a PCI-based PC.



VideoLogic's PCIMovie graphics accelerator card can work with other cards, such as the MPEG video decoder card ($349), to bring high-quality playback of MPEG movies to the PC.

PCIMovie's on-the-fly hardware dithering helps get rid of ugly banding that can occur during video playback.

The new Graphics Expression card from ATI Technologies (Thornhill, Ontario, Canada, (905) 882-2600) offers affordable 64-bit graphics and video playback acceleration in a DRAM-based card that sells for just $249 in PCI, VL-Bus, and even ISA versions. ATI officials say the low cost is due in part to the mach64CX processor that handles graphics and video acceleration, obviating the need for a second chip set. Other savings were achieved by the use of DRAM instead of more expensive video memory. The card assists video playback by delivering about 15-fps playback at 640- by 480-pixel resolution in the PCI and VL-Bus versions.

Matrox Graphics' (Dorval, Quebec, Canada, (514) 685-7230) MGA Impression Plus ($449) comes ready to support the soon-to-be-released VideoLogic's PowerPlay64 processor with VMC, or VESA Media Channel ($149). ThePowerPlay64 upgrade snaps into a socket on the MGA Impression Plus.

Diamond (Sunnyvale, CA, (408) 736-2000), which expected to ship its Viper Pro Video ($479 for VL-Bus or PCI version with 2 MB of video memory) at the end of August, designed the card so that the video chip shares the video memory with the graphics accelerator.

Craig Rush, who is the product manager for Diamond's Viper Pro line of cards, says that as video acceleration becomes more common, "The quality of multimedia titles will improve because multimedia developers will have more incentive to make higher-quality recordings."

—Steven J. Vaughan-Nichols

MoSys Offers Better Memory for Video

A video data stream can move only as fast as the slowest component in its path. Today, video users are finding that insufficient memory bandwidth is damming up the flow of video information. To break this dam, start-up company MoSys developed a memory architecture called MultiBank.

In Multibank, small, independent 256-Kb banks of DRAM are on a single chip. This results in faster speed and shorter latency times, which company officials claim gives MultiBank DRAMs 10(MDRAMs) a peak bandwidth of 660 MBps with 15-nanosecond or less access times. MoSys officials say that the MDRAM average throughput is 500 percent faster than standard DRAM and 250 percent faster then Rambus's high-speed DRAM.

MoSys officials also state that MDRAM's granular architecture makes it easy to produce customized MDRAMs of a particular size, so that graphics-card producers can buy only the memory they need for a given resolution rather then having to buy more DRAM than the resolution requires. For example, with conventional DRAM, you must have 4 MB of RAM to support 1024- by 768-pixel resolution with 24-bit color. The actual amount you need is 2.4 MB of RAM, and, with MDRAM, that's exactly how much you'd get.

MoSys's vice president of marketing, Gary Banta, claims that they now have agreements with S3, Trident Microsystems, and Tseng Laboratories for use of MDRAM. Jim Handy, director and principal analyst with market-research house DataQuest, is not as optimistic about MDRAM's future as its proponents are. According to Handy, numerous solutions that address the memory-bandwidth problem, such as Mitisubhi's 3D with internal processing, cache DRAM, and EDO (extended data out) DRAM, will compete with MDRAM.

—SJVN

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CD-ROM STANDARDS

Coming "Soon": 3-GB CD-ROMs

A significant limitation of current CD-ROM standards is their inability to allow more than 70 minutes of compressed VHS-quality video on a disc. Several CD-ROM companies are preparing new video formats that, when combined with compression, will let you put over 2 hours of full-screen, full-motion video with 16-bit audio on a disc. However, it could take more than a year before consumer-level products are available that conform to a proposed New High-Density CD System that's being developed by Philips and Sony.

Toshiba, Time Warner, and CD-ROM drive manufacturer JVC are also working on new formats. All three formats use similar techniques, such as an increase in pit density and reliance on the MPEG 2 video-compression standard. But drive vendors and medium producers have traditionally looked to Philips and Sony to set the standard.

The proposed standard's smaller track pitch (see the figure) presents a problem for the infrared laser used in CD-ROM drives today. Because the laser beams used in current CD-ROM drives are not narrow enough to read the smaller high-density CD-ROM pits in the new discs, existing players will not be able to read a New High-Density CD-ROM. However, Philips says CD-ROM players built for the new standard will read older discs.

Another area of concern is that of CD-ROM production. Philips officials say today's technology is capable of pressing higher-density discs, but *mastering* the discs is another matter. Philips says the blue lasers used for mastering might not be able to handle the new discs: It might be necessary to use narrower ultraviolet lasers.

Philips is negotiating with members of the CD-ROM, film, publishing, and game industries to reach consensus on the New High-Density standard. The company expected to have a proposal completed by the end of the summer.

—Michael Nadeau and Bram Vermeer

The read-only New High-Density CD System will require a major increase in pit density, which it will accomplish by halving the track pitch from 1.6 micrometers to 0.8 micrometer. This will reduce the pit width by a similar ratio and effectively quadruple capacity to 2.7 GB. Further improvements in error correction and the mechanical specifications will give the disc a capacity of about 3 GB. The proposed standard will supplement changes to the track pitch and pit density with MPEG 2 compression to give the disc a capacity of more than 2 hours of video with standard TV resolution.

PC SWITCHING-HUB CARDS

Ethernet Switching at a Fraction of the Cost

Even with the benefits of improved network performance, companies hesitate to use Ethernet switching because it appears to be too expensive or unfamiliar. Both issues disappear thanks to a new class of product, a switching hub on a PC card.

PC-based switching-hub cards offer the benefits of Ethernet switching for as low as $200 per port, or about half the price per port of a stand-alone Ethernet switching hub. The low price, however, doesn't mean a compromise on features. Card-based products from Matrox Network Products Group (Dorval, Quebec, Canada), Xedia (Wilmington, MA), and XNET Technology (Milpitas, CA) all offer advanced management capabilities.

None of these cards require you to change existing Ethernet cabling, hubs, or workstation network adapter cards. They all cost less than comparable stand-alone switching-hub products because you avoid the extra cost of a hub chassis—they occupy a slot in an existing server or PC.

Each product has unique features. For example, the NetSwitch/16 from Matrox ((514) 685-7230) can be used in small workgroups to prove out the concept of Ethernet switching. If it looks like switching will be used more extensively, multiple Matrox cards can be combined to bring the number of switched ports from 16 to as many as 256.

The XNET Series 1800 ParallelSwitch from XNET ((408) 263-6888) installs in a server and thus eliminates the latency that can occur between a stand-alone switching hub and a server. The ParallelSwitch comes with six Ethernet ports through which the card can deliver an aggregate throughput of 60 MBps between a server and multiple LAN segments.

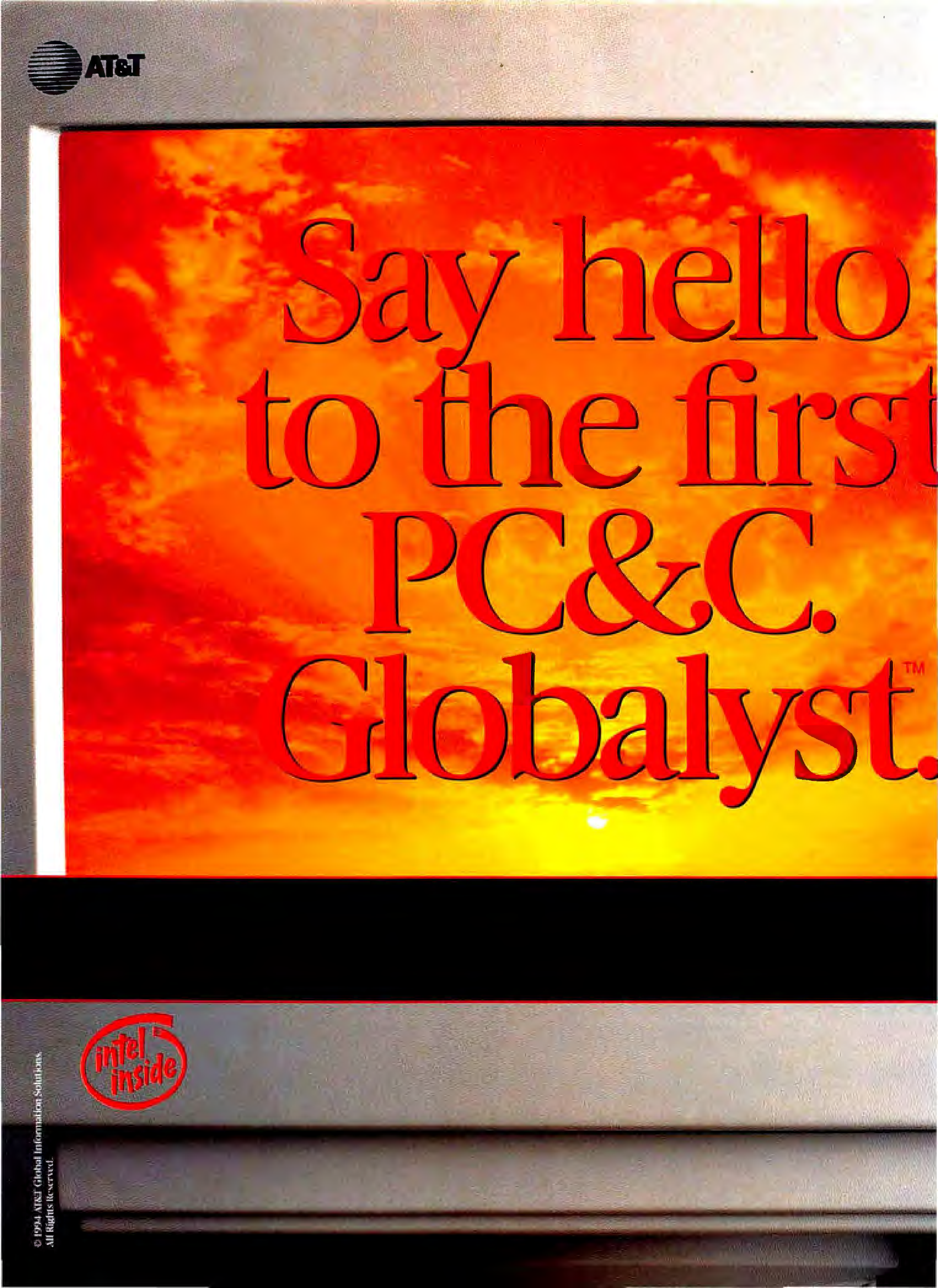
The MADswitch/PC from Xedia ((508) 658-7200) provides six Ethernet connections to a server. Xedia, which also offers stand-alone Ethernet switching hubs, likes to distinguish the PC-card version from the stand-alone hub. "Consider [the MADswitch/PC] a superNIC card," says Ian Davison, Xedia's CEO. "If you need six connections to the server, use one card rather than six. This takes less room in the server and has the advantage over the individual-cards approach in that peer traffic never hits the server." The card's processor handles all that traffic, resulting in less drain on the server's CPU.

—Salvatore Salamone

ETHERNET SWITCHING-HUB CARDS AT A GLANCE

COMPANY	PRODUCT	DESCRIPTION	ADVANTAGES
Matrox Network Products Group	NetSwitch/16	16-port card that goes in a separate PC	Can daisy chain cards to accommodate up to 256 switched ports
Xedia	MADswitch/PC	Six-switched Ethernet-port card that goes into the server	Includes NetWare 3.1x ODI (Open Data-Link Interface) driver and can be used with Xedia's stand-alone switching hubs
XNET Technology	Series 1800 ParallelSwitch	Six-port card for a server	Reduces latency by providing a single step between Ethernet LANs and the server


The way we hear it, the reign of the PC is about to come to a screeching halt.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ENCRYPTION

Software-Key Escrow Emerges

For the last year, the U.S. government tried to convince the country that it should embrace the Clipper encryption chip—the top-secret chip for protecting secrets that came with a trapdoor that allowed law-enforcement officials to listen in. Public reaction to the plan was largely negative, because many people believed that the technology was overly expensive, dangerously fragile, and an unwelcome invasion of privacy. Now, Trusted Information Systems (Glenwood, MD) is offering a new software-based proposal that keeps the trapdoor for law enforcement but may eliminate many objections to cost and flexibility.

Many of the objections to Clipper's cost emerged from the government's plan to fix the design in hardware. A solution using software can be distributed at little cost, incorporated into operating systems, and quickly updated in the event the system is compromised.

TIS's system still maintains the controversial "escrow" feature by using public-key encryption technology to attach an additional field called the LEAF (Law Enforcement Access Field) that contains the session key for the conversation encrypted with the government's public key. Only law-enforcement officials would have access to the matching private key that could decode this extra field. This key can be split into many parts and distributed to different parties if necessary.

Many companies proposed similar schemes, but TIS took the additional step of defending against "rogue" implementations that could fool law-enforcement officials. Matthew Blaze, a researcher for AT&T (Holmdel, NJ), discovered such a flaw in the first prototypes of the Tessera PCMCIA cards that adapted Clipper for PCs. These attacks work by binding in a false session key into the LEAF so that law-enforcement personnel can't decrypt the message. The TIS implementation defeats this by requiring both ends of the conversation to compute the LEAF using the chosen session key. The receiving end compares its LEAF to the one sent and shuts down if they don't match. This will force hackers to tamper with the equipment on both ends of the conversation—a limitation that TIS hopes will be severe enough to keep many in line.

The TIS proposal is just a proposal, but many people expect that it will be seriously studied by government officials. Others think that the most important problem is still individual privacy. David Banisar, a lawyer for EPIC (Electronic Privacy Information Center) in Washington, D.C., says, "We are concerned that the cure for Clipper is worse than the disease. Key escrow in software or hardware is a bad idea and threatens the security and privacy of communications. The Fourth Amendment doesn't require that every man, woman, and child in the U.S. leave a copy of their keys at the local police station. It's unacceptable to have these requirements for our communications."

—Peter Wayner

CODE TALK

RICK GREHAN

System Commander for Multiple Operating-System Projects

I was at the beginning of a protracted development project that would require me to install several operating systems on a single PC. I knew I was going to need DOS/Windows, OS/2, and Windows NT, and probably Unix and NetWare as well.

My new C/C++ development platform—Watcom's C++ 10.0—could handle everything except Unix. But how would I manage all those partitions? System Commander from V Communications ($99.95, San Jose, CA, (408) 296-4224) provided an answer.

When you boot a PC with System Commander installed, a menu appears, displaying a list of the operating systems on your various partitions. The manual boasted that System Commander could handle up to 42 operating systems on one PC, which was far more than I'd need.

System Commander's menu displays a list of operating systems on your PC.

When I installed the software, which was a quick-and-easy process, I had only a single DOS partition, so the menu held a lone entry. I next installed OS/2. Part of the OS/2 installation requires a reboot, during which System Commander popped up, told me I had just created an OS/2 partition, and asked me if I would like to add the new operating system to the menu. I told it "yes," and everything proceeded nicely. The same thing happened when I installed my third partition, which held NT.

System Commander easily handles the three operating systems I now have installed, but its benefits don't stop there. It has built-in boot-record virus protection. Upon installation, System Commander makes a copy of the boot record, and if it later detects a virus in that record, it overwrites the infected version with the saved copy. Also, once your selected operating system is booted and active, System Commander completely removes itself from memory. No bits and pieces are left resident.

You can also use System Commander to store multiple DOSes on a single partition. Suppose you wanted to install old reliable DOS 3.3 and DOS 6.x on the same partition and boot either operating system. No problem. System Commander saves the operating-system files in its own, hidden file. When you bring your machine up, each operating system appears on the menu. System Commander can even tolerate operating systems that destroy the boot record upon installation (according to the documentation, Japanese DOS/V 6 does this).

Though I have only three operating systems on my machine for now, more are on the way. I'm counting on System Commander to keep them in line.

INTEL TECHNOLOGY BRIEFING

NETWORKING TECHNOLOGY
TRACKING YOUR NETWORK

Fast Ethernet and DMI: Two New Standards That Put More Control in Sight.

Today's business environment is putting greater demands on our networks than ever before. Multi-megabyte e-mail, graphics and multimedia files are becoming quite common. But so are network traffic jams. And to complicate things further, the thousands of products that make our PCs so flexible are also making them harder to manage. In this brief, we'll tell you how Intel is working with other industry leaders to develop two new standards—Fast Ethernet and the Desktop Management Interface—to help you manage and control your network.

Fast Ethernet

Given the demands on today's networks, even the most powerful PCs are becoming handicapped by 10 Mbps Ethernet. So in an effort to increase Ethernet throughput, Intel joined with other industry partners in 1993 to form the Fast Ethernet Alliance.

What resulted was a specification for ten times the original 10 Mbps bandwidth. The new 100 Mbps Ethernet provides all the bandwidth today's new technologies require while maintaining the original CSMA/CD protocol. Which means companies don't have to sacrifice their original Ethernet investment.

The Desktop Management Interface

But network traffic isn't the only place we're losing control. The more than 80,000 applications and products that can be added to the PC have made it much more flexible, but they've also made it more difficult to control because they have no common form of management.

That's why Intel formed the Desktop Management Task Force with companies like AST,* Compaq,* DEC,* Dell,* HP,* IBM,* Microsoft,* Novell,* SunSoft,* Symantec* and SynOptics.* The goal was to create a technology that allowed manufacturers to design management capabilities and intelligence into their products.

Their answer was the Desktop Management Interface (DMI). DMI is a technology that defines a standard mechanism for accessing and configuring data in any piece of hardware or software.

Managing the PC's Many Pieces

DMI ACTS AS AN INFORMATION BROKER, ENABLING A LAN MANAGER TO GAIN CONFIGURATION DATA ABOUT THE DESKTOP AND ITS MANY PERIPHERALS AND APPLICATIONS. TAKE SOFTWARE DISTRIBUTION, FOR EXAMPLE. WITH A DMI-COMPLIANT MANAGEMENT APPLICATION (LIKE INTEL'S LANDESK™ MANAGER SOFTWARE), A LAN MANAGER CAN TELL WHAT VERSION IS CURRENTLY RUNNING, AS WELL AS GET INFORMATION ABOUT THE SYSTEM'S PROCESSOR, MEMORY AND DISK CAPACITY. THIS ALLOWS HIM TO SET UP THE SOFTWARE BASED ON THE CONFIGURATION AND FEATURES OF THE PARTICULAR PC, SIMPLIFYING THE INSTALLATION PROCESS.

TROUBLESHOOTING IS ALSO SIMPLIFIED BECAUSE DMI-COMPLIANT PRODUCTS CAN SUPPLY INFORMATION ABOUT AN ERROR, REQUEST, OR UNEXPECTED EVENT. FOR EXAMPLE, A DMI-COMPLIANT PRINTER WILL BE ABLE TO COMMUNICATE THAT IT IS JAMMED OR OUT OF PAPER, RATHER THAN SEND A VAGUE "CANNOT PRINT" MESSAGE.

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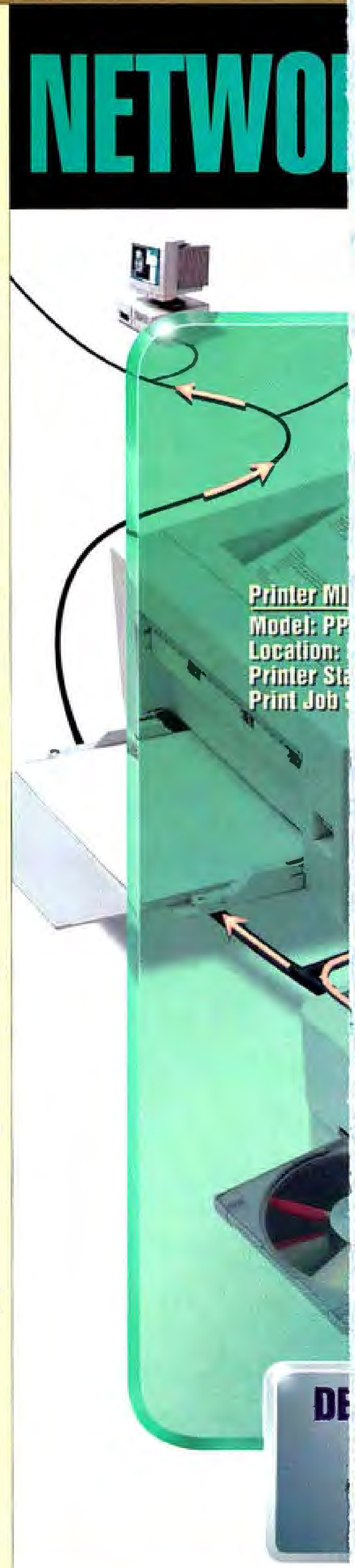
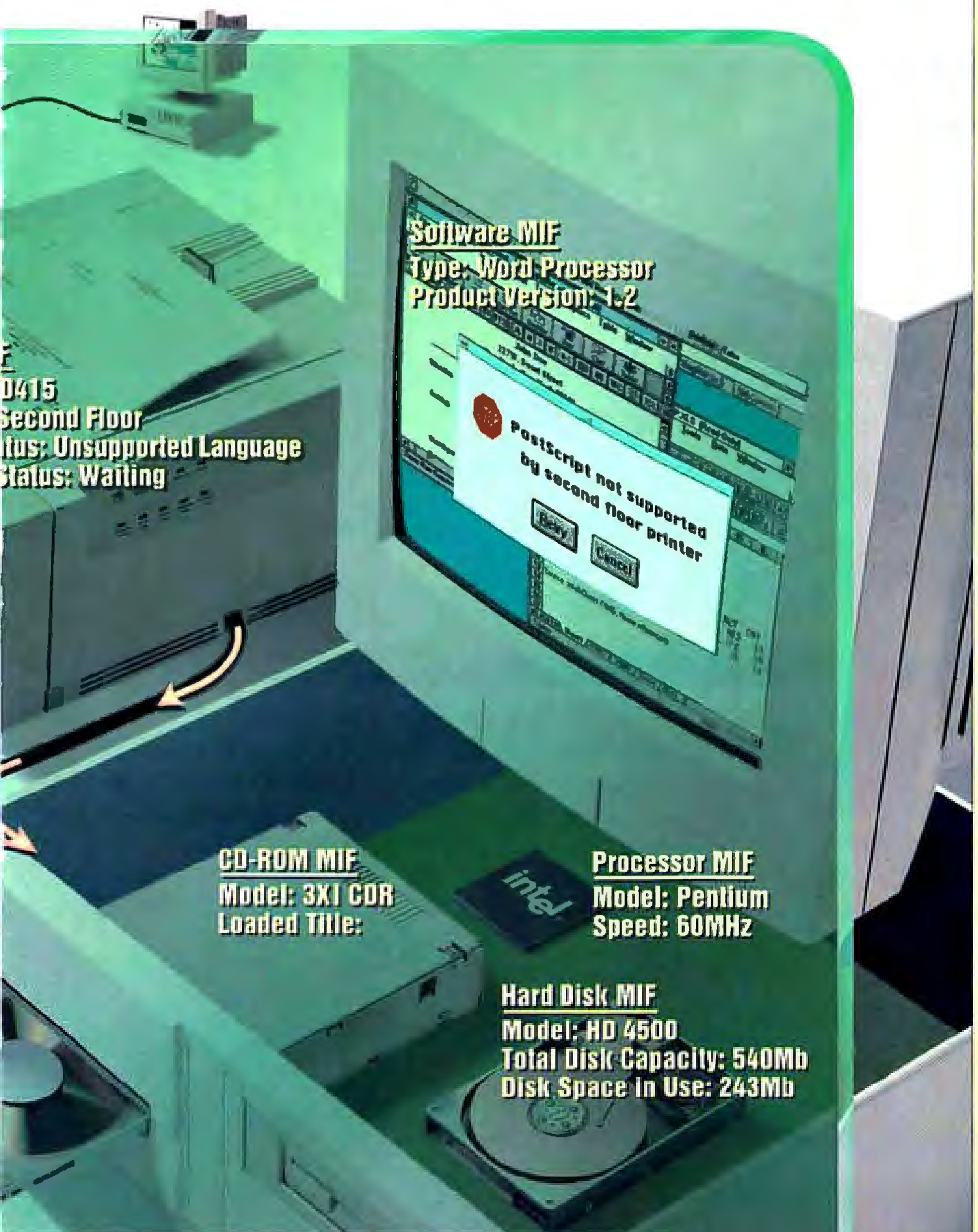


RKING TECHNOLOGY



SKTOP MANAGEMENT INTERFACE

DMI GIVES LAN MANAGERS A WINDOW INTO THEIR PCS, ALLOWING THEM TO MONITOR, MANAGE OR CONFIGURE NY DMI-COMPLIANT PRODUCT EITHER LOCALLY OR REMOTELY. USERS CAN OBTAIN SPECIFIC INFORMATION ABOUT THEIR NETWORK. FOR EXAMPLE, PRINTER PROBLEMS.

HOW DOES DMI WORK?

BASICALLY, DMI IS SOFTWARE CALLED THE SERVICE LAYER AND AN ASCII DATABASE CONTAINING MANAGEMENT INFORMATION FORMAT FILES (MIF FILES).

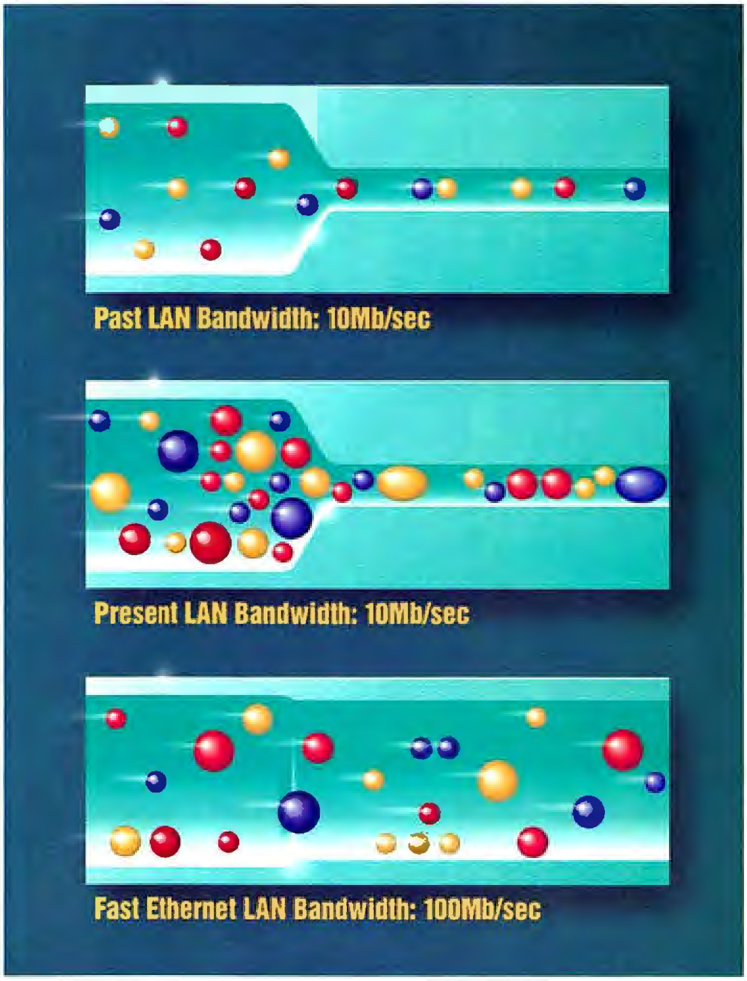
EVERY DMI-COMPLIANT PRODUCT SUCH AS A HARD DISK, CD-ROM, ETC. HAS ITS OWN UNIQUE MIF DESCRIBING ITS IDENTIFYING CHARACTERISTICS LIKE MODEL NUMBER, SERIAL NUMBER AND SPEED, AS WELL AS THE DEVICE'S MANAGEABLE CHARACTERISTICS, SUCH AS A MONITOR'S RESOLUTION.

THE SERVICE LAYER

WHEN AN APPLICATION OR HARDWARE PRODUCT IS INSTALLED, ITS MIF IS PASSED TO THE SERVICE LAYER AND THEN STORED IN A DATABASE ON THE PC'S HARD DRIVE. THE SERVICE LAYER IS SOFTWARE THAT RESIDES IN THE OPERATING SYSTEM AND ACTS AS A TRAFFIC CONTROLLER, HANDLING ALL REQUESTS FOR DATA IN THE MIF. THE SERVICE LAYER DYNAMICALLY NOTIFIES MANAGEMENT APPLICATIONS OF THE NEW DEVICE, THEN MAKES INFORMATION ABOUT THAT DEVICE AVAILABLE TO OTHER PRODUCTS—EVEN IF THEY'RE FROM DIFFERENT MANUFACTURERS.

Increasing Demands On Network Bandwidth

The average number of users connected to networks has almost doubled over the past few years. And the number of messages per user on the network has grown as well. But perhaps more importantly, these messages have grown in size. For example, e-mails often contain several documents or multimedia and graphics files. All of this puts a tremendous strain on network bandwidth. But with today's Fast Ethernet specification, the original 10 Mbps bandwidth is increased to 100 Mbps, providing more than enough room for the large number of users transmitting large quantities of data over the network.



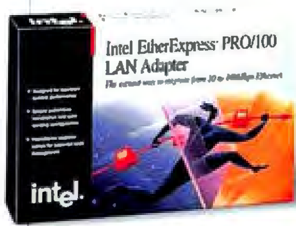
What do DMI and Fast Ethernet mean to Intel products?

In addition to developing these two new standards, Intel is incorporating them into their new networking products.

For example, the new Intel EtherExpress™ PRO/100 adapter cards utilize the Fast Ethernet standard, making them the first network interface cards to integrate seamlessly into your Ethernet environment at both 10 Mbps and 100 Mbps.

Intel's entire line of EtherExpress PRO adapters supports the DMI specification. Which means a LAN manager, working from any DMI-compliant application, will be able to access information about the adapter's address, IRQ, drivers and more for maximum network control.

DMI will also be supported in the next version of Intel's LANDesk Manager software, providing a robust, end-to-end solution.



Want to learn more? Call 1-800-955-5599.

For more information about the DMI and Fast Ethernet standards, or about Intel networking products that incorporate these technologies, just call our toll-free number and ask for literature package #207. Or dial Intel's FaxBack* at 1-800-525-3019 and ask for document #5572.

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242285-001

Blasts from the Past

As we approach our twentieth year of publishing BYTE, we'll be looking back at highlights from two decades of covering the PC revolution.

5 Years Ago in BYTE

The big story that month was Apple's Macintosh Portable. It's now considered cool to write off Apple's first attempt at a mobile Mac as a 16-pound goof. But it was an innovative box. It was the first with an active-matrix LCD. Thanks to the use of low-power components and clever power management tricks, the machine could run for 7 to 8 hours on a battery. And the trackball was built right into the chassis. Editors Tom Thompson and Frank Hayes were right when they predicted that the Mac Portable would have a big influence on mobile computers of the future. And most of all, Apple learned from its mistakes: The next portable out of Cupertino was the hot-selling, slim, and sleek PowerBook.

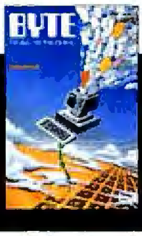
> **On the Market in October 1989**
> Gateway 2000 and Zeos were selling 20-MHz 386 machines—1 MB of RAM, an 80-MB hard drive—for $2995. Early adopters could go to ALR and buy the PowerCache 4, a 25-MHz 486, for $9990.

BASIC turned 25 years old and was given tribute in an article by famous BASIC programmer Bill Gates, who looked at the future and saw the language acquiring a visual component. "A visual BASIC program will be a mixture of code, programmer-written objects, and visually specified objects."

Optical computing was in the spotlight, with a look at optical interconnections, hybrid optic/electronic chips, blue lasers, and optical storage. Our forecast? "The 1990s should be the decade for introducing optics into computers." Surely we meant the later 1990s.

Jerry Pournelle, wanting to try out the new Ami word processor, spent 40 minutes installing Windows/386, only to be kicked into DOS. ("Clearly, there are some odd bugs in Windows/386.") He decided to stick with DOS and Desqview for the time.

10 Years Ago in BYTE



We took our first look at the IBM AT. With its torrid 6-MHz 286, the machine was about 2.5 times faster than the old PC. The base system came with 256 KB of RAM, but you could jack it up to 3 MB using *five* expansion cards. If you wanted a box with a 20-MB hard drive, monochrome monitor, and color graphics card, you had to shell out $6600. Our initial reaction? "The IBM PC AT is an impressive machine, but the most important reason for its existence has yet to arrive—a powerful multiuser operating system such as Unix." We promised to get back when Xenix was available.

IBM AT

> "Home computers must advance by a generation before they'll be useful. . . home users will need 32-bit CPUs and a megabyte or more of memory. . ."
> —Phil Lemmons, editor in chief, October 1984

> **Federal Vapor Squad**
> A Microbytes news item reported that Commodore Business Machines, with a slight nudge from the FTC, had agreed to the novel concept of not advertising "capabilities that don't yet exist." Commodore had promoted the CP/M capabilities of the C64 computer long before a promised Z80 coprocessor was available.

An ad for the Apple IIe touted the fact that you could increase its RAM to "an elephantine 512K." Yow! Not only that, but you could pop in a Z80 card and run CP/M. That same ad heralded the new Apple IIc ($1300, 128 KB of RAM).

With a Winchester drive "now within the means of the average owner," an article explained how to add a hard drive to an IBM PC. But you should be careful: "Adding a hard disk to your system might overload the power supply."

Another article told readers how to write a driver so they could use a Microsoft mouse with Lotus 1-2-3.

15 Years Ago in BYTE

You had to do it yourself back then, kids. Editor Carl Helmers described the processor board in part two of a series on building your own 6809-based personal computer system; he'd detailed the backplane design the month before. Down in his Circuit Cellar, Steve Ciarcia told you how to build an LED graphics display you could hook up to your computer. Another article explained how to interface the S-100 bus with Intel's 8255 chip. There were listings for programs that analyzed utility bills, traced genealogy, did least-squares fitting of data, and simulated 3-D graphics. ■

> **In the News in October 1979**
> Telecomputing Corp. of America started an on-line service that featured programs and databases, UPI files, airline schedules, and real estate listings. "The service will be available in 200 U.S. cities at $2.75 per hour." It was called The Source. . . . Shugart was rumored to be readying an 8-inch Winchester drive for less than $1000; it would hold 5 MB. . . . Atari received FCC approval to sell the Model 400 and 800 computers.
>
> 
>
> Atari 800

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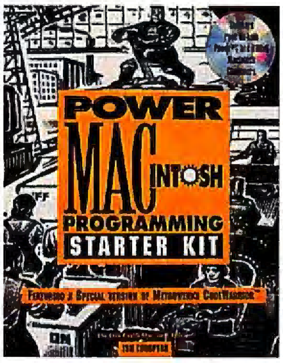


Build Power Macintosh Applications

RAYMOND GA CÔTÉ

With the introduction of Macs based on the PowerPC processor, Apple has raised the bar in terms of what the industry thinks is fast and powerful. In addition, the latest version of System 7 for the PowerPC has some unique (and confusing) system extensions that take advantage of this new processor. Along with the new computer systems come new development environments, in particular, Metrowerks CodeWarrior.

In the midst of this ever-increasing complexity, Tom Thompson, a BYTE senior technical editor and an Associate Apple Developer, has written a simple and wonderful book, *Power Macintosh Programming Starter Kit*. "Simple" describes its clear and concise coverage of program development for the PowerPC. "Wonderful" characterizes Thompson's ability to explain the sometimes subtle distinctions between developing for a 680x0 Mac and the new Power Mac.

Power Macintosh Programming Starter Kit lets you immediately start producing your first Power Mac applications. It includes a CD-ROM that contains a limited version of the Metrowerks CodeWarrior C compiler and debugger that runs on both 680x0 and Power Macs. With it, you can build and test all the sample programs in the book.

At first glance, this book may seem a little too basic. It starts by providing a brief history of the Mac and sets the stage for where the PowerPC fits into the environment. Next, several chapters walk you through Metrowerks CodeWarrior and help you build your first application in that environment. Don't, however, be deceived. It is rare to find a programming book that uses Process Manager calls as a beginning example. Even the second example, a simple text-munging application, manages to stay interesting by introducing the Core Apple Events set and implementing a drag-and-drop interface. In short, these may be toy demonstration programs, but Thompson has made the effort to ensure they fully comply with Apple development and user-interface guidelines.

This attention to detail can be found throughout the book. Through simple examples, you'll work through the Code Fragment manager, build fat binaries (i.e., programs that can run in native mode on both 680x0 and Power Macs), and patch system-level traps. At no point during the process will you feel lost or out of your depth. The book eases you into deeper waters, where you suddenly discover to your delight that you know how to swim. Closing chapters include high- and low-level debugging techniques, porting considerations, and listings of all the sample programs (also included on the CD-ROM).

If you are new to programming and you have just purchased a Power Mac, *Power Macintosh Programming Starter Kit* will help you through your first applications. It will also guide you deeper into the Mac Toolbox than most "getting started" programming books. If you're a seasoned Mac developer, pick up a copy, too. The chapters on building fat binaries and patching PowerPC Toolbox calls alone are worth the price. ■

POWER MACINTOSH PROGRAMMING STARTER KIT

Tom Thompson
Hayden Books
ISBN 1-56830-091-3

$39.95

Raymond GA Côté is a BYTE consulting editor and vice president of product development at Appropriate Solutions (Peterborough, NH).

SCIENCE AT YOUR FINGERTIPS

MCGRAW-HILL MULTIMEDIA ENCYCLOPEDIA OF SCIENCE & TECHNOLOGY **McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020, (212) 512-2000, $1300 for single-user version (annual update, $325), $1600 for two to eight workstations, $1800 for nine to 20 workstations (annual update for network versions, $425)**

It can be intimidating when you start to skip around the McGraw-Hill Multimedia Encyclopedia of Science & Technology. Packed onto the CD-ROM are 7300 articles in 81 disciplines; 105,100 terms; 122,600 definitions; 550 color photos, drawings, maps, and charts; 39 animation sequences, which is a particularly powerful way to convey complicated scientific concepts; and nearly 40 minutes of audio. I quickly got the feeling that there is quite a bit about science I don't know.

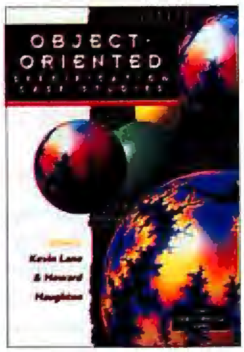
But perhaps *intimidating* is the wrong word to describe this large collection of scientific information. On second thought, *intriguing* is a better word to use because it's all too easy to spend countless hours exploring this treasure trove of technical topics. You can, for example, hear sound as it travels through the human ear, watch the continents separate, or see the heart pump blood. This is a powerful way to learn science. If, on the other hand, you need a quick definition, you can zero in on information by keyword, Boolean, hypertext, and context-relevant searching.

McGraw-Hill (which is BYTE's parent company) plans to update the CD-ROM on an annual basis. You'll need at least a 386 PC with 4 MB of RAM, a hard drive, an ISO 9660 CD-ROM drive, and Windows 3.1. I can't think of a school or library that shouldn't have a copy of this massive work.

—Rich Friedman

FUTURE OBJECT-ORIENTED LANGUAGES

OBJECT-ORIENTED SPECIFICATION CASE STUDIES edited by Kevin Lano and Howard Haughton Prentice-Hall, ISBN 0-13-097015-8, $39



Once we get beyond Visual Basic and C++, do we know just where OOPLs (object-oriented programming languages) are headed? This book attempts to answer that question. It applies the mathematical structure of formal methods to OOPL design. It describes a number of leading-edge languages and provides detailed specifications for their syntax and how they can be used.

The editors begin *Object-Oriented Specification Case Studies* by showing how two commonly used object-oriented structured methods for specification and analysis—Object Modeling Technique and Object-Oriented Analysis—can model various types of objects. With these analytical tools under their belt, Lano and Haughton compare a number of OOPLs that are still in the theoretical and developmental stages. Finally, they show how these languages can support design and specification activities at various points in the software life cycle.

After laying this groundwork, the editors then turn the book over to a series of case studies written by a variety of international contributors. First, three researchers from the Federal University of Pernambuco, Brazil, show how to specify the Unix file system using the language MooZ.

Next, two computer scientists at the University of Queensland, Australia, introduce Object-Z and use it to specify a mobile-phone system. Lano and Haughton themselves present Z++ and show how it might be used in a machine-recognition system. Two Oxford University researchers discuss OOZE (Object-Oriented Z Environment) and show how to use it in sample applications involving bank accounts and block-structured symbol tables.

Moving to Smalltalk-based OOPLs, a colleague of the editors at Lloyd's Register in the U.K. discusses object orientation in VDM++. The editors discuss Fresco, a proposed but incomplete environment for building reusable software components. Wrapping up this array of little-known systems and OOPLs, two Brazilian researchers discuss SmallVDM, a development environment and tool set.

You should be aware right from the start that this book is not easy sledding. It presumes that you are familiar with a considerable number of highly technical and abstract areas, including object orientation and various ways of formally specifying computer language syntax and structure. Also, it is difficult to fully understand many of the examples if you are not well acquainted with Z—a language/notation system that I had not encountered prior to opening this book. Because Z is the basis for so many of the languages studied here, it's unfortunate that the editors neither describe nor discuss it directly. Despite this limitation, if you want to find out the directions that OOPLs are headed, this book will probably give you what you need. ■ —*Russell Kay*

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The Network with Smarts

New agent-based WANs presage the future of connected computing

ANDY REINHARDT

Whether fronted by a character-mode or a graphical interface, or whether built on a mainframe, a Unix server, or a stand-alone PC, traditional on-line services and WANs share a basic assumption: Bits travel from one end to the other over a dumb pipe. The minicomputers at the core of CompuServe, the desktop PCs and Macs calling America Online, and the laptops dialing into remote-access servers have all the brains, while the networks to which they attach know virtually nothing—other than the addresses of the sender and recipient—about the messages crossing their wires and waves.

All that, however, is about to change, as a new generation of "smart" networks comes on-line. Drawing on the efforts of thousands of researchers and programmers in the telco, Internet, and on-line communities, General Magic (Mountain View, CA), AT&T (Basking Ridge, NJ), and IBM (Armonk, NY) are developing network services that will change the very definition of a WAN. Instead of being a mere conduit for applications executing at its endpoints, the network becomes a host for distributed applications that execute inside and outside the "cloud," or perimeter, of the wide-area service. Sun Microsystems got it right years ago when it prophesied that "The network is the computer."

The end-user device connected to the smart WAN can be simple or state-of-the-art, stationary or mobile. The network can adjust itself to the access device, and an application assumes the presence of a flexible communications infrastructure. The user and applications developer are shielded from the ugly complexity of networking and communications, and service providers can reach new audiences without tailoring their offerings to a specific delivery platform.

Instead of relying only on real-time, connection-oriented sessions, smart networks make extensive use of store-and-forward messaging transports. They are designed to host software agents, or proxies, that move around the network, routing or filtering messages sent to a user and seeking out information or services on the user's behalf. Agents can work all the time, even when users are asleep.

The advantages are powerful: Agents make data networks smarter about people, instead of requiring people to be smart about networks. They let you focus on getting your job done, rather than on the details of how to communicate. You can get the messages you want wherever you are, prioritize your work, and eliminate the chaff. And agents help you find information or services without having to know about and delve into every corner of the network.

The first commercially available agent-based WAN, from AT&T, is slated to come on-line this fall, but it will take years before smart networks are common. In the near term, their growth will be limited by their novelty—especially by misunderstanding and mistrust of agents—and by the cost of switching from existing solutions. However, over time, agents will be an essential component of networks because they provide a flexible means of accommodating the exploding variety of devices and services.

Distributed Intelligence

The emergence of the intelligent backbone is occuring in parallel with advancing capabilities at the endpoints of the network, such as LAN server–based telephony services, desktop telephony APIs, and more communications-enabled applications (see "Computer Telephony," July BYTE). In fact, a rivalry is shaping up among players (e.g., computer and peripheral makers, software companies, and some phone equipment suppliers) who build advanced telephony products for the desktop and those companies (e.g., carriers, packet-network services, and some equipment suppliers) who want to push intelligence into the network itself and profit from increased fees and usage. These approaches are not mutually exclusive; some companies, such as AT&T, straddle both camps and stand to benefit in either scenario.

For example, one emerging software category is the "universal inbox," a single place where faxes, E-mail, and voice messages are collected and presented to the user. Apple first implemented such a capability in System 7 Pro, and Microsoft is building one into Chicago that, if used with services that support Windows TAPI (Telephony API), will handle all these message types. Third-party products are also available, such as OneView from Centigram Communications (San Jose, CA). But doing this task on the desktop is only one approach: Carriers aim to support it as well in their networks, making messages accessible to a user from work, home, or on the road.

The Mobile Worker

No matter how widespread client-side telephony applications become, smart backbones are bound to flourish because of inherent technology and market shifts. One driving factor is the transition to mobility and wireless networking. Wireless links are more expensive, less reliable, and slower than land lines, so real-time connections are harder to maintain, and the exchange of rich media is impractical. Good wireless protocols tolerate interruptions and quality degradation and are designed to connect, exchange brief messages, and sign off; store-and-forward messaging is thus the best solution for intermittently connected computing. Mobile devices, with their premium on size, weight, battery life, and low cost, also aren't well-suited to resource- and bandwidth-hungry RPC (remote procedure call) mechanisms. When you add the complexity (from a service provider's point of view) of supporting multiple devices (e.g., a laptop, an organizer, a pager, and a cellular phone) per user, there's an obvious need for lighter-weight and more flexible architectures than traditional terminal processes, RPCs, and virtual circuits.

This is where agent-based networks shine, because they work well on connectionless, low-bandwidth infrastructures. Agents facilitate mobile attachment, relieve work from remote systems (permitting them to be smaller and cheaper), and simplify interfacing with multiple devices and back-end services. Traditional WANs let you accomplish work only when you're connected or, if responsibility is pushed out to the client, require data reconciliation during connect sessions. Agent-based WANs, by contrast, let you inject a task into the network that executes whether or not you are connected. The agent operates continually, as near to the data as possible, minimizing network traffic and reducing how much the user's system and the back-end service need to know about each other. When it has results to report or needs further guidance, the agent finds its way back to the sender.

A classic example is E-mail filtering and routing. In a client-based implementation, the rules engine lives on your system, not on the network, so messages aren't processed or screened unless you are attached to your mailbox. In an agent implementation, the rules execute on the network when you're not connected, and your mail filter can even contact you via pager if you receive an urgent message. This scenario could be implemented as a conventional server process, but it would be network-specific and have to be programmed in advance. Agents permit greater flexibility; for instance, they could teach a server new message-handling techniques by injecting a mail-filtering method.

New Services

AT&T's PersonaLink and the as-yet unnamed offering from IBM Intelligent Communications Services are new agent-based systems. These services use different architectures from one another and aim at widely different audiences and applications; however, both provide an agent-based message-handling and information-delivery platform.

AT&T's PersonaLink, built around General Mag-

Don't Write Off the Internet

AT&T says it had to start from scratch to create a state-of-the-art network capable of supporting agents and agent-based applications, such as shopping and smart mail. While there's surely truth to this claim, it may be slightly self-justifying or merely a reflection of how radically the company had to confront its own cultural biases. It doesn't mean, however, that everybody has to start from scratch.

The most noteworthy example of a more incremental approach is the Internet, which is nothing if not resilient. People are now working to add technologies such as security, encryption, and agent-passing to the Internet, and someday it could offer functions similar to those of PersonaLink.

The most immediate option is CommerceNet, a set of commercial services built on top of the Internet. A group of organizations headed by Electronic Information Technologies (Menlo Park, CA), Stanford University's Center for Information Technology, and the Bay Area Regional Research Network (BARRNet), with a membership that runs from companies like IBM, Intel, and Pac Bell to Citicorp and American Express, is promulgating standards and technologies to address the Internet's weakness in security, lack of billing capability, and need for a good user interface. Using RSA public key encryption, the Mosaic front end, and other widely supported technologies, the CommerceNet consortium aims to "business-enable" the Internet and thus allow its commercial potential to be exploited. The key breakthrough is an enhanced version of the basic World Wide Web HyperText Transport Protocol, called Secure-HTTP, that will allow secure, authenticated comunication of information among Web clients and servers.

For agents, Safe-Tcl (Tool Control Language), a limited version of the Tcl scripting language for Unix, is emerging as an adjunct to the MIME (Multipurpose Internet Mail Extensions) E-mail standard. Safe-Tcl scripts embedded into MIME messages can travel to remote systems and execute there with less risk of performing dangerous activities. Release 1.0's Jerry Michalski asks rhetorically, "Is [Safe-Tcl] Open Telescript?" He responds that while they are similar (robust and extensible scripting languages that use tunneling), they are emerging from different cultures and have different front ends. Safe-Tcl builds on the extensive Internet infrastructure, whereas PersonaLink has to start from scratch.

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Audible Alarm	YES	NO	YES
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Site Wiring Fault Indicator	YES	NO	YES
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Model	Minuteman A500	APC BK600	Tripp Lite Omni 500
PRICE	$289	$399	$379
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Line-Interactive	YES	NO	YES
LED Status Indicators	YES 4-LED's	NO	YES 4-LED's
Site Wiring Fault Indicator	YES	YES	NO
Test Button	YES	YES	NO
Self Diagnostic Test	YES	NO	NO

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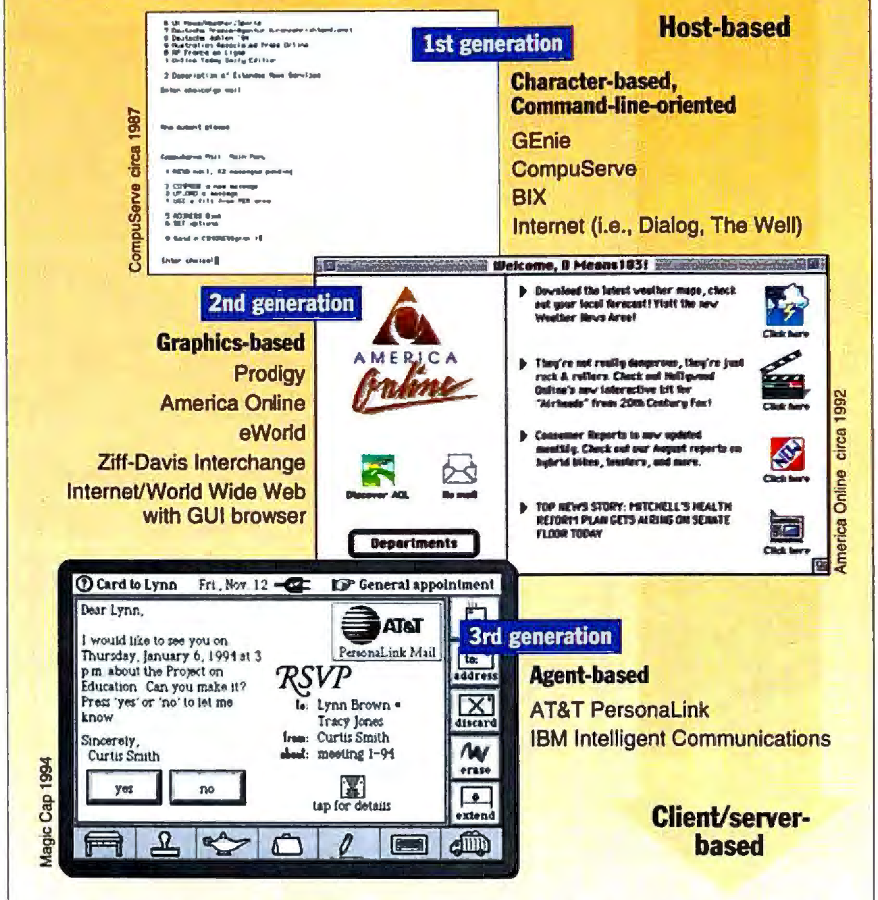

The evolution of on-line services has mirrored general computer technology, from host-based to client/server, and from character-based to GUI and now to agents. In first-generation services, information came from the host, and all the work was done there except for local screen-rendering and locally maintained address books, message folders, and downloaded files. Second-generation services introduced GUIs and the exchange of graphics primitives; more computer power was presumed to be on the user's side of the pipe, and the architecture shifted subtly toward client/server. In agent-based services, roving software objects can conduct business on behalf of users even when they aren't connected to the network.

ic's Telescript technology, is an electronic community for E-mail, information retrieval, and on-line shopping slated to become available this fall in the U.S. only (for more on Telescript, see "Agents Away," May BYTE). The network consists initially of centralized servers accessed by 800-number service or wirelessly through the Ardis packet radio network underneath Motorola's MNI (Mobile Network Integration) service umbrella. Eventually AT&T will add local-access nodes on a nationwide packet network, expand to distributed servers, and add service in other countries.

Using PersonaLink requires Telescript-enabled devices and "Telescripted" software. At first, this means that only two devices will work with PersonaLink: the Motorola Envoy and the Sony Magic Link. Both are handheld computers (or Personal Intelligent Communicators) designed around General Magic's Magic Cap operating system, which has Telescript built in. Additional Magic Cap devices are expected to be introduced in 1995 by General Magic alliance members Philips and Matsushita, and perhaps eventually by Apple or AT&T. Also in early 1995, General Magic is expected to release Magic Cap software for Windows and the Mac OS, which will make it possible for Macs and DOS/Windows machines to talk to PersonaLink.

IBM's Ambitious Service

IBM's Intelligent Communications service, slated to start up in 1995, is a different beast. It will be a communications "super-service," a hub for routing and translating communications from one service and medium to another: desktop to mobile, PDA (personal digital assistant) to mainframe, E-mail to fax, and text to speech. For instance, once it is fully implemented, you might send a cc:Mail message into the service from your desktop, use a wireless Newton in the back of a cab to view a fax, and then have the network read your IBM PROFS mail to you over a cellular phone. The sophisticated routing features would let you specify a scenario, such as "If I get a fax from Toshi regarding the Kyoto project, please run it through OCR and read it into my voice-mail box, send a copy of the text to Barbara, and forward the fax image to the optical-archive mailbox in the legal department."

Outside the Intelligent Communications cloud, IBM doesn't require new devices or protocols or applications; on the contrary, it welcomes and supports virtually any communications technology now in use. But inside the cloud, it uses an innovative agent architecture that isolates subscriber profiles and preferences from access devices and service providers, all under the aegis of centralized billing, security, and authentication.

These two services symbolize different concepts of the agent network. PersonaLink is an applications environment, a built-from-scratch messaging platform through which third-party content and service providers can deliver information, entertainment, and shopping. It is aimed at individual consumers, especially because it will be reached initially through the user-friendly Magic Cap interface. It's not meant as a message gateway, although it will support Internet and X.400 mail, fax, and paging. And while Telescript could someday become the lingua franca of wide-area communications, PersonaLink does not now support a diversity of access devices.

By contrast, Intelligent Communications is an umbrella for smart message routing, a giant gateway for consolidating wide-area communications among mobile professionals. It will relieve corporations of the considerable burden of creating and maintaining their own networks, but it's not an applications environment per se. User and service programs still execute outside the cloud, but they can become network-enabled by supporting Intelligent Communications APIs and object standards.

In a sense, PersonaLink takes the longer view, to a future where software agents act out human wishes; it provides a marketplace for agents or a framework for negotiation between customers and suppliers. Intelligent Communications is more about the here and now, addressing the frustrations and desires of today's mobile and on-line users. However, its state-of-

the-art solution is designed with a clear eye to the future.

Intelligent Communications

When IBM set out to design Intelligent Communications, it surveyed mobile users about their problems and wishes and assembled from these a set of objectives for the service. The studies showed that users had trouble with "roaming" among carriers and desired a seamless network with a single point of customer support and one bill. They also disliked having to check multiple inboxes for voice mail, public and private E-mail, and faxes. They complained of information overload and asked for new ways to filter and prioritize messages and for a means of event notification for important messages.

The key attributes of IBM's solution, says Doug Sweeny, the general manager for Intelligent Communications, are personalization and integration. The service lets you tie together everything you're already using, create custom message-processing scenarios, and wrap it all in the interface of your choice. You can also receive information (e.g., headlines, weather, and stock quotes) from third parties in the form of messages sent to your inbox. "We use intelligence to mask the complexity of the network, and we use agents to help you gather, prioritize, and automate handling of messages," Sweeny says.

In AT&T's PersonaLink, all devices and programs must be tooled to speak Telescript; in Intelligent Communications, they speak in their native vocabularies, and the cloud translates for them. And instead of opting for the lowest common denominator, these translations are aimed at the highest capability level supported on each platform. Thus, a rich text document might be converted to simple text for display on a pager's LCD but could appear as-is on a graphical Newton.

Intelligent Communications uses a modern, message-based, interprocess communication architecture in which tasks are insulated from one another by published interfaces. As in contemporary system object frameworks, no direct "hard-wired" interaction occurs between processes; rather, their communications with one another are passed through an arbitrating layer or channel. This software layering lets Intelligent Communications achieve its goal of total neutrality.

The service is neutral with respect to devices: Any manufacturer's products can work with it, and all services are available to all devices within their inherent limitations (e.g., a cellular phone cannot display faxes). By separating presentation from service, the IBM network permits users to continue using their current devices, environments, and applications. It is also neutral with respect to carriers, media (land line, cellular, CDPD, X.25, or ISDN; low-bandwidth or intermittent), and protocols. Carriers can maintain their own directory services or systems management capabilities without affecting the behavior of IBM's service.

At the back end, the same kind of abstraction applies. Service and content providers can join the network with their existing offerings, which are virtualized to appear as Intelligent Communications objects, or they can retool their service interfaces to accept and emit Intelligent Communications objects. As long as the service provider is willing to bind to an enabling library or to support emerging standards such as OLE or OpenDoc, users can tap into their services without starting from scratch.

Intelligent Communications will run over a variety of media, including Ardis packet radio, the joint IBM/Sears Advantis network, and (unannounced) third-party phone and packet networks. It will offer gateways to Prodigy, the Internet, and most other public and private E-mail systems. The core hardware servers are IBM RS/6000s running AIX (just like the Internet backbone that IBM co-operates under contract to the federal government), and the basic internal network protocol is TCP/IP. Intelligent Communications uses X.500 directory services internally but will, in principle, be able to make use of external directories (i.e., in enterprise or carrier systems) as well as to publish its own directories to these external systems. The service will accommodate two kinds of network traffic in its first release: analog voice and asynchronous data.

Foxy Proxies

The key to making Intelligent Communications work is its use of proxies, or *agents*, that stand in for subscribers, devices, mailboxes, and services (see the figure "Intelligent Communications"). The network never connects subscribers directly to services, because, IBM says, this can force application-specific coupling between the front end and back end, inhibit support for transparent mobility, and limit opportunities for adding intelligence (and value) to a subscriber's use of the service. Likewise, directory inquiries never discover the actual network address of a service; instead, all such interaction is arbitrated through the cloud. As a result, users never have to know how or where to find a service, and service providers never have to understand how to interact directly with a subscriber unit.

Inside the cloud, "the currency of the network is objects," says Mac McInerney, assistant general manager of development for the service. Intelligent Communications objects are self-descriptive, containing both static data and dynamic scripts; their presentation and interface elements are highly abstracted so that the information they contain can be adapted to the context in which

IBM's Intelligent Communications

IBM's Intelligent Communications is a messaging hub that seamlessly connects virtually any subscriber device to any back-end service, translating among formats as necessary. Its key architectural component is proxies, or software agents, that abstract the characteristics and preferences of users, devices, routing paths, and service providers. Proxies will let you access a LAN-based E-mail system from your notebook at one moment and later have a host-based news feed read to you over a cellular phone.

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it is being presented. Therefore, a list box on a laptop GUI could convert automatically to a spoken selection menu in a telephony interface.

The *subscriber proxy* virtualizes the characteristics and preferences of a user. Every subscriber (including services) has an entry in the distributed X.500 directory, including name, phone and fax numbers, physical address, and home location (home location is the default service node where a user attaches to the network). Mobile users can also shadow their home location in another place for faster response times. Because the network is distributed, your subscriber proxy is available to represent you anywhere you log in.

Information about the device or devices you use to attach to the network is contained in *device proxies*, which are independent of the subscriber proxy. Thus, the same person can connect at one time with a PC and at another time with a telephone, and Intelligent Communications will accommodate the difference. Even endpoints that have been tooled to directly accept and emit objects talk through "lightweight" proxies that administer functions such as security and billing.

Device proxies hold information about each machine's ability to present various objects, knowing, for instance, that one system has a color screen and keyboard while another has a monochrome screen and stylus. Devices can limit the *abilities* they expose at any given time, so if you wanted to receive your E-mail in spoken form while driving, your PDA could represent itself for the time being as speech-only. These proxies also understand network access methods, so delivery can be optimized to the medium being used; thus, you could automatically postpone transmission of a video clip during a wireless session until you were later connected over a T1 link.

It is in conjunction with the device proxy that IBM's remarkable format translations occur. For now, these include text-to-fax, fax-to-text (via OCR), and E-mail and document format conversions. Down the road, IBM plans to support a speech-based user interface and will add speech recognition, as well as text-to-speech and speech-to-text transformations.

Murray's Low-Priority Folder

The *Alter Ego* is a programmed rules engine that represents a user's routing preferences (including how accessible the user wants to be). Over time, IBM says, this will evolve into an adaptive inference engine that learns through observation how you work and what you like. The first level of the engine does fast routing of real-time interactions, such as phone calls and paging. The second, deeper level handles non-real-time events in negotiation with other network services or Alter Egos; for instance, following the instructions "If I get mail from the CEO, page me; if I get any faxes from Finland, forward them to my hotel in Orlando; send all other mail to Murray," Murray's Alter Ego might say, "If I get mail forwarded to me from anybody, put it into my low-priority folder."

The *service proxy* is, in some senses, the most important of all, because it is through this mechanism that IBM hopes to accommodate its huge mainframe customer base and the great majority of information databases that now use legacy systems and software. The service proxy virtualizes the back end, making it appear to the network like an Intelligent Communications object. This way, you can mask a programmatic API (e.g., use the proxy to issue a SQL query against a DB2 database) or even a terminal interface. The service proxy can also serve as a gateway to LANs.

Service proxies know about service addresses, network types, protocols, and billing systems, yet they hide these details from a user. "Intelligent Communications–adapted" services retain their native interfaces and rely on the proxy for translation to and from the object framework. "Intelligent Communications–enabled" services go a step further, tailoring their front ends to accept and emit Intelligent Communications objects. One advantage for the vendor in full-enabling is that it may reduce network traffic between the service platform and the network.

Intelligent Communications supports legacy services with a proxy that acts as a terminal emulator, operating a session between only itself and the host. By encapsulating the entire legacy system in an object wrapper, IBM allows traditional information providers to offer services on the network without immediately retooling their interfaces or downsizing to servers. The service proxy also solves potential timing problems, because real-time communication occurs between only the proxy and the service, not end to end from the subscriber device to the host. This decoupling frees a user to access session-oriented services over less predictable wireless transports.

The real advantage of the service proxy is that it lets providers, even small outfits lacking programming expertise and resources, get onto the network easily. AT&T wants to encourage similar participation with PersonaLink, but making the leap to Telescript requires more up-front investment. After all, how many neighborhood flower shops or pizza parlors will be able to set up and maintain an on-line, object-oriented merchandising server?

This Link Is Personal

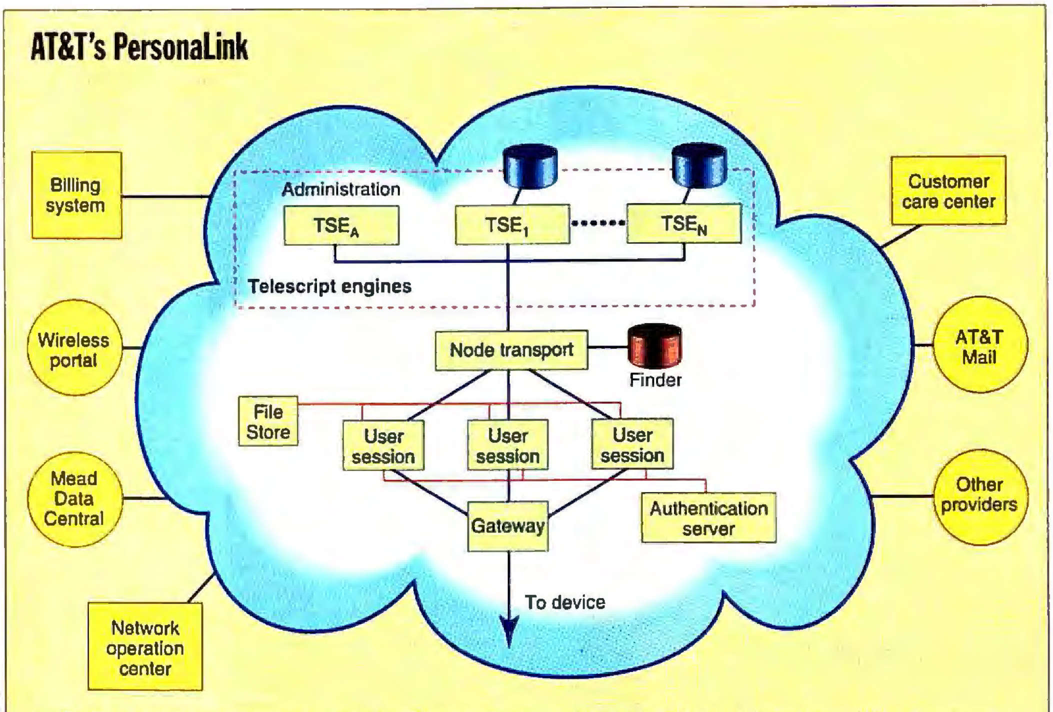
From the very beginning, AT&T has viewed PersonaLink as both a toehold into future business opportunities and a test bed for emerging network concepts. Says Gordon Bridge, president of AT&T EasyLink Services, the division that includes PersonaLink: "This was our first opportunity to develop an end-to-end solution based on connectivity—not piecemeal, not retrofit, but from scratch." What this includes, Bridge notes, is a new operating system, new devices, a new network, new customer-service programs, and new billing services—in short, "every aspect of the infrastructure is green field."

AT&T took this risk in part because it wanted to explore and validate new ideas in network management and business organization, something too dangerous and expensive to undertake on the existing phone and data networks. "It's very hard to change a service once it's up and running, so we architected PersonaLink the way it ought to be done from the beginning," says Joe Gigas, network operations manager.

For reliability, the service uses features such as redundancy, self-healing, and performance-based monitoring (i.e., setting targets based on actual user throughput and capacity, instead of arbitrary internal factors such as disk utilization or error rates). And, in a break with the past, PersonaLink uses almost entirely standards-based hardware and software management (e.g., SNMP and HP OpenView). As a result, it requires much less human supervision than traditional telco networks and can run on less expensive off-the-shelf equipment. Much of the internal operations management is performed via Telescript agents that query services and report results. "This is a model for future network design and management," Gigas says.

In its initial release, PersonaLink is centralized, but it's designed to be scalable and distributed. Built on RISC-based symmetric multiprocessor servers running Unix, the service operates out of four data centers (one for the core Telescript engines, and one each for network operations, customer support, and billing) connected by T1 (private, 1.544-Mbps) data lines. In-

AT&T's PersonaLink



AT&T's PersonaLink now employs a centralized architecture, but it's designed to be distributed. Users connect through gateways from 800-number or wireless services and are immediately authenticated. Only then are their agents accepted and passed through a node transport subsystem to an appropriate Telescript engine. The PersonaLink customer-support, billing, and operations centers are separate entities from the service core. PersonaLink will have mail gateways to AT&T Mail and from there out to X.400 and the Internet. Mead Data Central will provide a news feed to PersonaLink subscribers.

coming calls to the 800-service or from Motorola's MNI are routed to a terminal server/router and from there across Ethernet to the server core. In the initial release, all third-party services, such as shopping and information, are centralized at AT&T, but in the future, third-party Telescript engines can run anywhere.

Agent Foundation

Aside from its genetic use of agents, PersonaLink is different from previous services in several ways. It's designed to support multimedia message types, including voice, graphics, and annotation, and, of course, it supports intelligent routing and smart mailboxes. All addressing is done with human names, not strange numbers or codes, and it uses advanced security provisions, including automatic encryption of all communications.

A typical PersonaLink scenario begins on a hand-held device running the Magic Cap operating system. To create a message, the user selects a recipient from a local address book or queries PersonaLink for an address and then writes the message using a local text processor. Magic Cap includes a drawer of "rubber stamps" for messages (e.g., Urgent), which appear as icons on the message as well as translate into Telescript handling instructions.

The finished message is combined with a script that tells it how and where to go, thus becoming a mobile Telescript *agent*. The script starts executing locally because it could include instructions for, say, accessing the local file store. But when the Telescript engine encounters a `Go` operation, it stops executing the script and readies the agent for transmission by saving all the variables, pointers, and stack values. If the *place* to which the agent is going is on the local machine, it is sent there; otherwise, it's wrapped up in a message, encrypted by a local RSA-like public key encryption routine, and dispatched across the WAN.

This "bag of bits," as AT&T calls it, travels to its destination over a live connection. When it arrives at the PersonaLink service node, it passes through a gateway process where it is immediately dispatched to a dedicated authentication and security server (see the figure "AT&T PersonaLink"). PersonaLink uses two-way authentication (unusual in on-line services), in which both the device and the service must prove to each other that they are legimate. Rogue devices are thus prevented from logging on and, conversely, users can't dial in to a phantom service that pretends to be PersonaLink and steals personal data, mail, or merchandise orders. The authentication server also decrypts the message.

Once past this security barrier, the agent is copied to a file store for backup, and only at this point is the connection with the sending device broken. The device can then carry on with other activities while the agent does its job at the PersonaLink service.

First, the agent goes to a node transport subsystem, which looks up the recipient's mailbox address in the Finder database. It then goes to the mailbox (itself a stationary Telescript agent), which can decide whether or not it wants to accept the agent. If it does, the message is unwrapped, and the script continues to execute.

Even at this point, no interaction has occurred between the mobile and stationary agents. Only when the Telescript engine encounters a `Meet` command in the mobile agent do transactions (e.g., mail delivery) occur between the two. Of course, interactions between agents can be used for applications beyond E-mail. For example, a user on a device could send an agent to pick from the available seats at a concert or to pick a book from an on-line catalog.

In the first release of PersonaLink, the smart mailbox will allow users to filter and route incoming messages based on sender or contents, to auto-forward messages to another mailbox or fax machine, to auto-delete messages, or to be notified via pager that a message has arrived. Mead Data Central will provide a news feed (i.e., headlines, stocks, sports, and weather). A shopping "mall" from start-up eShop (San Mateo, CA), which will front other electronic merchants still to be announced, will appear shortly after the initial release date.

PersonaLink's software architecture allows for a mixture of data sources; for instance, to reduce data transmission needs, an electronic catalog, including images, graphics primitives, templates, and parts lists, could be shipped to users on a disk or PCMCIA card. Then the only data that would be necessary to send over the line would be new items, current prices, and spot sales. Another way Telescript preserves bandwidth is by exchanging only "reference pointers" to objects that already exist on the target platform. For instance, most icons exist in firmware on Magic Cap devices, so if they're used in an incoming message, they can be referenced instead of being sent from the server.

continued

In adherence with a "shoppers bill of rights," AT&T won't provide back-end vendors with information about individual users. But PersonaLink will be able to monitor behavior such as frequent trips by a user to a given store. Then, when the user returns to that store, the network could flag this to the vendor, who might decide to offer an on-the-spot discount or some other purchase incentive. (The only way a vendor will be able to "acquire" a customer name is if a user buys something from a vendor, just as it is today in the real world.)

Teaching New Tricks

The ultimate benefit of Telescript's agent architecture to users and vendors (and to AT&T) is the flexibility it affords. Contemporary on-line services are generally monolithic: To add a new feature to AOL or Prodigy requires that it be written into the core, carefully tested, and brought online without disrupting 24-hour access. PersonaLink is also aiming for 24-hour service, but its design allows agents to teach the network new tricks all the time. "We didn't have to build in all the capabilities ourselves," says Alex Gillon, director of technology development for PersonaLink Services. "This has huge implications for network design and management, because we don't have to keep turning over the network software."

PersonaLink's open design could unleash a cottage industry of agents: Perhaps someone will build a better mailbox or devise an agent to find Rolling Stones tickets. But the service also needs to be protected from disruptive or merely badly written agents; hence the major emphasis on security provisions (see the text box "Telescript Security").

AT&T's PersonaLink and IBM's Intelligent Communications share their use of agents, their openness, and their enormous ambitiousness. IBM is looking for a way to keep its bread-and-butter large accounts in the fold, and Intelligent Communications will offer these customers a way to enable legacy applications with mobile access. Rather than see customers drift away to distributed computing solutions from other vendors, IBM is providing the much-needed glue to pull together public and private E-mail, text, image, voice, and paging under a single umbrella—even if some or all of these services run on non-IBM platforms. While it's refreshingly ecumenical, Intelligent Communications is deeply based on a familiar IBM concept: Some people will pay good money to have you take responsibility out of their hands and provide a bulletproof solution.

AT&T's strategy is different: The company doesn't have a large base of business-computing users to protect, but it does dominate the domestic market for voice and data telephony among companies and consumers. PersonaLink is a framework for the future of wide-area telecommunications, whether it's for the purpose of calling your grandmother, negotiating a business deal, or buying a wool sweater. It has the potential of becoming the supermall of the information highway, the on-line service for the 180-million Americans not now online, but it could also form the basis for business-to-business electronic commerce.

As with several projects in the telco giant's past, however, PersonaLink betrays an AT&T-centric worldview. The service is all new, requiring users and third-party vendors to start from scratch with new devices, new software, a new interface, and a new service subscription. In effect, AT&T is saying, "If everybody would just convert to our standard, we could all communicate." On the other hand, IBM is saying, "Come one, come all; we'll translate among your formats—and we'll charge you for the privilege."

AT&T argues that having once made the investment to leap into Telescript, users and vendors will discover richer on-line services and new ways of conducting business. Given that Telescript is not proprietary technology, AT&T argues that it will succeed because it is the first to market and will be the best at running a network.

Perhaps AT&T's biggest potential stumbling block is this conceptual contradiction: PersonaLink is aimed at consumers and individuals and, for now, is accessed only from the cartoon-like Magic Cap interface. Yet the access devices (e.g., the $1500 Motorola Envoy) are hardly priced at consumer levels. Resolving this conflict will have to be a priority for AT&T if it is going to attract a large enough base of users and a community of information and merchandise vendors.

IBM's dilemma will be that in trying to please everybody, it may be biting off more than it can chew. Its Intelligent Communications service is already running a little late and isn't expected to be fully up and running until late in 1995. Meanwhile, other services will continue to add gateways and format converters. If you add to these a universal mailbox and mail filter on your client, you can get much of what Intelligent Communications aims to provide but without ongoing charges.

Agents aren't just a neat technical breakthrough that simplify mobile access and enable new types of back-end services. To an increasing degree, they will become an essential aspect of WAN design because they handle ever-increasing complexity. Service providers can't possibly support the surging base of users, devices, and on-line vendors with monolithic system architectures. Adding more and more point-to-point gateways or rewriting their service's core engine to accommodate new features is economically infeasible. So the only choice is to embrace the new world of distributed, modular, object-oriented technologies.

Telescript Security

Among the biggest concerns about Telescript is that an *agent* isn't much different from a virus. General Magic and AT&T have addressed this problem in numerous ways. The first is that Telescript is an interpreted language. A virus is typically executable code that inserts itself into a target machine; requiring agents to be interpreted at a destination precludes executing something unrecognizable or illegal.

As described above, Telescript agents are encrypted and have to pass an authentication barrier. Once past it, they must have a valid address to go to (for additional security, users can layer end-to-end encryption on top of that built into the network). A *place* can also refuse to accept an agent if it's asking for something the place doesn't want to provide.

Telescript supports a scheme, known as *permissions*, to regulate the activities and life span of agents. It includes limits such as how long an agent can live, how many CPU cycles it can consume, and whether or not it can spawn children or clone itself. Permissions are negotiated among the agent, place, and PersonaLink network itself: The agent asks for a set of permits, and the place and the network publish the sets they are willing to grant. The minimum coincidence of the three becomes the set of allowed permits. Thus, a mailbox could grant an agent from its owner the right to view its contents and delete messages but would refuse those rights to an agent representing somebody else.

Andy Reinhardt is BYTE's West Coast bureau chief. He can be reached on the Internet at areinhardt@bix.com.

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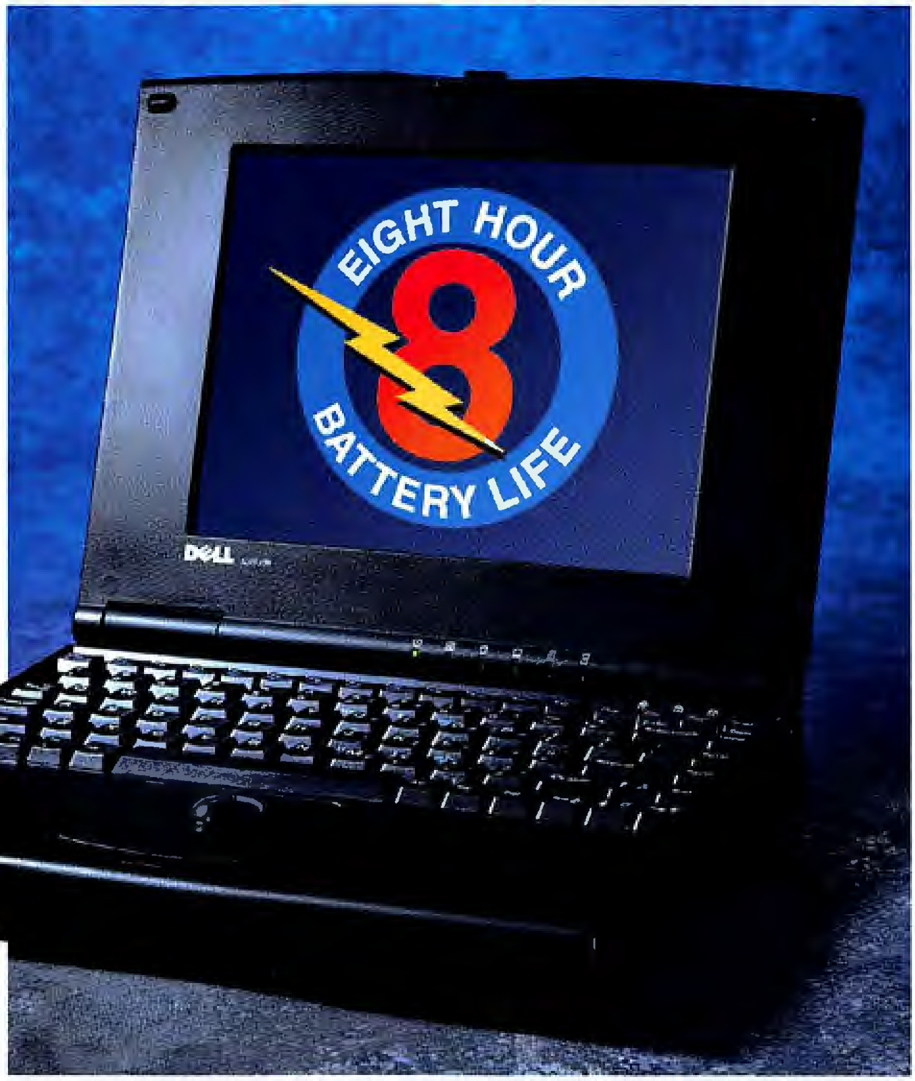

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Dell Latitude, 2 NiMH batteries DX2/50 STN	12:15
OLD RECORD FOR 486 MONO:	12:07
IBM ThinkPad 350C (SL/25) passive	8:50
IBM ThinkPad 500 (486/slc) mono	6:30
Toshiba T4800ct (DX4/75) TFT	5:30
IBM ThinkPad 755Cs (DX4/75) passive	5:00
Compaq Contura 4/25c (SL/25) passive	4:32

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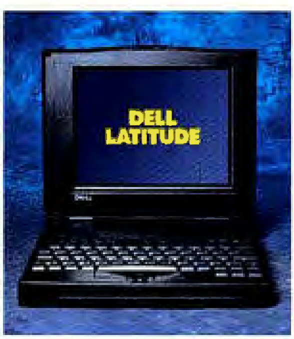

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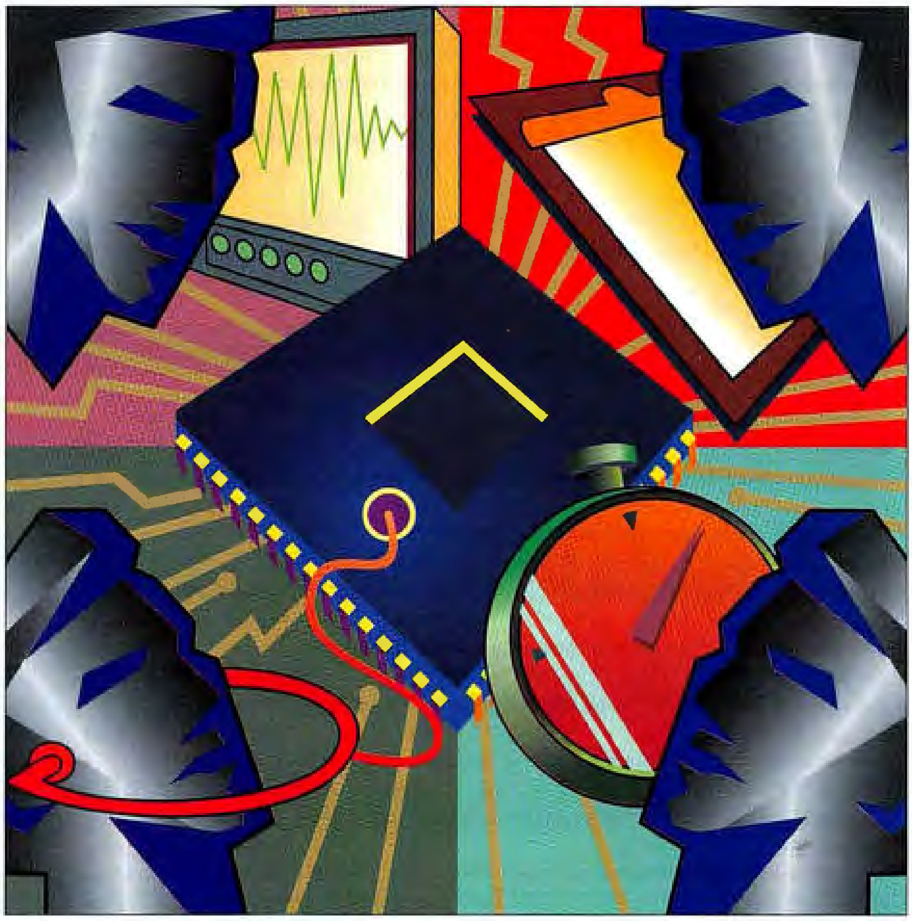

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Everyone agrees that the best way to find the machine that meets your needs is to run your own mix of applications on it and measure the results. Since this is often impractical, if not downright impossible, the next-best approach is to run a typical mix of programs and average the results together to come up with a measure of performance. This is what the SPEC benchmark suite tries to do.

Produced by the System Performance Evaluation Corp. (and hence their name), the SPEC benchmarks are widely used as a tool for comparing the performance of platforms that use different processors. By knowing enough about what the SPEC suite and other benchmarks measure, you can discover how to best use these tools to evaluate systems that match your needs.

The SPEC CPU benchmarks provide a standard yardstick for comparing performance across platforms

Before SPEC

Prior to the advent of the SPEC suite, there were two common ways of reporting performance. The first was the easiest: using system parameters, such as the clock rate of the processor or the number of instructions processed per time unit. This latter value, usually expressed in MIPS (millions of instructions per second), was popular for a while. However, it was never terribly accurate in comparing different architectures, and it became even more troublesome when RISC processors became popular.

RISC processors use simple instructions, so they need to process more instructions to do the same amount of work as a CISC machine. The Intel x86 architecture also causes trouble during performance measurements because it has wildly varying execution timings, depending on which instructions are being measured. Manufacturers tried to patch up the problem by using VAX MIPS—millions of VAX-equivalent instructions per second. As you can imagine, there were a lot of complaints about the way these numbers were computed.

The other common strategy for measuring performance relied on "synthetic" benchmarks, such as Whetstone and Dhrystone (see the text box "A World of Benchmarks" on page 68). These short programs were developed in an attempt to mimic the behavior of existing applications; a programmer typically studied a set of applications and developed code that performed a representative mixture of arithmetic computations, loops, function calls, and so forth.

Aside from the problem of making such codes truly representative of real applications, synthetic benchmarks began to fall afoul of the improvements that were made in compiler optimization. These improved compilers could determine that many computations were not actually being used and optimized them out of the code, making a mockery of the benchmark. Peculiarities in architecture design also skewed results. A system might

THE SPEC92 BENCHMARK SUITE, RELEASE 1.1

NAME	INT/FLOAT	LANGUAGE	LINES	VECTORIZABLE?	PRECISION
008.espresso Minimizes Boolean functions.	Int	C	11,000	No	N/A
022.li Runs Lisp interpreter on nine-queens problem.	Int	C	5000	No	N/A
023.eqntott Translates Boolean equations into truth table.	Int	C	2600	No	N/A
026.compress Compresses a file using adaptive Lempel-Ziv coding.	Int	C	1000	No	N/A
072.sc Calculates values within a spreadsheet based on the curses Unix cursor-control package.	Int	C	7100	No	N/A
085.gcc Part of the GNU C compiler, translating source files into optimized Sun-3 assembly language output.	Int	C	58,800	No	N/A
013.spice2g6 Simulates analog circuits.	Float	Fortran	15,000	No	Double
015.doduc A Monte Carlo simulation based on a thermo-hydraulic model for a nuclear-reactor component.	Float	Fortran	5300	No	Double
034.mdljdp2 Solves motion equations for a 500-atom model.	Float	Fortran	3600	No	Double
039.wave5 Solves particle-in-cell simulation of equations of motion on a Cartesian mesh.	Float	Fortran	6400	No	Single
047.tomcatv Generates 2-D boundary-fitted meshes for general geometric domains.	Float	Fortran	100	Yes	Double
048 ora Traces rays through an optical surface containing spherical and planar surfaces.	Float	Fortran	300	No	Double
052.alvinn Trains neural networks through a back-propagation algorithm.	Float	C	200	No	Single
056.ear An inner-ear simulation relying on fast Fourier transforms and other math-library functions.	Float	C	3300	No	Single
077.mdljsp2 Like 034.mdljdp2, solves motion equations for a model of 500 atoms.	Float	Fortran	3100	No	Single
078.swm256 Solves a system of shallow-water equations using finite-difference approximations.	Float	Fortran	300	No	Single
089.su2cor Calculates the mass of elementary particles in the framework of the Quark Gluon theory.	Float	Fortran	1700	Yes	Double
090.hydro2d Uses hydrodynamic Navier Stokes equations to calculate galactical jets.	Float	Fortran	1700	Yes	Double
093.nasa7 Executes seven program kernels of operations used frequently in NASA applications, such as fast Fourier transforms and matrix manipulations.	Float	Fortran	800	No	Double
094.fpppp Calculates a 2-electron integral derivative in quantum chemistry applications.	Float	Fortran	2100	No	Double

N/A = not applicable.

be particularly efficient in one feature that some benchmark used heavily (e.g., function-call overhead) and would thus look better than it probably should have.

Enter SPEC

Realizing that a realistic and widely used benchmark would be a major step forward, a group of companies, including DEC, Hewlett-Packard, IBM, Intel, and Sun, joined together to form SPEC. This non-profit company is charged with developing and supporting standardized benchmarks. SPEC is best known for its CPU performance suite, but it has developed, and continues to investigate, benchmarks in other areas, such as graphics and networks.

SPEC has identified a set of programs in widespread use, frozen the source code, established a way to measure performance, and defined a formula for averaging the individual results. The programs are divided into two sets: one that relies on integer computations and one that relies on floating-point operations. The original SPEC benchmark suite was released in 1989 (and is thus called SPEC89). SPEC92 is a more recent follow-up, extending the total number of programs in the two sets from 10 to 20.

Both suites measure the performance of each program and combine the values into summary statistics. The strategy for measuring a program is to time its execution and compute what's known as its *SPECratio* by dividing a reference value by the execution time. If the reference is 10,000 seconds, for example, a 1000-second run yields a SPECratio of 10. The reference value is the execution time on a VAX-11/780, a popular VAX model.

SPEC89 defined three summary metrics: SPECint89, SPECfp89, and SPECmark89. To compute SPECint89, the benchmark finds the geometric average of the SPECratios for each integer-based program. SPECfp89 is the analogous result for the floating-point programs. SPECmark89 is computed by taking the geometric average of the other two values in an attempt to describe a system's overall performance with a single number.

SPEC made a few changes to the suite when it released a second, and considerably

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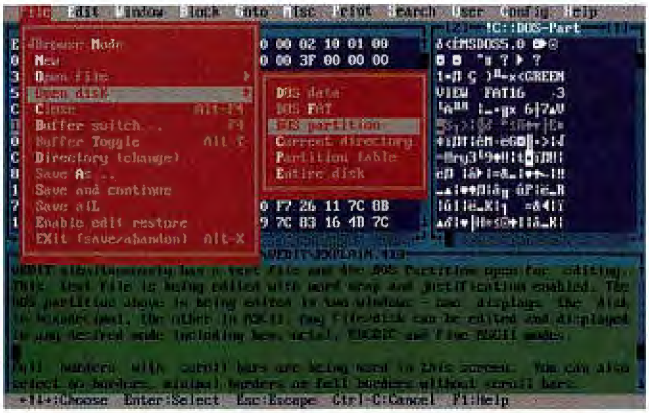

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A World of Benchmarks

While the SPEC ratings are probably the most commonly used measure of performance, there is a wide variety of other standardized benchmarks. The list is too long for us to discuss them all in depth here, but we've listed a few below to show the different ways that benchmarks are designed.

Whetstone. An early synthetic benchmark developed by Curnow and Wichman in 1976. It measures floating-point performance and is used to compare architectures and the optimizing compilers that run on them. The code is short and has been translated from its original language (Algol) into many others. Although it is sometimes modified and is not always applied carefully, Whetstone has spread widely throughout the computer community and serves as a useful basis for discussing performance.

Dhrystone. A synthetic benchmark developed by Reinhold Weicker in the early 1980s that focuses on integer and string performance. The name is a play on words, paying respect to the influence of its predecessor, Whetstone. Originally written in Ada, the benchmark has been ported to numerous other languages and has become another popular performance measurement.

Linpack. Jack Dongarra has been a leader in the development of several widely used linear-algebra packages, including Linpack and Lapack. As part of that effort, he maintains a report that measures the performance of a broad variety of machines using various elements of the Linpack library.

NAS Parallel Benchmark. NAS is a branch of the NASA Ames Research Lab; it works with many parallel architectures. Frustrated by the fact that it's extremely hard to compare all the wildly different architectures, members of NAS developed an interesting alternative to traditional benchmarking suites.

On a parallel machine, an application must typically be rewritten completely, in a new form or a new language, for it to exploit the machine most effectively. The NAS suite provides a straightforward sequential implementation of each algorithm, but the heart of the benchmark is an algorithmic definition of each computation.

Manufacturers are to report how well a simple port of the application runs, but they are also free to develop their own implementations, which are as efficient as they can make them. A set of restrictions on the language can be used to ensure that a machine is not completely unusable by a scientific programmer who is familiar with other parallel architectures.

Using the NAS suite is a great deal more difficult than using something like SPEC, because it involves writing a set of tuned parallel applications. However, the suite gives manufacturers a chance to demonstrate what their machines can do in a way that is impossible with more traditional benchmarks.

Perfect Club. The University of Illinois, which has worked with supercomputing for many years, was not satisfied with the benchmarking techniques being used. The university's Perfect Club suite takes the same general approach that the SPEC suite does: Assemble a set of real applications donated by interested parties and organize them into a standardized benchmark. In fact, the Perfect Club has recently become part of SPEC.

The Perfect Club programs are floating-point-intensive and are usually executed on supercomputers. A major goal of the Perfect Club project was to characterize applications in terms of their algorithmic behavior, allowing users to get meaningful predictions of the performance they could expect for their own applications.

ICOMP. In the old days, Intel had a few different chips on the market that were relatively easy to compare to each other. Then came the proliferation of 486SX versus 486, clock doubling, and so forth. To help the consumer figure out how different Intel processors compare to one another, the company developed an index that provides a single number to measure them. It is based solely on the processor and does not reflect the performance of a particular machine design. The metric hasn't really caught on yet, but Intel's marketing muscle may succeed in making it more prominent.

expanded, version in 1992. It decided that the integer and floating-point measurements were too different to combine into one value, so SPECmarks were eliminated in SPEC92. In addition, there are two new ratings, which are called SPECrate_fp92 and SPECrate_int92. These are designed to measure how well the system handles multitasking and are computed by running multiple copies of a benchmark simultaneously.

The SPECrate formula takes the ratio of reference time to measured time and scales it by a constant value and by the number of instances of the benchmark that are executing. This value cannot be compared to the SPECfp or SPECint rating, but it lets you compare how one architecture versus another degrades due to multitasking.

The suite has changed substantially, so SPEC89 and SPEC92 values cannot be compared. SPEC recommends that the SPEC89 suite no longer be used, so this article will focus on the newer version.

The SPEC92 floating-point suite contains 14 programs; the integer suite has six. The table "The SPEC92 Benchmark Suite, Release 1.1" on page 66 summarizes the programs, noting the language they are written in, their size, numeric precision (if relevant), and whether they vectorize, and gives a brief description of each.

The table "SPEC Results" on page 70 shows the SPEC ratings of a number of different machines. The values are a subset of those published in the SPEC newsletter. If you have access to the World Wide Web, you can find the latest newsletters and other information on the University of Tennessee server at http://netlib2.cs.utk.edu/performance/html/PDStop.html.

Interpreting SPEC

Although the SPEC rating shouldn't be used blindly, the existence of the suite and its standardization have constituted a great step forward in benchmarking. It is quite

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SPEC RESULTS

One surprising aspect of perusing different SPEC ratings is the overlap between x86 systems and RISC-based workstations. A PC based on a 100-MHz Pentium outperforms a SparcStation 20 in integer calculations and costs less. The fastest RISC processors do, however, provide much better floating-point performance.

SYSTEM	PROCESSOR	CLOCK (INTERNAL/BUS)	EXTERNAL CACHE	SPECINT92	SPECFP92
Compaq Deskpro	486DX2	66 MHz/33 MHz	256 KB (level 2)	32.2	16.0
Digital prototype	DECchip 21164	300 MHz	None	300	510
HP 9000 735/125	PA-RISC 7150	125 MHz	256 KB-I/256 KB-D (both level 1)	136	201
IBM RS/6000 Model 41	PowerPC 601	80 MHz	512 KB (level 2)	88	99
Intel prototype	Pentium	100 MHz/66 MHz	512 KB (level 2)	100	80.6
SGI Indy	R4600PC	100 MHz	1 MB (level 2)	62.8	49.9
Sun SparcStation 20 Model 6	SuperSparc	60 MHz	1 MB (level 2)	89	103

a useful measure for the general-purpose computer user and represents a major improvement over its predecessors. The participation of many different companies keeps the playing field relatively level, although there has been no shortage of intense politicking and internal struggle.

The most important point to keep in mind when reading and comparing SPEC numbers is that they are narrowly focused on measuring the performance of the CPU (or, more accurately, the ability of the CPU, memory system, and compiler to cooperate). While the speed of the CPU is certainly an important part of a machine's performance, other issues can be much more important, depending on the way the machine is being used. For instance, many of the huge mainframes used by banks to handle check transactions offer relatively modest CPU performance because they are optimized for I/O operations. But trying to replace them with a workstation that has an equal or higher SPEC rating would be a total disaster.

The system with the highest SPEC rating may not be best for you.

Know What You're Measuring

Although the CPU is one of the easier parts of a system to measure, it isn't always the most important one, as the above example illustrates. Performance is always limited by the weakest link in the chain, so the system with the highest SPEC rating isn't necessarily the best one for your particular needs.

A common source of delay, for example, is I/O. While the CPU is waiting for the disk or the network, the number of MFLOPS it could otherwise perform may be impressive but won't help much. I/O is often triggered when the operating system runs out of RAM in the machine and is forced to swap data out. At a critical point, swapping turns into thrashing, and performance drops through the floor. For many systems, doubling the amount of RAM would do much more for performance than doubling the speed of the processor.

Applications where a system handles a series of updates to a database, known as *transaction-processing* applications, are often more dependent on I/O behavior than on the CPU's performance. To address the needs of this market niche, there are specialized benchmarks that are much more accurate in measuring transaction performance than the SPEC CPU suite.

Another important thing to consider is whether you are running programs that have been compiled to run on your CPU. Because there is so much software available for the Intel x86 chips, many of the fast RISC CPUs use emulation to give users access to more programs. Unfortunately, emulation takes a terrible toll on performance, slowing down a chip by a factor of 3 or more (sometimes *much* more). For example, although a DEC Alpha 21064 is much faster than a 486/33 when running native code, it's much slower than the 486/33 when emulating the x86 instruction set.

Finally, there is a wide variety of specialized hardware that may be the limiting factor in determining performance. For example, some machines sport a DSP (digital signal processing) chip to manage sound waves; these chips encode a small set of operations into hardware so that it can execute them quickly. If your machine is largely used for sound mixing and has sufficient I/O capacity, the performance of the CPU may not be particularly important. Some machines have special engines that handle the math needed for 3-D graphics. On a more modest scale, the display adapter in a personal computer may be the part of the system that has the most effect on the user's perception of its performance.

SPEC and You

The SPEC applications are designed to reflect the needs of a typical computer user, so you may be able to engage in some selective interpretation to make the statistics more useful to you. The integer programs range from system-administration to programming and business applications, while the floating-point codes include a wide variety of scientific programs.

The simplest way to refine your understanding of the ratings is to pay attention to only one or the other number. If your needs do not include molecular modeling and computational fluid dynamics, for example, you may find that the SPECfp rating of your processor is largely irrelevant. The Intel x86 architecture has never been a very fast floating-point engine, but that fact has had little impact on most of the people who use it.

Some users, however, have unusual requirements and may need more information than they can get from the summary ratings. If you rely on a small group of specialized codes and are concerned about their performance, one solution is to cobble together your own summary statistics by choosing the most closely related members of the SPEC suite and ignoring the others.

In addition to the obvious distinction between integer and floating-point, the table "The SPEC92 Benchmark Suite, Release 1.1" shows whether each SPEC program is single- or double-precision and whether it vectorizes well. Some architectures are particularly good or bad at handling one level of precision versus another.

Vectorization can also skew results dramatically; a vector architecture or a superscalar one with a good compiler will execute vectorizable code quickly. If you can vectorize your program, the compiler's efficiency at finding opportunities and

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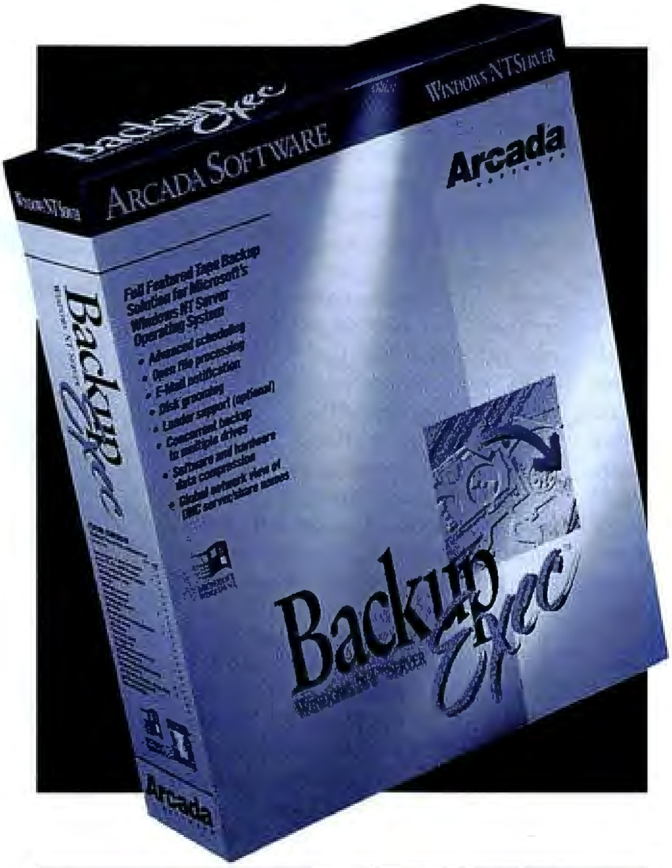

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the architecture for exploiting them are of crucial concern. If, on the other hand, your code vectorizes poorly or not at all, the SPECfp ratings of vectorizing architectures could be misleading.

When you have the SPECratios of all the programs in the suite, you can compensate for these various factors simply by defining your own summary statistic, which you could call MySPECfp. The simplest way to do this is to pick the programs that are similar to your own applications and ignore the rest.

A more sophisticated approach is to assign each application a weight based on how relevant it seems to be to your own needs. Then you compute MySPECfp for each architecture of interest and use that rather than the standard value to make your comparison. You might also compute the ratio of MySPECfp to SPECfp on each architecture to see how much difference your customization makes to the results.

Even though most users can probably match their CPU requirements fairly well by picking and choosing among SPEC programs, there are a few operations that are not well represented. For instance, none of the programs is primarily dependent on the performance of pointer operations. If you have a program that spends most of its time in tight loops walking over complex data structures, the SPEC rating may not reveal which architecture is particularly well tuned for you.

Additionally, none of the SPEC programs is a heavy user of integer division. Although this operation isn't all that common, it is very important in manipulating images compressed using the MPEG format. In general, if you are very much dependent on a specific algorithm that may be unusual in its computational behavior, it is useful to run some of your own tests to supplement the SPEC ratings before you make a final decision about which system is best for your needs.

Reliability and Benchmarks

The most difficult task in benchmarking is achieving consistency in the face of intelligent and motivated adversaries and a broad variety of architectures, compilers, and environments. The war between the benchmark developers and those who try to outwit them has a long and colorful history, attesting to the ingenuity and persistence of both sides.

You can infer some of the tactics of the past by reading the document that defines how SPEC ratings can be computed. It forbids, for example, the insertion of special code into the executable based on the name of the function being compiled. This was a classic gambit done by compiler writers, who could use highly optimized and hand-tuned code for the key routines in a benchmark.

The measurement programs provided with the benchmark suite also check the output of each program to make sure that the architecture not only runs quickly but also produces the correct answer. Many optimizing compilers offer switches that allow them to assume the program is well behaved so they can use optimizations that would otherwise be unsafe. Not every benchmark user has been completely scrupulous in making sure that these assumptions were correct.

Another old trick is to have a special library that tunes the standard system routines for a particular benchmark. If the benchmark allocates memory only in, say, 200-byte chunks, the allocation routine can be rewritten so that it runs extremely fast. The SPEC suite can be compiled with specialized libraries as long as they are not specific to any individual program. Since the suite as a whole contains such a broad variety of programs, there is relatively little opportunity to affect the overall rating with such dubious tactics.

Contact Information

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The guideline document does allow certain favorite tricks, as long as they are documented. For instance, the Unix operating system can usually be put into what is called *single-user mode*, where a number of the features of the operating-system kernel are disabled. Since there is less system overhead, performance can improve significantly. Source code changes are allowed when they are necessary for portability, but the fact that they were made must be noted when the test results are reported publicly.

Even without any covert gamesmanship, determining the best performance of a program on a given machine is difficult. Modern compilers often provide a lengthy list of switches that allow the programmer to fine-tune the optimization strategy. Subtle interactions can yield substantial differences in final performance that are difficult to predict. The manufacturer has a tremendous incentive to do everything possible to improve its products' SPEC ratings, so it will devote care and attention to that end and will thus achieve better performance than the average programmer would.

However, SPEC is in the process of changing its policy so that the reported results are more in line with the performance that users will actually see. SPEC is introducing a new rating, called the SPECbase, that places a set of restrictions on the flags that can be specified during compilation. So, in addition to SPECfp92, there is now a SPECbase_fp92, and so forth.

The new rating requires, among other things, that the same flags be used for all benchmarks and that the options be safe. When reporting the results for a machine, manufacturers must report either just the SPECbase values or both the SPECbase results and the fully tuned results. The new policy should be in effect by the time you read this.

By providing a large suite of applications and restricting the tricks that manufacturers can use, SPEC has helped to make the numbers game more respectable. Although manufacturers examine each SPEC program carefully and tune a machine to improve its rating, the size and diversity of the SPEC applications make it difficult to perform them well without also speeding up everyone else's code. Wherever there are benchmarks, there will be efforts to outwit them, but the existence of the SPEC suite has done much to improve the honesty of reported results.

A Realistic Picture

The SPEC benchmarks are a major improvement over their predecessors. By relying on real applications, they provide a realistic picture of performance. However, they are not perfect. Before you accept the SPEC values as holy writ, you must decide whether the mix of applications in the benchmark suite is similar to your own. You must also consider how important CPU speed is to you and whether some other aspect of the system is the real performance bottleneck.

Seemingly authoritative measurements such as the SPEC values are seductively tempting because they make comparisons so easy. It's up to the savvy customer to look past the numbers to understand how they can be used in making informed decisions. ■

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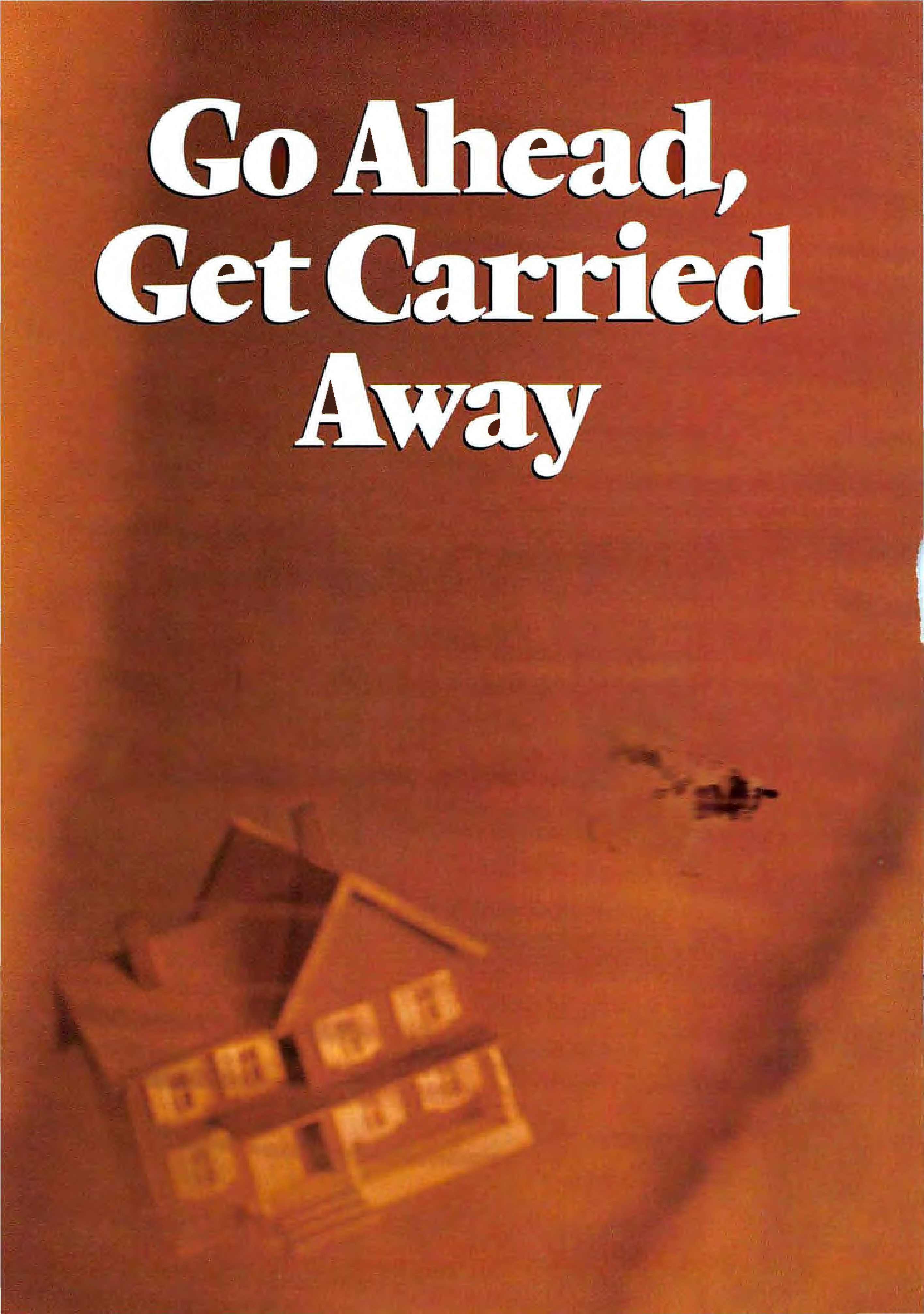


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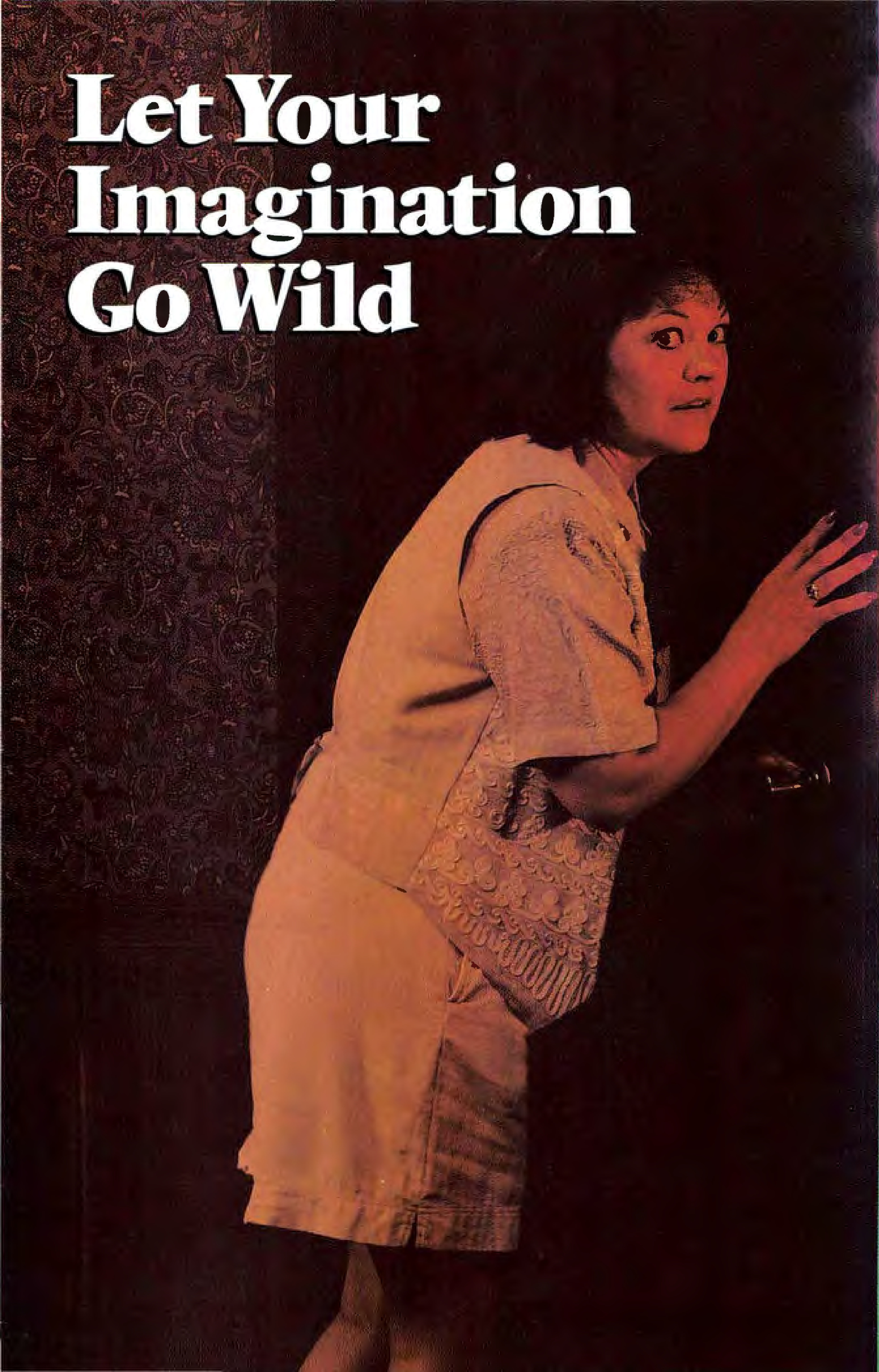


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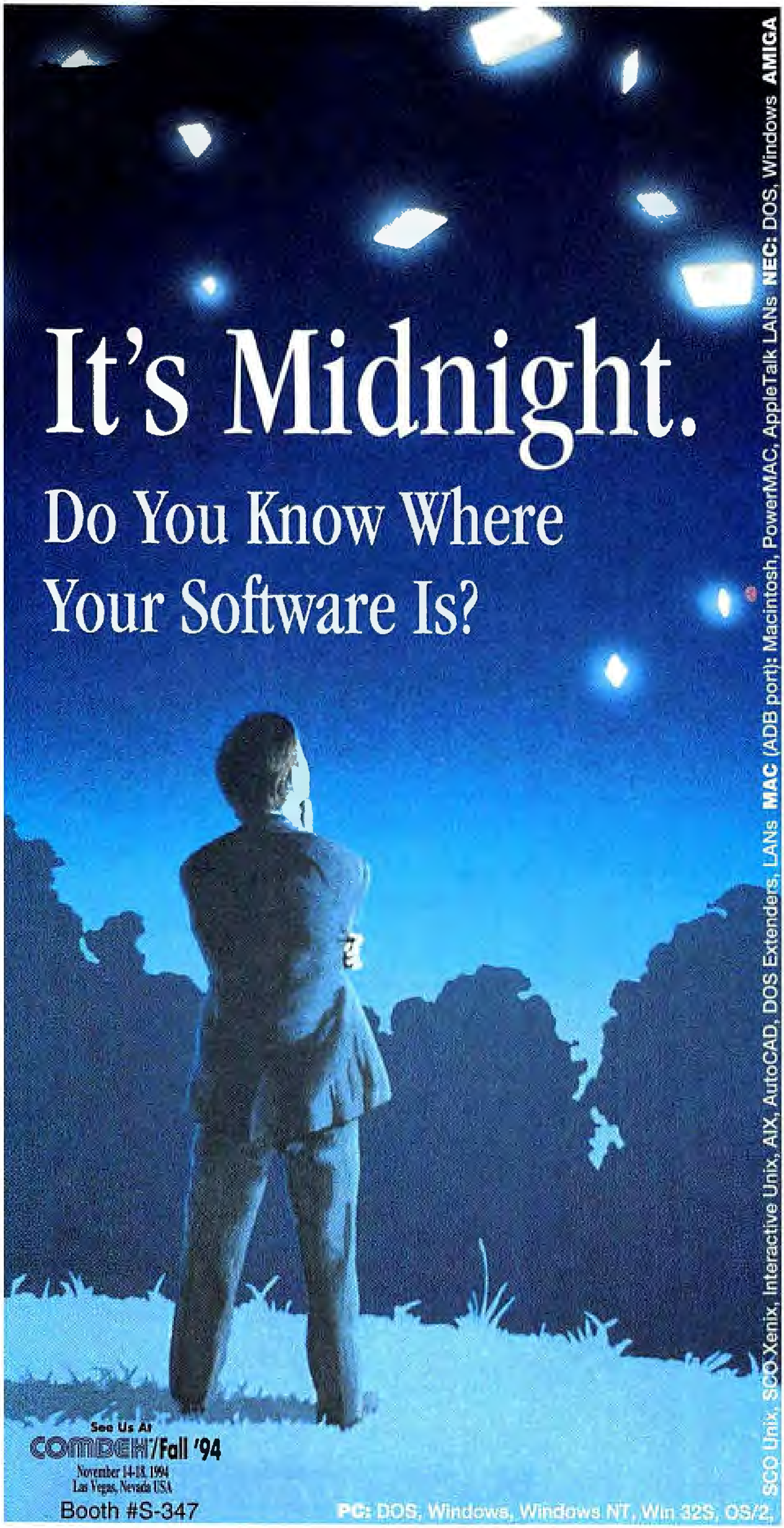

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Unix at 25

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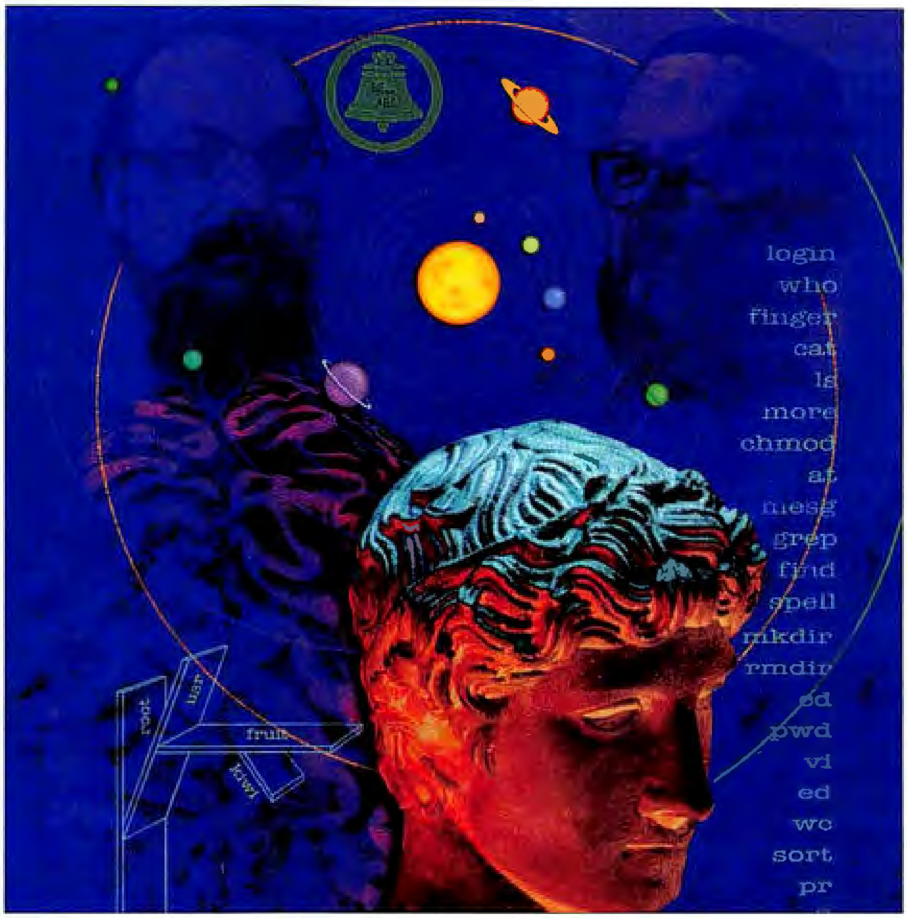

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New Jersey, in the muggy summer of 1969, was the birthplace of Unix. It was born out of the frustration that resulted when AT&T's BTL (Bell Telephone Labs) withdrew from the Multics (Multiplexed Information and Computing Service) project, a joint attempt by BTL, General Electric, and MIT to create an operating system for a large computer accommodating up to a thousand simultaneous users.

The story of the subsequent growth and development of Unix is the tale of one of the major developments in computing. "[Unix] put into the realm of the user things that were just inconceivable prior to that," notes David Tolbrook, inventor of the first dynamic cursor. He adds that Unix was not so much a great advance in computing as it was a great simplification. It demonstrated that a relatively small operating system could run on multiple hardware platforms. Unix, for the first time, showed that an operating system could be portable, machine-independent, and affordable.

The history of Unix is as much about collaboration as it is about technology

Some of the Unix operating system's greatest strengths, however, stem not from its simplicity but from the truly collaborative nature of its development and evolution. Rather than being the product of a manufacturer with hardware to sell, Unix grew from the desire of a few individuals to build a system that was simple, could support more than one user, and could serve as a comfortable programming environment. Other endearing attributes were forced upon Unix by the arcane attitude of its foster parent, AT&T, toward would-be playmates.

AT&T's "house rules" for Unix included no support, no bug fixes, and no credit. The strict rearing practices of AT&T contrasted with the congeniality of Unix's conception, but both had the effect of encouraging collaboration among Unix users. As a result, Unix was not only the first portable operating system but the first, and arguably only, collaboratively developed and supported operating system—a true open system.

Family Tree

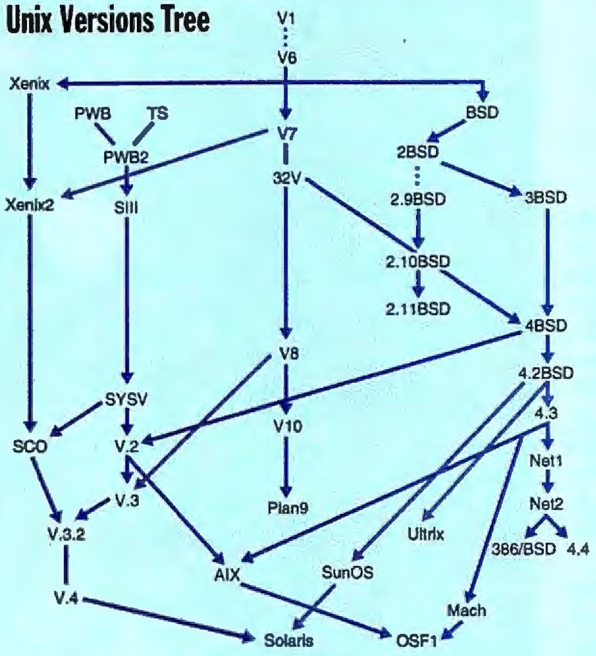
The roots of the Unix operating system go back to Multics. Although it would later become a limited success, in early 1969 the Multics operating system could barely accommodate three simultaneous users. Ken Thompson, at BTL, began working on a game called Space Travel on a Multics machine—a GE-645. Space Travel was actually a serious astronomical simulation program, not merely a game. But it cost a great deal of compute time to play Space Travel on the GE-645 machine, and "frivolous" operating-system development efforts were deemed unjustifiable by BTL.

Fortunately, Thompson and Dennis Ritchie located a DEC PDP-7 computer that was not in use. The PDP-7 had a 340 display, but the system came with only an assembler and a loader, and just one user at a time could use the computer. On this crude and restrictive environment, parts of a single-user Unix system were soon developed: Space Travel was rewritten for the PDP-7, and an assembler and a rudimentary operating-system kernel were written.

During April, May, and June of 1969, Thompson toyed with the idea of writing a multiuser file system. "It was never down to a design to the point of where you put the addresses and how you expand files and things like that," Thompson explains. "Dennis [Ritchie], [Rudd] Canaday, and I were discussing ideas of the general nature of keeping the files out of each other's hair, and the nitty-gritty of expanding the real implementation. [And the discussions] became the working document for the file system, which was just built in a day or two on the PDP-7."

Ritchie, Thompson, and Joe Ossanna—all Multics veterans—had tried several times to convince BTL to purchase a computer for the company's computing research group. But in 1969, most computers meant an expenditure of well over $100,000. And despite its work on file systems and tools, the research group still had no computer of its own. Efforts to get BTL to purchase a PDP-10, or to at least partially lease or purchase a machine, were totally unsuccessful.

Unix Versions Tree



The lineage of early Unix versions was simple and direct. This contrasts with the complex proliferation that followed the commercialization of Unix.

Ossanna then suggested the purchase of a PDP-11/20 for a text-preparation project, in part because the administration at BTL regarded text processing as something useful. As a result of the PDP-7 development efforts to date (and confidence in the value of the text-processing system to be developed), Max Mathews, director of acoustics research, agreed to chip in seed money for a system. The PDP-11 purchase was approved. Doug McIlroy, another Multics veteran, notes that "without that helping hand from outside computer science, Unix might never have gotten beyond the fetal stage."

Unix Development System

It was summer 1970 before the PDP-11 became available to the research group. At first, "only the processor and memory arrived; there was no disk, and there was no operating software," notes Ritchie. Nonetheless, Unix came alive soon thereafter. "Ken [Thompson] got it going before there was a disk," he continues. "He divided the memory into two chunks, got the operating system going in one piece, and used the other piece for a sort of RAM disk."

Later, when the disk arrived, work proceeded on both the operating system and the text processor. "We knew there was a scam going on—we'd promised [to develop] a word processing system, not an operating system," Ritchie adds. But the text-processing project was a success, and the patent department of BTL became the first commercial Unix user, sharing the PDP-11/20 with the research group.

Unix's development at this point proceeded under several basic philosophical principles: Write programs to do one thing and do it well; write programs so they will work together; and write programs to handle text streams. These properties constitute a universal interface.

Unix Goes Public

With several BTL staff members from outside the research group using the typesetting facilities of the PDP-11, the need to document the operating system grew. The result was the first *Unix Programmer's Manual* by Thompson and Ritchie, which was dated November 3, 1971. A second edition, which appeared in June 1972, noted that "the number of Unix installations has grown to 10." From that point forward, the various versions emanating from New Jersey were designated (ambiguously) by edition (which referred to the manuals) and by version (which referred to the disks or tapes). See the text box "BTL Unix Editions" on page 78.

By the third edition, the number of installations was 16; by the fourth, it was "above 30"; by the fifth, "above 50." That was 20 years ago; the numbers grew too fast for listing thereafter. One of those first 16 sites in 1972 was New York Telephone (which was part of the Bell System). The first user not based in New Jersey was Neil Groundwater (who was then with New York Telephone and is now with Sun Microsystems in Colorado Springs).

Then in October 1973, Thompson and Ritchie gave a paper at the SOSP (Symposium on Operating System Principles), and the cat was out of the bag. Immediately after SOSP, other sites began requesting this new system. The first user to get a tape of the system was Lou Katz at Columbia University in Manhattan. "Cy [Cyrus Levinthal, chair of the department of biological sciences] got RKO5s [disk packs] for the department, but we didn't have a drive," Katz says. "So I drove down to Murray Hill, and Ken [Thompson] cut me a 9-track tape."

That was in July 1974; Unix was not quite five years old. Then the publication of the SOSP paper in the July issue of the *Communications of the ACM* caused an explosion in demand for the fledgling operating system.

Early Cooperation Among Users

The general attitude of AT&T toward Unix—"no advertising, no support, no bug fixes, payment in advance"—made it necessary for users to band together. It is important to remember that AT&T was operating under a consent decree, and it would be nearly a decade before Judge Harold Greene would issue his ruling that created the Baby Bells.

The decision on the part of the AT&T lawyers to allow educational institutions to receive Unix but to deny support or bug fixes had an immediate effect: It forced the users to share with one another. They shared ideas, information, programs, bug fixes, and hardware fixes. The first meeting of the Unix User Group—which would later become the Usenix Association—was held on May 15, 1974, in the Merritt

Conference Room at Columbia's College of Physicians and Surgeons. About two dozen people showed up.

Then, a little over a year later—in July 1975—Mel Ferentz, then at Brooklyn College, issued the first Unix news report: "Circulation 37." In a very short period of time, the Universities of Waterloo and Toronto in Canada, the University of New South Wales in Australia, Queen Mary College in London, and the International Institute for Applied Systems and Analysis (Laxenburg, Austria) had all received RKO5s or tapes.

The AT&T lawyers, concerned with consent-decree compliance, had believed it was safe to allow universities to have Unix. Soon they decided to let two more agencies license the system: the U.S. government and The Rand Corporation, a research organization run on government funds. But this decision was the proverbial camel's nose. There were 33 institutions on Ferentz's 1975 list of users; there were 138 in September 1976, 37 of them outside the U.S. And, in 1977, Interactive Systems (Santa Monica, CA) became the first company to support Unix commercially. It was soon followed by Human Computing Resources in Toronto.

Berkeley Software Distribution

One of the 33 institutions on Ferentz's 1975 list was the University of California–Berkeley, where Ken Thompson had been a student. In 1975 he returned as a visiting professor, bringing the latest version of Unix with him.

Arriving at the university at nearly the same time were two graduate students: Chuck Haley and Bill Joy. They were fascinated by Unix and began working on the Pascal system that Thompson had hacked together, improving it to the point where it became the programming system of choice for the students.

However, when the university's Model 33 Teletype terminals were replaced by ADM-3 screen terminals, Haley and Joy felt frustrated by `ed`, the line editor. They took an editor called `em`—which stood for "`ed` for mortals"—that had been developed by George Coulouris at Queen Mary College in London, and they developed the line-at-a-time editor `ex`. And it was from `ex` that Joy derived `vi`, a full-screen visual editor.

The Right Stuff

Once news of Haley's and Joy's Pascal compiler started circulating, Joy began producing the BSD Berkeley Software Distribution (see the table "Berkeley Unix Versions" on page 80). It was first offered in March 1978. The license was on one side of a sheet of paper. The tape consisted of the Unix Pascal System ("created by W. N. Joy, S. L. Graham, C. B. Haley, and K. Thompson") and the `ex` text editor ("created by W. N. Joy"). The descriptive sheet that accompanied the license stated that "The distribution is a standard 'tp' format, 800-bpi magnetic tape. A 1200-foot reel is the minimum and preferred size." It cost $50.

The fact that the BSD release had a simple license agreement, credited those who produced the software, and was priced at the actual cost of the media and distribution exemplifies what was best about Unix in its first decade and what made it such a popular operating system. A typical scenario went as follows: Something was created at BTL. It was distributed in source form. A user in the U.K. created something else from it. Another user in California improved on both the original and the U.K. version, and that was distributed to the community at cost. The improved version was then incorporated into the next BTL release. There was no way that AT&T's patent-and-licensing office could control this, and the system just got better and more widely used all the time.

Bill Joy, acting as distribution secretary, sent out about 30 free copies of BSD in 1978. Working on `vi` led him to something else: optimizing code for several different types of terminals. Joy decided to consolidate screen management by using an interpreter that was driven by the terminal's characteristics to redraw the screen. Thus, `termcap` was born.

By mid-1978, enough had been done (i.e., the Pascal system was more robust and could be run on the PDP-11/34, and `vi` and `termcap` were included) that a second BSD was put on tape. Bill Joy answered the phone, put together the distributions, and incorporated user feedback into the system. He also shipped nearly 75 tapes of 2BSD. (The last version of Unix for the PDP-11 was 2.10.1, available from the Usenix Association in 1989. It was about 80 MB and cost $200—still a real bargain.)

Unix Grows

Up to this point, Unix could be run only on a DEC PDP system. By 1977, Tom Lyon had ported some parts of version 6 to the IBM 360 at Princeton. The next year saw Ritchie and Steve Johnson (in New Jersey) and Richard Miller (at the University of Wollongong, Australia) port Unix to an Interdata 8/32 and an Interdata 7/32, respectively. The system was not quite 10 years old, but it could run on a variety of DEC machines and on the Interdatas: Portability was born. Version 7 was the first portable Unix.

By the age of 10, Unix was already in high school. In January 1979, Brian Harvey went to Lincoln-Sudbury Regional High School, in the suburbs of Boston, "to set up a computer department." He talked the school board into getting a bond issued for equipment and persuaded DEC to give the high school a massive discount. The result was that the school received equipment worth about $200,000 for a cost of just $50,000.

However, installation "took the cooperative efforts of computer scientists at

BTL Unix Editions

Below is a list of the 10 AT&T BTL (Bell Telephone Labs) editions of the *Unix Programmer's Manual*. The tenth edition was published commercially in 1990. The first six editions bear the names of Thompson and Ritchie on the title page; the seventh edition was headed, for the first time, with the statement "Unix (tm) time-sharing system," with no names, although there is a brief preface by "B. W. Kernighan [and] M. D. McIlroy." The eighth and ninth editions carry brief prefaces by McIlroy alone; they also carry the rubric "research version." The preface to the tenth edition is signed "A. G. Hume, M. D. McIlroy, October, 1989."

BTL Unix Time Line

1st Edition	2nd Edition	3rd Edition	4th Edition	5th Edition	6th Edition	7th Edition	8th Edition	9th Edition	10th Edition
11/71	6/72	2/73	11/73	6/74	5/75	1/79	2/85	9/86	10/89

BERKELEY UNIX VERSIONS

DATE	NAME	CONTENTS
Late 1977	BSD	Unix Pascal; ex (for the PDP-11)
Mid-1978	2BSD	The above, plus vi, termcap, Mail, more, and csh (for the PDP-11/34)
Late 1979	3BSD	Virtual memory; Berkeley utilities (based on 32V; for the VAX)
October 1980	4BSD	Faster file system; job control; reliable signals; auto-reboot; delivermail; Franz Lisp (for the VAX-11/750)
June 1981	4.1BSD	Auto-configuration; performance improvements
April 1982	4.1a	A test release for ARPANET sites; TCP/IP and sockets
June 1982	4.1b	A test release used in graduate classes at Berkeley; fast file system and new networking code
Late 1982	4.1c	Most of 4.2, except the new signaling facility; became SunOS
September 1983	4.2BSD	A major revision; included TCP/IP, general framework, ffs, redesigned system interface, new signal facility
June 1986	4.3BSD	XNS networking; 4.2 tuning; directory-name cache; Internet name server
June 1988	4.3-Tahoe	Several internal kernel facilities (memory allocator, debugger, disk-label support); improved TCP algorithms; supported CCI Power 6 (Tahoe)
November 1988	Net-1	Subset of 4.3-Tahoe; included networking, C library, utility programs, and network log-in; distributed via anonymous ftp with no prior license required
June 1990	4.3-Reno	A test release for 4.4BSD features: vnode framework, NFS, and OSI support; supported VAX, Tahoe, and HP 9000/300
June 1991	Net-2	A subset of Reno; included new virtual memory (from Mach via Utah) and a port to the Intel 386/486
June 1993	4.4BSD	A complete rewrite of the system to eliminate AT&T code; added portals and Posix compliance to all of Reno and Net-2
June 1994	4.4-Lite	A release that eliminated all code protested by USL/Novell; basically identical to 4.4BSD

several places, because our PDP-11 had a type of disk drive that the original version 7 couldn't handle," says Harvey. His 15-year-olds not only solved that problem and several others, but they began writing a variety of useful programs.

Unix at 10 was also in use worldwide: Haruhisa Ishida introduced the system to the University of Tokyo in 1976; it was in use in several Australian universities; and there were many sites in the U.K., the Netherlands, Germany, France, Denmark, Austria, and Israel. All this was accomplished with no advertising or support.

Version 7 of Unix, which came from BTL in June 1979, offered several major improvements. It accommodated large file systems, did not restrict the number of user accounts, and had improved reliability. Unix 7 had tremendous influence because of this and because of the number of new commands it contained: `awk`, `lint`, `make`, and `uucp`, for example. The programmer's manual for the seventh edition had grown to nearly 400 pages, and it was accompanied by two 400-page supplementary volumes. This version of Unix also contained a full Kernighan and Ritchie C compiler; a far more sophisticated shell, `sh` (the Bourne shell); Dick Haight's `find`, `cpio`, and `expr`; and a large number of `include` files.

Commercializing Unix

The Unix industry also blossomed from version 7. This release gave rise to several Unix ports: 32-bit implementations, as well as Xenix2, a collaboration of Microsoft and The Santa Cruz Operation, which was the first Unix implementation for the Intel 8086 chip. (Xenix1 was based on version 6.) Version 7 also gave rise to Unix for the Z8000 and 68000 chips. And 32V—the port of version 7 that John Reiser and Tom London did at BTL in Holmdel, under the management of Charlie Roberts—gave rise to 3BSD in 1979.

The 10-year-old system had grown quickly: Version 7 led to more goodies than the local candy store, no matter where the programmer's store happened to be. Version 8 ported `vi` (by Bill Joy), `curses` (by Ken Arnold), and `termcap` (by Joy) from BSD. Arnold's `curses` was yet another example of the influence of games on software development: It's a screen handler and optimization program that Arnold wrote to make the playing of Rogue easier.

But as useful as version 7 was, it also was quite irksome, but not because of the code—far from it. Rather, as Andy Tanenbaum of the Free University in Amsterdam puts it, "When AT&T released version 7, it began to realize that Unix was a valuable commercial product, so it issued version 7 with a license that prohibited the source code from being studied in courses, in order to avoid endangering its status as a trade secret. Many universities complied by simply dropping the study of Unix and teaching only theory."

Tanenbaum's solution was to "write a new operating system from scratch that would be compatible with Unix" but without "even one line of AT&T code." Tanenbaum called it Minix. It was the second Unix clone, the first being P. J. Plauger's Idris.

Bill Joy left Berkeley shortly before 4.2BSD came out. He took the then-current system, 4.1c, with him to Sun Microsystems. Sun's system was ultimately upgraded to 4.2BSD after the official release. Sam Leffler then took over, finished up the last bits and pieces of 4.2BSD, and pushed that out the door.

Although Leffler took over Joy's responsibilities, he was not appointed to Joy's post and felt slighted by this. So Leffler left for Lucasfilm—at first only part time so that 4.2BSD could be completed—and Mike Karels, who had been involved with the 2.9BSD release, took over the job.

The 4.2BSD release was a great success, as Kirk McKusick, chief programmer for BSD releases 4.3 and 4.4, points out. "More copies of 4.2 had been shipped [in the first 18 months] than all of the previous Berkeley Software Distributions combined," he notes. Several commercial operating systems were based on 4.2; DEC's Ultrix and SunOS were the most notable. Nonetheless, there were a lot of complaints about 4.2BSD, and Karels spent most of his first year on the job tuning and polishing. It was 1983, and Unix had become an unruly teenager.

Unix Matures

A great deal could be written about how various vendors embraced (or failed to embrace) Unix. For example, Doug McIlroy of AT&T comments that "IBM and BTL managed the TSS/Unix [time-sharing system] marriage quite early on, but that had no effect on IBM, while Amdahl promptly came on board. DEC tried to ignore Unix, and still does, Armando Stettner notwithstanding. Hewlett-Packard, which, like DEC and IBM, had a proprietary operating system, took up Unix enthusiastically, as did the Japanese. And there's Sun, where Unix and hardware grew symbioti-

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cally, and which propagated BSD."

Internally, DEC had a mind-set for its first 20 years that Stettner refers to as "NIH"—which stands for "not invented here." The fact that Unix was a product of BTL was enough to turn off DEC's engineers. Up to 1978, for most of the world Unix meant "AT&T's operating system," although at AT&T Unix was a "telecommunications-support tool."

AT&T believed, because of the consent decree, that it was constrained to stay out of the computer business. Unix was handed off from AT&T's research division to USG—the Unix Support Group, which controlled Unix's future for most of the 1970s. Then, in 1979, Microsoft and SCO came out with Xenix2, and in 1980 Berkeley introduced 4BSD. Both were version 7 derivatives. Xenix remains a popular implementation, although it has become increasingly incompatible with others.

Judge Greene's decision regarding the Baby Bells meant that AT&T could loose its teenager upon the world, and System V soon was on the scene. The mid-to-late 1980s saw enormous growth in the number of Unix systems vendors and applications—and users of those applications. Unix broke into big business, into Wall Street, and into law firms.

The advent of the workstation, the growth of networking, and the maturity of the operating system itself have all made Unix an adult. By the time it was 21, in 1990, two rival consortia—the Open Software Foundation and Unix International—were contesting for its favors. (UI faded away last year.) Despite its age, Unix was the subject of a custody battle.

As is customary, the courts were soon involved. Unix Systems Laboratories sued Berkeley Software Design, Inc., claiming BSDI infringed on USL copyright and misappropriated trade secrets. A preliminary injunction against BSDI was denied, with the court ruling that USL "failed to show a likelihood of success on either its copyright claim or its trade-secret claim." These claims were undermined by AT&T's distribution of early Unix source code without copyright notice.

BSDI countersued. USL sued the Regents of the University of California; the Regents countersued. AT&T sold Unix to Novell. Novell, after considering things for a while, dropped the suits. BSDI and the Regents then dropped theirs. Novell began to sell the Unix birthright to X/Open. OSF then changed direction, and some of the former members of UI joined OSF. And the evolution continues.

Putative standards and consortia have done nothing to calm the splintered 25-year-old. Solaris, HP-UX, AIX, Ultrix, and myriad other derivatives sit at the OSF table. In fact, Unix has influenced every operating system that is sold today. Since the late 1970s, Unix has had a profound impact on DOS, Mac OS, and Windows NT. Windowing, multitasking, and networking would not be what they are today without Unix.

Sunil Das, of City University, London, notes that "technically, Unix is a simple, coherent system that pushes a few good ideas to the limit." But let history not forget that some of those ideas had nothing to do with operating systems; they had to do with sharing, collaboration, and the user-driven evolution of technology supported by a capable, concerned pan-corporate community of developers and users. ■

Peter H. Salus is the author of A Quarter Century of UNIX *(Addison-Wesley, 1994) and is managing editor of* Computing Systems *(an MIT Press quarterly). He is currently working on a history of the Internet and its protocols. He can be reached on the Internet or BIX at phs@netcom.com.*

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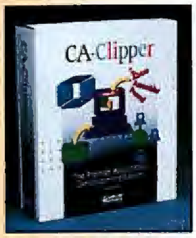

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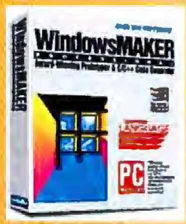

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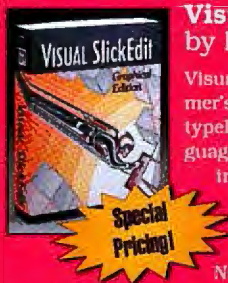

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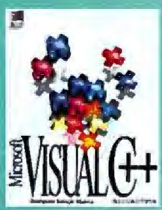

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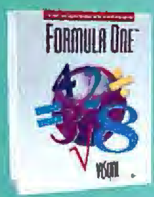

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Experts in the

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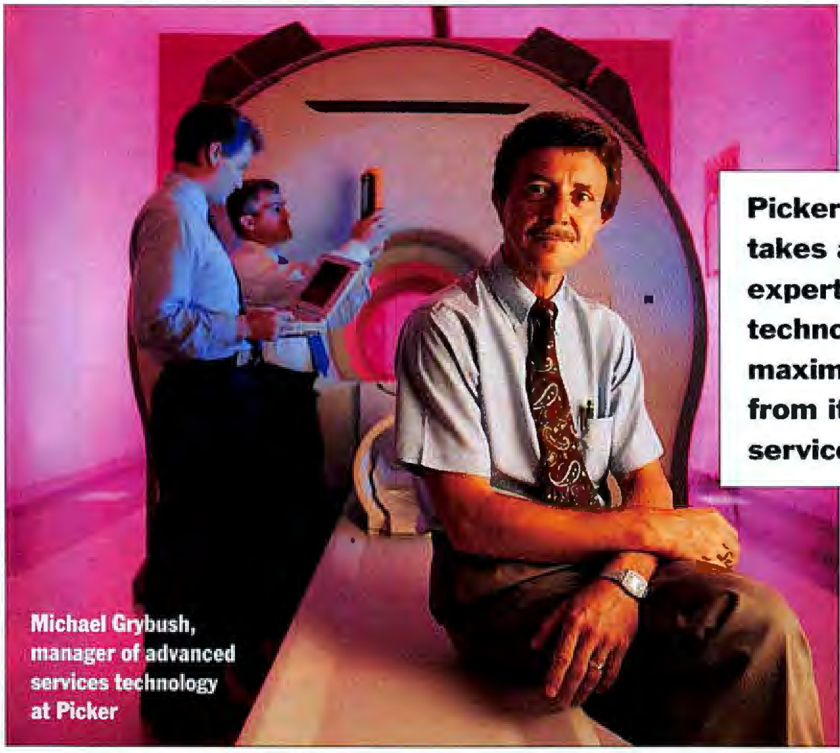
It wasn't all that long ago that field engineers from Picker International headed out each day with a pager, some test equipment, and a car crammed full of three-ring binders thick with schematic diagrams, parts catalogs, and other product documentation. The Cleveland-based billion-dollar-a-year provider of medical diagnostic systems was respected for the quality of its field service, but the prospects for continued improvement and opportunities to leverage the company's experience and growing knowledge base were limited.

With service revenues accounting for one-fifth of its annual income, and with health-care product purchases slowed by cost-containment pressures and regulatory uncertainty, the last thing Picker wanted was to restrict its service opportunities. The company concluded that more effective capture, management, and use of product and service information was critical to sustaining and expanding its service market. Central to the solution it devised is an expert system that captures key information from the company's phalanx of field engineers and makes this information available throughout the organization.



Michael Grybush, manager of advanced services technology at Picker

DANIEL LEVIN PHOTOGRAPHY © 1994

Picker International takes advantage of expert-system technology to wring maximum leverage from its field-service operation

The Way We Were

A number of years ago, Picker licensed field-service dispatching software from Astea International (Bedford, MA) and customized it to support the company's field-service requirements. The software, Fieldwatch, ran on an IBM 3090 mainframe at Picker's centralized customer-support facility. Fieldwatch managed the formal dispatching operation and also handled associated functions (e.g., call accounting, inventory management, and billing).

Fieldwatch dispatched field engineers using a commercial paging service. The engineers telephoned when they were paged. They were assigned a service call and provided with a description of the problem as reported by the customer. The field engineer called the customer and then went to repair the equipment. After the equipment had been worked on, the engineer telephoned the dispatch center and described all activities and parts associated with the repair. This information was entered into customer and service databases.

Information Repositories

These databases are critical to Picker's ability to assess its field-service performance. They also provide important information concerning product reliability. "We've accumulated a massive amount of information," said Nancy Booth, manager of service operations at Picker. "We measure equipment performance, mean-time-to-repair, how quickly we respond to customers, and we track hardware failures. This helps us identify components that need to be fixed or improved and allows us to design products that are not only more reliable but more readily repaired."

The databases contained valuable, comprehensive information about the customer site and all past maintenance and repair activities. But this was available only at the central facility and was not accessible to an engineer in the field. If field-service personnel could access historical service documents, they would be better prepared to resolve problems. And if they could dial into the customer's Picker equipment (many Picker products support dial-in capability, and future systems are slated to incorporate this support), they could test and diagnose the system remotely—even before visiting the site. The company decided to invest in laptops for each field engineer. It also obtained software to support remote access to databases and expanded dispatching services.

All this pointed to the need to restructure dispatching to provide

Field

access to a range of product, customer, and service documents and records. "About a year ago," said Booth, "we implemented nationwide a PC remote interface to our dispatching system and service databases. Now, when a field engineer gets a page, he dials into our mainframe computer from his laptop PC and receives all open service calls." At the same time, past service histories for each call can be downloaded to the laptop.

The new laptop-enabled dispatching accomplished more than simply improving the amount and availability of service and repair information. It significantly reduced personnel requirements at the central dispatching facility. "The field engineer is no longer calling the customer report center to log activities," said Booth. That resulted not only in far fewer operators and data-entry personnel but in fewer data-entry errors.

There was an additional dividend. "Our Fieldwatch system is on an IBM 3090 mainframe—an environment where purchase, maintenance, and development costs run very high. With PCs, you can do a lot more for a lot less money," Booth said. Picker spent nearly $2.5 million dollars enhancing its dispatching system and buying more than 900 Toshiba T4500s to run a combination of off-the-shelf and custom-developed applications and utilities (see the figure "Field-Service Laptop" on page 88).

The company is saving a million dollars a year in personnel and other dispatching-center costs as a result of that investment. It intends to leverage the service and repair information collected to both reduce equipment operating costs and improve equipment and service performance.

Expert-System Quest

With field-service laptops deployed and dispatching enhanced, Picker had in place the technological foundation needed to provide field engineers with Questor, its expert-system diagnostic support. Built on TestBench, the Carnegie Group's (Pittsburgh, PA) expert-system software, and populated with Picker's knowledge base, Questor guides field engineers through the diagnosis and repair of Picker products. Because Questor provides links to on-line documentation and because it presents a diagnostic approach developed and refined by Picker subject-matter experts, the system makes diagnostic procedures in the field more uniform and more successful.

Questor is a Windows-based application that presents the field engineer with a decision-tree architecture for problem analysis and repair. Each limb on the tree includes a "why" window that describes the purpose of the proposed procedure and a "how" window that explains exactly how to execute the procedure. Questor also includes a notepad, where field engineers can record observations and capture errors in or improvements to Questor.

The contents of the notepad, as well as a log of the diagnostic pathway traversed during the repair, are stored on the laptop. They can be transmitted to centralized service databases for review and, if appropriate, incorporation into the next release of Questor.

continued

Restructuring Field Service

The Challenge

Picker International wanted to maximize return on field-service investment by:

- decreasing response time
- lessening reliance on costly mainframes
- increasing efficiency of field engineers
- capturing and disseminating expert knowledge

The Response

These goals moved Picker to restructure its field-service operation by:

- moving field engineers to a portable computing platform
- restructuring dispatching to get information to engineers more quickly
- replacing static and bulky paper-based documentation with hypertext documentation

The Focus

Expert-system technology let Picker tie together its field-service infrastructure by:

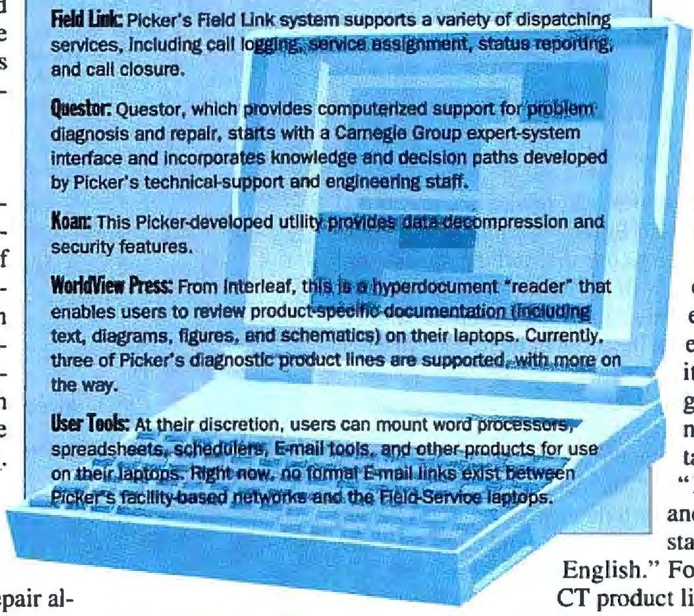
- capturing site data for later inclusion in the knowledge base
- giving on-site engineers access to all appropriate documentation
- giving engineers access to the experiences of other engineers
- providing practical information for design and manufacturing

Lessons Learned

The Picker experience demonstrates that:

- Expert systems can be built incrementally. Don't wait for the final, overarching vision to fall into place to get started and make progress.
- The knowledge engineer should have some domain knowledge.
- The object-oriented approach pays dividends in flexibility.
- Capturing equipment and repair statistics enables the improvement not only of support and repair processes, it enables the improvement of the products themselves.
- Empirical information about product failures and repairs also helps in creating products that are designed to be repaired.
- Don't be surprised if your existing accounting structure can't provide the information required; you may need to pilot a special accounting approach.
- Making information more broadly and flexibly available leverages that information by enabling its use when and where it will do the most good.

This feedback loop between Questor users and designers not only provides for improvements in the product, it permits the collection of observations concerning diagnostic and repair processes and procedures. When aggregated and analyzed, these observations can be used to drive process improvements throughout the field-service organization.



Field-Service Laptop

Toshiba T4500 laptop: 486SL (25 MHz) with 8 MB of memory, an 85-MB hard drive (soon to be upgraded to 340 MB), a 14.4-Kbps fax modem, a trackball, and a monochrome display at 640- by 480-pixel resolution. Software includes DOS and Windows 3.1.

Field Link: Picker's Field Link system supports a variety of dispatching services, including call logging, service assignment, status reporting, and call closure.

Questor: Questor, which provides computerized support for problem diagnosis and repair, starts with a Carnegie Group expert-system interface and incorporates knowledge and decision paths developed by Picker's technical-support and engineering staff.

Koan: This Picker-developed utility provides data decompression and security features.

WorldView Press: From Interleaf, this is a hyperdocument "reader" that enables users to review product-specific documentation (including text, diagrams, figures, and schematics) on their laptops. Currently, three of Picker's diagnostic product lines are supported, with more on the way.

User Tools: At their discretion, users can mount word processors, spreadsheets, schedulers, E-mail tools, and other products for use on their laptops. Right now, no formal E-mail links exist between Picker's facility-based networks and the Field-Service laptops.

Knowledge-Base Architecture

Picker relied on a variety of resources when developing the on-line knowledge bases for each of its supported products. Service-engineering specialists, offering both engineering and manufacturing expertise, as well as regional and district specialists, collaborated with knowledge engineers to articulate diagnostic and repair strategies. However, developing tactics and tools to support those strategies has taken a while.

Picker first examined expert systems to support diagnostics and repair almost five years ago. "We were in analysis paralysis for a good long time," noted Michael Grybush, manager of advanced services technology. Although it was stymied on exactly how to proceed, the company recognized the need for something like flowcharts and decided to start there. "Copying the diagnostic-tree concept, a master product-diagnosis flowchart of 75 pages of 'IF...THEN...ELSE' with targets at the bottom of each page saying 'Go to page XX' was built. It's a big, ugly, formal document that, if you had the patience, would take you close to the source of a problem," said Grybush.

Originally conceived of as a repository for practical diagnostic approaches, the flowchart served a broader purpose as well. "It was a reasonable jumping-off spot to begin putting down the [knowledge-base] architecture because there's a direct correspondence between the flowchart and the structures used to build Questor," Grybush said.

The flowchart helped Picker knowledge-base developers ensure that the approach was not only diagnostically appropriate but was also comprehensive and presented a complete model. "The whole thing is a huge state machine, and how you move from one state to the next depends upon where you are in the path and what your various inputs are," said Grybush.

The flowchart was critical in the early stages of the Questor knowledge-base development effort. As time went on, however, it became less representative of an optimal diagnostic pathway. This was partly because the chart was generated early in the development life cycle and partly because, as a paper-based document, it remained static while Picker's understanding of how its systems worked—and failed—grew over time.

Knowledge-Base Development

Picker knowledge engineers familiar with its products and skilled in the construction of knowledge bases used technical-service notes and on-line documentation to supplement the flowcharts and interviews with domain experts. "The same knowledge-extraction process that one would use to create the troubleshooting flowchart is used to create the on-line diagnostic adviser," noted Grybush.

The development of Picker's knowledge base for its CT (computed tomography) product line took, for example, three months. During this time, one experienced knowledge engineer worked 300 hours researching and preparing the CT knowledge base in TestBench.

It could have taken a lot longer. "TestBench's object-oriented approach greatly simplifies and speeds development," Grybush said, contrasting this with more error-prone and time-consuming programming methods. "As you develop your knowledge base, moving objects around the decision tree is as simple as clicking and dragging, and the objects' attributes follow from one place to another." A Unix-based Sun SparcStation with 24 MB of memory, about 700 MB of hard drive space, a tape drive, and a large-screen color display supported the knowledge-base development. (The Carnegie Group will soon release a Windows-based knowledge-engineering environment.)

In theory, a knowledge engineer with no subject-matter expertise can extract knowledge from a domain expert, but Picker's experience recommended a different approach. "We've found it to be much more advantageous if the knowledge engineers know what they are talking about," Grybush said. "It simplifies interpretation and diminishes the misunderstandings that stem from using English." For technical expertise in the CT product line, the knowledge engineer drew upon one primary-domain expert (120 hours) and four secondary-domain experts (15 hours each). The resulting knowledge base includes 1400 objects and is encoded in a 1-MB binary file.

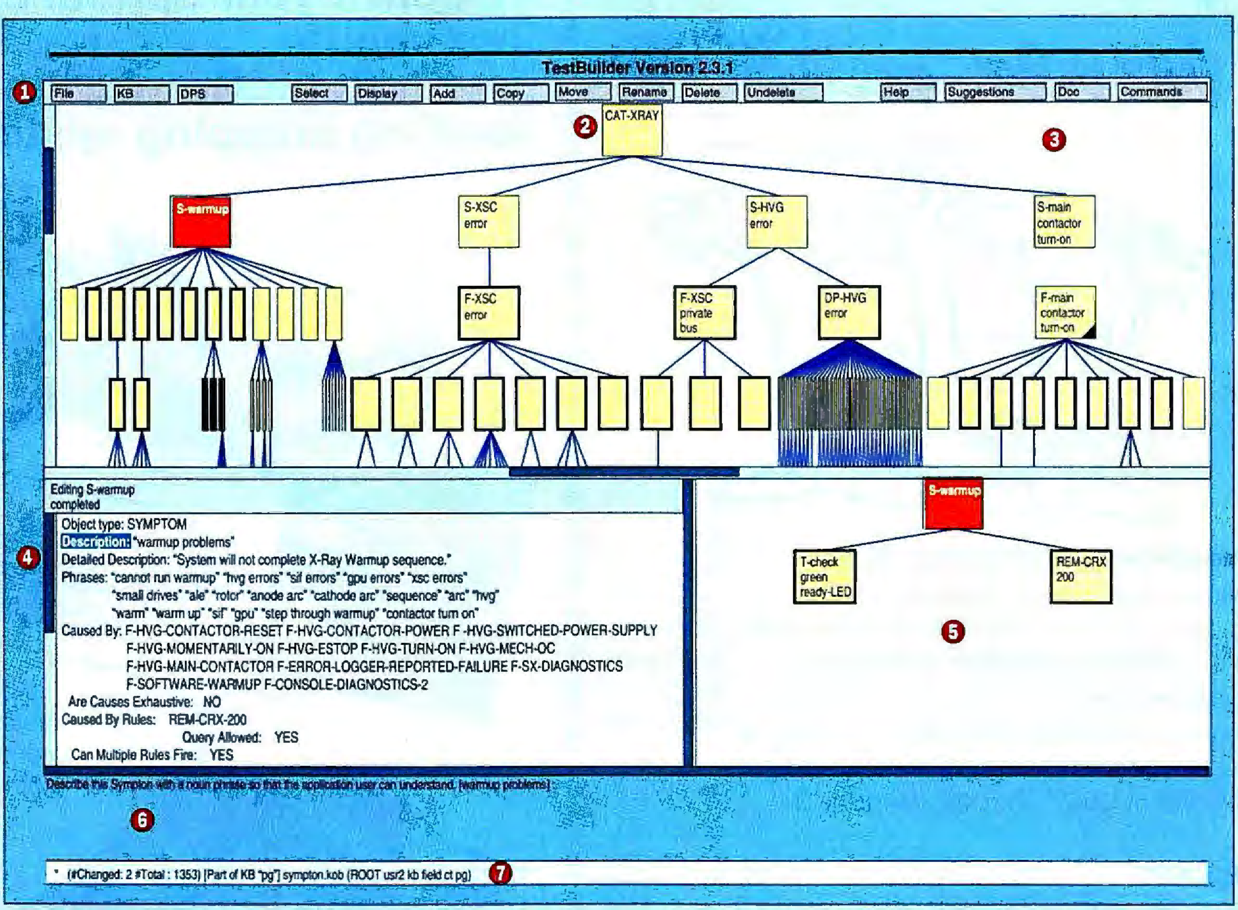
Objectifying Knowledge

Objects in the knowledge base include, symptoms, tests, repairs, decision points, questions, components, rules, and so on. "An object might be an observed failure, such as 'console will not boot,'" noted Grybush. Associated with objects are attributes. "There might be a pointer to a text string or to a bit-mapped image. There might be another pointer to some text called 'why,' to describe why you're being asked to do a procedure. These pointers are different, depending upon the type of object you're dealing with, and, in the strictest sense, the inheritance properties of objects follow smoothly through this general object-oriented model."

Some of the most useful objects in the knowledge base are electronic documents (see the text box "Supporting Questor with Electronic Documents" on page 94). These include hypertext product documentation, repair procedures, parts lists, block and schematic diagrams, and so on. "Vectors are generated inside the Questor environment, and these point to a path, file, chapter, and page within a hypertext document. Once you're there, you can wander around the document in a hyperlinked fashion," Grybush said.

continued

Knowledge Editor Interface



This screen from the Carnegie Group's TestBuilder program illustrates a maintenance session of Picker's PQ knowledge base. The screen has six areas: toolbar, global view, local view, object view, text-entry area, and status line. Each of these areas is fixed in relative dimension, although the TestBuilder window as a whole can be resized.

1 The toolbar looks and acts familiar, but it incorporates controls for the knowledge base (KB) and the diagnostic problem solver (DPS). It also adds a button—"Suggestions"—that suggests attributes and properties for objects being developed.

2 The primary TestBuilder window is the global view. This window provides a high-level view of the problem-solving hierarchy. In this example, the top four tiers of a 20-level knowledge base are displayed, but users can scroll down to view any portion of the hierarchy.

3 The topmost box (Cat-XRay) indicates that this hierarchy addresses the category "X-ray problems." Four primary symptoms are identified, and each of these has "children." Those child-objects with the "F" preface are Failures; those with DP are Decision Points. The leftmost symptom, "S-WARMUP," has been highlighted. As a consequence, more information on the S-WARMUP object is displayed in both the lower-left window, object detail, and the lower-right window, local view.

4 The object detail window displays the symptom object's attributes. Included are a detailed text description of the object, short phrases associated with the object or with prospective causes (both of which can be targets of a natural-language search during diagnosis), and rules to further structure the knowledge base and guide the diagnostic process. For objects with more attribute data than fits in the window, users can scroll through the information.

5 The local view window depicts the object selected in the global view. The object (S-WARMUP) is decomposed to show the next steps in the diagnostic process. Steps are executed in a left-to-right—rather than top-to-bottom—fashion. In this case, the local view shows that a test object (check green ready-LED) is to be executed first. Then, based on the results of that test, irrelevant children are removed (REM-CRX 200) prior to examining other failure or causal objects (seen in the global view window) underneath the symptom objects.

6 The text-entry window is associated with the field within the object view that has been selected. In this example, "Description" has been highlighted, and the prompt directly above the text-entry window reflects this selection, asking users to enter symptom text.

7 A status line shows that two of the 1353 objects in the PQ knowledge base have been modified and also displays the filename and directory path.

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Supporting Questor with Electronic Documents

If Picker's Questor expert system was going to deliver the benefits planned, it would have to support on-line electronic documentation. Picker had nearly a hundred products, each with its own technical-documentation set that included as many as nine three-ring binders. Documentation sets cost an average of $500 per product line, and with over 900 field engineers who needed to be kept current on as many as six products, the costs added up fast.


Larry Stanich and Dave Randall of Picker

Updating the paper manuals was cumbersome, and, in practice, it wasn't unusual for a field engineer's documentation to be out-of-revision. These considerations only added incentive to go on-line.

By the second quarter of 1993, Picker had assessed the service organization's immediate document management needs and began exploring electronic solutions. Within three months, it had narrowed the vendors to four prospects and began experimenting in-house with on-line product documentation.

Questor would be called upon to support wave-form diagrams, circuit schematics, and other figures, in addition to text. "We realized we needed graphics that could be viewed with the text, we realized we needed to let field engineers make notes on the documents, and we realized we needed to be able to secure the documentation," said Larry Stanich, who is training program manager at Picker.

Stanich had his technical staff develop a limited prototype based on Asymetrix's (Bellevue, WA) ToolBook, which was already being used in-house. While this effort showed they were headed in the right direction and demonstrated the value of on-line hyperdocumentation for Questor, the prototype platform was simply not scalable.

While three vendors—Folio (Provo, UT), InfoAccess (Bellevue, WA), and Interleaf (Waltham, MA)—were final contenders to provide the software to support Picker's on-line field-documentation system, Stanich and his colleagues selected Interleaf. "It wasn't so much that the other vendors couldn't support our needs," said Stanich. "It was the fact that Interleaf met all our requirements in a much more elegant way."

Early this year, Picker purchased Interleaf 5 and WorldView Press, which support document authoring and the conversion of existing documents into Interleaf format, respectively. The company also purchased a document "filter" package, Filtrex, from Blueberry Software (Sebastapol, CA). This was used to translate text and graphics into Interleaf format—in particular, WordPerfect text documents that included merged graphics.

A Document Management System

While the field engineers' laptops would serve as the platforms to let users "read" the electronic documents, an "authoring" environment was also needed. For this, Picker bought two Sun SparcStation IPX machines—each with a 424-MB hard drive and 64 MB of RAM.

Most of Picker's paper-based documentation was available in its native (i.e., word processor, graphics, or CAD) on-line format. However, some of it was not. To accommodate those portions, Picker bought a Fujitsu M3096G 11- by 17-inch scanner with an automatic document feeder. Scanning software—ScanWorX from Xerox Imaging Systems—and a dedicated printer rounded out the authoring environment. Both Sun SparcStations were connected to the company's NetWare network.

Early in 1993, Picker spent $25,000 on hardware and another $125,000 on software from Interleaf. The big-ticket item was the lowest-priced: the viewer licenses for the 900 field engineers. During the second quarter of 1993, Dave Randall (communications technology specialist at Picker) and his colleagues went about learning how to use the Interleaf software and how to restructure Picker's documents to take advantage of the hyperlinked environment. These experiences yielded guidelines and practices on converting Picker documents for use in WorldView Press.

Paper Hyperdocuments

Picker (like many other companies) decided to start by making each on-line document identical in appearance to its paper counterpart, for two reasons. First, this made navigating hyperdocumentation as familiar an experience as using paper, and thus made the transition from the three-ring binders to the laptop as straightforward as possible for Picker's field engineers. Second, it kept the paper and

TestBench

TestBench not only supports Picker's electronic documents, it provides a prebuilt structure for diagnostic knowledge-base development. Rather than providing developers a generic expert-system shell, TestBench offers an object-oriented, diagnostic-specific development system that includes proven problem-solving strategies and a diagnostic methodology.

"It may be an empty shell in terms of the exact way to diagnose a particular problem, but the framework for diagnosing problems is built into the product," said Kenneth Kleinberg, research director for Applied Intelligent Systems at the Gartner Group (Stamford, CT). "You have problems; you have ways of testing for them. You have ways of dealing with multiple paths and ways of running different tests and verifying that the repairs you made are accurate and complete." Grybush and other Picker employees credit this prefocus on diagnostic support with on-line materials synchronized in format.

For Picker, the experience of converting documents from paper to hyperdocuments simulating paper has been a bit trying. In theory, converting a document for viewing consists of passing it through a software filter and installing content-appropriate hyperlinks. In practice, as much as 5 minutes per page is spent making sure that every on-line page looks exactly like its paper partner.

"The filtering package and Interleaf do an excellent job of converting, but here and there you have a tab that is off, or a hard return, or maybe there's some text that got 'sucked up' into a table cell," explained Randall. Correcting those things is the most time-consuming part of the conversion process.

Before moving forward on the electronic field-service documentation project, Picker needed to resolve the issue of confidentiality of data on the mobile laptops. The company spent millions of dollars developing its knowledge base and its service and product documentation. It had to ensure that unauthorized access to the information would not be possible if a laptop were lost or stolen.

To accomplish this, Picker developed its own security system, Koan. It includes password protection to limit access and data compression to render data on the disk unintelligible. Encryption keys are updated by communication with central dispatch and expire in several days. Files are decrypted on-the-fly and are unlocked only for TestView and WorldView Press applications (which operate at suboperating-system levels). Copy, Print, and Move commands are disabled when these applications are running. If any tampering is detected, the keys self-destruct, rendering the hard disk data inaccessible.

significantly simplifying the development and implementation of its expert system.

TestBench employs a series of problem-solving approaches appropriate to diagnostic situations. These approaches include decision-tree reasoning for structured but simple problems; fault-hierarchy reasoning for highly structured and complex problems; case-based reasoning for shallow, simple lookup types of problems; and rule-based reasoning for exception-oriented problems.

TestBench does not include a model-based-reasoning paradigm. "This approach tends to be valuable when you understand a good deal about how a product functions, but not much about how it fails," said Kleinberg. "A good example is circuit-board diagnosis, where the designed function of the component is well known, but the ways it could fail are many and unanticipated." Given that TestBench focuses on failures and their causes, model-based reasoning tends to have limited applicability for most prospective users.

TestBench Architecture

Structurally, TestBench has three components (see the figure "TestBench Components" on page 96): TestBuilder (composed of a Knowledge Editor and a Diagnostic Problem Solver), TestBridge (which translates the knowledge base developed with TestBuilder into files that can be accessed by TestView), and TestView (a run-time diagnostic procedure).

TestBench also includes a set of utilities for nondiagnostic-activity support. A log function captures the diagnostic procedure in ASCII format and generates statistical reports. A transcript function records the diagnostic session screen-by-screen for postdiagnosis review. A notepad gives users a means of recording comments and observations for feedback to knowledge-base developers. A recording feature enables users to interrupt and resume a diagnostic session.

Although most users interact with TestView, the bulk of the effort to create an expert diagnostic system like Questor is spent developing and debugging the knowledge base. This object-oriented knowledge base is organized in a causal hierarchy. Observable symptoms reside at the top, and possible causes, either failures or "cases," extend downward from the symptoms.

Each symptom is associated with its set of potential causes by a caused-by link. The knowledge base is organized as a network of failures or cases with failures having primary links to other causally related failures. Both objects (i.e., failures and cases with failures) have secondary links to other objects (e.g., tests and repairs), and the ordering of these links structures the diagnostic process.

TestBuilder

TestBuilder's Knowledge Editor builds and maintains the knowledge base, and its Diagnostic Problem Solver, or DPS, runs and debugs the knowledge base. Three levels of information can be distinguished, and the Knowledge Editor reflects and supports each. At the primary level is the outline of the hierarchical knowledge base. Clustered around each primary object in the hierarchy is secondary knowledge, consisting of tests, repairs, and rules that are associated with a selected failure or case. At the final level can be found additional descriptive and control information about the objects.

The Knowledge Editor supports two levels of expertise. In system-directed mode, the Knowledge Editor guides the developer in creating and defining objects in the knowledge base. In user-directed mode, the developer edits objects without intervention. The Knowledge Editor provides support for both graphic and textual editing (see the figure "Knowledge Editor Interface" on page 90). In graphic editing, an "object" cursor is used to position each object.

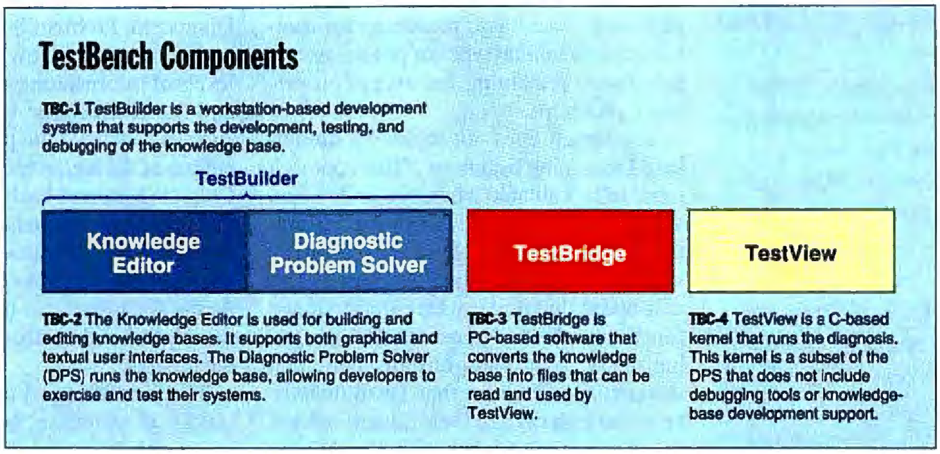
Case objects are linked to symptoms or grouped under case-clusters. Failures can be graphically linked to other failures, indicating what the cause of the problem is. When the knowledge base is edited graphically, the textual view is updated; when the knowledge base is edited textually, the graphic view is likewise updated.

The DPS uses knowledge databases and technician input to search out the cause of the problem being diagnosed. The cause may be determined by successful search of the failure hierarchy, or the technician may determine the cause using case-based reasoning. Problem text matching (which is driven by a natural-language interface or by a menu search of the knowledge base) enables the DPS to bypass the problem classification process and focus directly on the problem under investigation.

The DPS allows problems to be classified using fault-hierarchy reasoning or case-based reasoning. Fault-hierarchy reasoning evaluates candidate failures by assigning a confirmed, disconfirmed, or unknown state to each fault, proceeding through confirmed faults until a cause with no caused-by links is found. Using case-based reasoning, cases are tested and assigned scores that provide a level of probability or belief for each case.

The case score is determined by the developer of the tests. Because cases cannot have "children," they are considered to be the repairable object in the hierarchy. When a failure cause is confirmed, TestBench suggests the appropriate repair and helps the field engineer validate that the repair has been successful.

continued



TestBridge and TestView

For a knowledge base to be accessed, it must be converted for use on the appropriate platform. This procedure has three steps. First, knowledge-base files are compiled by TestBuilder into a single file (GKB) that is system-independent and usable by multiple platforms. Next, TestBridge transfers the GKB file from the development environment to the delivery system. Finally, the GKB file is converted from generic format to a binary file readable by the delivery system. The knowledge base is then ready for processing by TestView.

TestView is the run-time component of TestBench; it supports the same inferencing process performed by the DPS, but for the end user rather than the developer. TestView is organized in a modular structure that the Carnegie Group calls its Kernel Application Architecture. At the core is the TestView kernel; layered upon that are the Application Interface Module and the User Interface Module.

This layering offers developers maximum flexibility, enabling them to customize applications readily, to replace the User Interface Module with their own interface, and to embed diagnostic knowledge-base applications in their own software environments. The current version of TestView runs with a C kernel and has Visual Basic application- and user-interface layers.

The goal of TestBench is to help field engineers diagnose and repair problems faster. "What they really want is a decision support system, one that supports both novice and expert," said the Carnegie Group's Bodin. "They want a system that will help them through the diagnostic process; will augment their own intuition; will not constrain them in any way from arriving at the solution by forcing them down a specific path; and will fit the environment they have established, taking advantage of investments that they've already made in things like on-line documentation and graphics."

Assessing Questor's Performance

How well has TestBench served Picker? Shortly after developing the initial version of Questor for its MTX family of products, Picker measured the system's effectiveness using two separate classes (each with approximately 18 field engineers) that had just graduated from Questor-based product training. The company had previously determined MTTD (mean-time-to-diagnose) for its manual diagnostic methods and used this information as a baseline to assess Questor-supported repair of a set of six MTX system faults. In both classes, five of the six repairs were effected faster with Questor.

That means that one-sixth of the diagnoses were slower with Questor than when using paper-based resources and methods. Shouldn't every diagnosis go faster? It could be that with such a small sample base, one class attendee had solved that problem in the field the week before and so is lightning fast. It could be that talented, trained field engineers are just faster than expert systems. "A 'hot shot' with good intuition is going to be quicker than any codified process you can deliver," Grybush said.

Recognizing the limited value of these preliminary metrics, Grybush and his staff developed more effective methods of objectively assessing the diagnostic and repair performance improvements the Questor systems provide. "We now categorize the class of objects that are serviced by people with these tools and can, over time, make measurements of performance in sites where these tools were employed versus where they weren't," said Grybush.

This approach provides a broad sample base for drawing some statistically significant conclusions about diagnostic and repair performance. The idea is not to compare employee performance. "The idea is to find out where people are spending most of their time, so we can concentrate on supporting those areas well," Grybush said.

When Picker decided to move forward with the Questor expert-system initiative, it had already identified significant benefits to be gained, but what wasn't known was their magnitude and value. "We had a really hard time quantifying the benefits," said Picker's Larry Stanich, training program manager.

The fact that they couldn't quantify projected benefits gave Picker pause. "We began with the very strong intuition that this would allow us to serve our customers better and faster and that this was going to provide us with a good deal of tangible benefit in the long run," said David Kline, manager of magnetic resonance service engineering. "We held strong to that assumption and built some of these tools. We did both an alpha and a beta test using training-center staff and known experts from the field. Then we deployed tools to a larger base of engineers in the field, and we used their feedback to improve the tool."

As it turned out, determining the value of the benefits that were delivered was impossible as well. "Our accounting system is not capable of capturing the benefits as we deploy these systems," explained Kline. "We're now making up for that by creating accounting systems of our own, temporarily, to give us feedback."

Field Assessment

How well does the on-line documentation support Questor? "Suppose you're diagnosing an image-acquisition processor—that's a computer embedded in the diagnostic device," explained John Kuznicki, a Picker service-engineer specialist at one of its telephone-support resource centers.

"From the manual's table of contents, you position your mouse and click once to bring up the parts manual, which provides, for instance, a layout of the acquisition processor and all the power supplies. With a second click, you can see all the serviceable parts in the acquisition processor. Another click, and you can see a wave-form diagram. It's literally done in a matter of seconds. Compare this to hunting through paper documentation." Technical-support staff not only praise the result, on the whole, according to Stanich, they're 40 percent more productive. ■

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COLLAPSING

COMPLEXITY

LYN BOYER-NELLES © 1994

Combining elements of routers, hubs, and switching in one device can reduce LAN complexity and cut costs

SALVATORE SALAMONE

Mark Twain once said, "Put all your eggs in the one basket, and—watch that basket." That, in essence, is what many companies are doing with their networks: They are moving to a networking architecture called a *collapsed backbone*, in which all LANs are attached to one device that passes traffic from one LAN segment to another. Typically, the device used in the center of a collapsed-backbone network has been a router, but today it might be a hub or an ATM (Asynchronous Transfer Mode) switch.

Collapsed-backbone networks are fundamentally different from traditional backbone networks, in which each LAN is connected via a router or a hub to a backbone cable or fiber that runs throughout a building. In contrast, a collapsed-backbone network connects users to hubs that, in turn, are connected to a centrally located, high-performance router.

Using a collapsed-backbone network offers many benefits over using distributed networks. First, complexity is centralized, which makes the network easier to manage. Rather than dispersing routers throughout an organization, you can put a single router near the technical-support staff.

Compared to hubs, routers are complex to install, configure, and manage. This means that in a distributed network, networking staff frequently are dispatched to locations throughout a company's facilities to maintain the routers. With a collapsed-backbone network, however, you can keep a router in one spot and install hubs throughout the organization. This saves the recurring labor cost of sending a technician to every floor of a building whenever a problem with a device arises.

Adopting a collapsed-backbone architecture also provides an economy of scale. Installing one large router with inexpensive hubs is less expensive than providing many small routers for every floor or department.

Another reason to migrate to collapsed-backbone networks is that they provide the centralized management benefits of the old IBM mainframe environments. For example, a company can consolidate diagnostic and troubleshooting equipment in one location; as a result, the company requires less equipment than it would with a distributed-network architecture.

Collapsed-backbone networks also can provide a higher degree of security than distributed networks. For instance, access to a collapsed-backbone router is frequently controlled in much the same way as access to data centers was controlled in the days of mainframes. The central router typically is placed in a room to which access is restricted. In contrast, a distributed network, in which access to routers is dispersed throughout a corporation, may be harder to control.

The one drawback of a collapsed-backbone approach is that it introduces a single point of failure in the network. Equipment manufacturers,

BACKBONE-STRATEGY CHOICES

CENTRAL DEVICE	ADVANTAGES	DISADVANTAGES
Router	• Allows creation of fire walls for security and confining traffic to one LAN • Well-suited for connecting different types of LANs	• Difficult to manage and configure
Hub with integrated switching	• Simplified management and configuration • Well-suited for connecting similar LANs	• Does not provide advanced filtering of routers
ATM switch	• Can give LANs and individual workstations more bandwidth than using Ethernet switching • Provides connection-oriented sessions for delivery of time-critical data	• Expensive • Management limited compared to hub systems

however, have addressed this problem by building into router and hub chassis such features as redundant cooling fans and power supplies, as well as by using modular components that can be swapped in and out without bringing down the network.

Although these features do not make the device completely fault-tolerant, they do reduce downtime. Often, the only point of failure is a router's backplane, over which all the LAN-to-LAN traffic must pass. If that fails, the network goes down. But the same problem plagues distributed networks when backbone cabling is damaged. And the chance of cable damage occurring is greater, because the cabling runs throughout a building and is susceptible to accidental cuts.

A Changing Landscape

Collapsed-backbone networks have long been the domain of high-end router vendors such as Cisco Systems (Menlo Park, CA), Proteon (Westborough, MA), 3Com (Santa Clara, CA), and Wellfleet Communications (Billerica, MA). These vendors have long offered high-performance routers with the capacity (both in backplane bandwidth and packet-processing power) to handle the large volume of traffic that must pass between LANs in a collapsed-backbone environment.

Routers used in distributed-backbone networks do not have such high performance requirements because the bulk of backbone traffic passes over cabling. And the backplanes of departmental routers (i.e., those attached to the backbone cabling) carry only the packets destined for the LANs attached to that one router.

The collapsed-backbone landscape is changing, however. High-end hubs from such vendors as Cabletron Systems (Rochester, NH), Chipcom (Southborough, MA), IBM (White Plains, NY), Lannet (Irvine, CA), Standard Microsystems Corp. (Hauppauge, NY), Synoptics Communications (Santa Clara, CA), and 3Com now employ switching and bridge and routing modules for use in collapsed-backbone networks. A collapsed-backbone network can also be built using ATM switches, such as those offered by Fore Systems (Pittsburgh, PA) and Ungermann-Bass (Santa Clara, CA).

When designing a collapsed-backbone network, you must weigh several factors before choosing among a router, a hub, and an ATM switch. Considerations include the architecture of the existing network, the type and amount of traffic on the network, and whether the delivery of the data is time-sensitive. Your decision may also be influenced by corporate networking philosophy. Some companies, for example, design their networks around enterprise hubs. Because they have expertise in that product area (and a large investment in the hub's management system), they may stay with hubs rather than moving to a network based on stand-alone routers or ATM switches.

The overall networking environment determines which technology—routing, hubs, or ATM switches—you should use. "It's not a matter of hub-based switching versus routing," notes Chris Bennett, a product manager at 3Com. Each technology lends itself to specific environments. Routers, for instance, are well suited to handling a mix of network types and protocols. It's quite common to see a router-based collapsed-backbone network with Ethernet, token-ring, and FDDI (Fiber Distributed Data Interface) LANs all connected to a single router. In hub-based collapsed-backbone networks, all LAN segments are typically of the same type.

Routers are also ideally suited to networks that require advanced traffic filtering. Because routers operate at layer 3—the networking layer—of the OSI (Open Systems Interconnection) model, they can offer more sophisticated traffic filtering than other internetworking devices that work at lower layers. From a practical standpoint, router filtering allows network managers to set up what are commonly called *fire walls*, which keep traffic confined to a LAN segment.

Such fire walls are used in two ways. First, they can keep unwanted traffic from flooding a network. For instance, an application used by one department may employ a chatty networking protocol in which many exploratory or broadcast packets are sent onto the network. You can use a router to filter that traffic and confine it to that department's LAN. Doing this prevents the traffic from spreading over the entire corporate network, where it can consume large amounts of bandwidth and degrade network performance.

Fire walls also are commonly used to maintain security, because you can configure a router so that users on one LAN segment cannot access another network. A router's filtering capabilities can help in several ways. Filtering confines packets destined for users on the same LAN to that LAN, preventing a person on another LAN segment from eavesdropping on these packets. And with filtering, you can deny a user access to the network resources on a particular LAN segment. For instance, you can keep users away from file servers on LAN segments that they are not authorized to access. This helps maintain the confidentiality of employee records, such as salary information and reviews.

The downside to routers is their complexity. They have a reputation for being hard to configure, a difficulty that hub vendors have tried to capitalize on. Typically, hubs are easier to maintain and provide certain management functions not commonly available with routers. However, hubs are not suitable for all networking environments. For instance, they cannot perform the type of advanced filtering available with routers. And because they do not translate packet formats from, say, FDDI to Ethernet, they are not as adept at handling very mixed-type networks.

Hubs are suited to networks in which most LANs are of one type, such as Ethernet. But even in this case, hubs have not typically been used as the lone central device for a collapsed-backbone network. In the past, hubs, even large chassis–based enterprise hubs with backplanes designed to handle large volumes of LAN traffic,

still required a high-performance router (either a stand-alone unit or one plugged into the hub chassis) to create a collapsed backbone. In such a configuration, the different LAN segments were interconnected by passing the traffic over the backplane of the router, not through the hub.

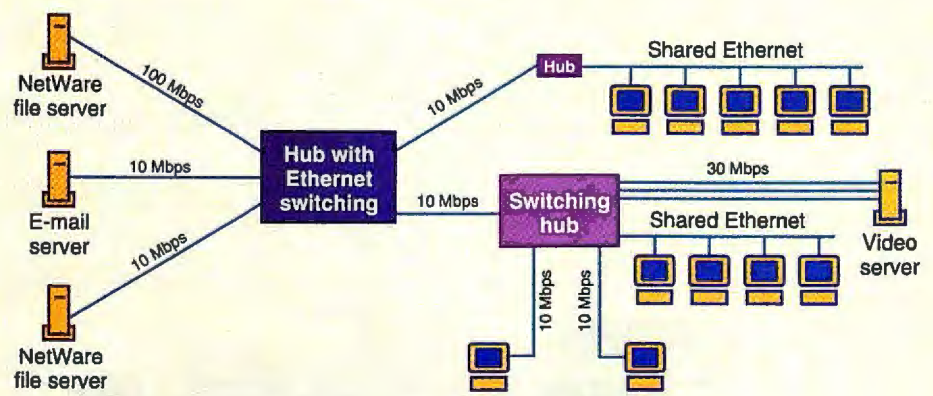
This situation has changed as hub vendors have integrated switching into their hubs. Hub vendors Cabletron, Networth (Irving, TX), Optical Data Systems (Richardson, TX), SMC, Synoptics, and 3Com now offer Ethernet switching products. Ethernet switching pioneers Alantec (San Jose, CA), Kalpana (Sunnyvale, CA), and Lannet have beefed up their offerings for the collapsed-backbone market.

All these vendors offer products that let you use high-end hubs as the center of a collapsed backbone. They use Ethernet switching modules that couple multiple LAN segments through a high-speed switching matrix. Typically, the switching matrix is capable of sustaining multiple, simultaneous connection paths between LAN segments. Ethernet switching lets you dedicate a full 10 Mbps to a LAN segment or even to a single workstation, instead of having all users and LAN segments share a single 10-Mbps pipe (see the figure "Collapsed Backbone with Ethernet Switching").

In contrast to the way that a router handles traffic, Ethernet switching hubs switch LAN traffic on a packet-by-packet basis, using address information contained within each packet's layer 2 (the MAC [media access control] layer) rather than layer 3 (the network layer), as a router would. In essence, that means Ethernet switching hubs act as multiport bridges, which unfortunately also means that these hubs are unable to perform the advanced filtering of a router.

However, backbones built around an enterprise hub with integrated Ethernet switching are easier to configure and manage. For example, hubs with Ethernet switching automatically know the MAC address of all devices attached to it. "This gives me a tremendous advantage, [because] the new product integrates easily into my network and the learning curve is almost zero," says Al Herrington, communications manager at St. Jude Children's Research Hospital (Memphis, TN) and a beta user of the ONcore Switching System, a new switching hub from Chipcom.

Collapsed Backbone with Ethernet Switching



Collapsed backbones that use Ethernet switching hubs as the central device allow LAN managers to improve network performance by dividing congested Ethernet networks into smaller segments that are connected through switched ports.

Separate Realities

The advantage to knowing the MAC address of each workstation on a network is that it eases one of the most common management tasks: the handling of moves, additions, and changes. Hubs have always been able to handle the changes that occur when a user moves from one location within a company to another.

Switching, however, introduces a new twist. Traditionally, handling changes meant dealing with users who had physically moved; now it goes beyond that. Location used to determine who was on a LAN; all the users in one department were in the same location and on the same LAN. Now, users' current projects often determine which group they are assigned to.

This creates a new type of networking architecture called *virtual LANs*, in which users are connected not according to location but according to logical requirements. For instance, a product development team may include a design engineer, a marketing person, someone from accounting, and a member of upper management. These people may be scattered over an organization, but they need access to each other and to common information.

One way to connect them is to rewire the building so that each person's workstation connects to a single hub for the group. But this approach is usually impractical. Instead, using the management features of a switching hub, you can assign project members to a virtual workgroup. For instance, the management system for Lannet's LET series of hubs allows a network administrator at a management console to use a mouse to "tag" a user and then drag and drop that user into a logical LAN segment.

This capability not only helps build workgroups based on work projects, but it also lets an administrator break large, congested Ethernet groups into smaller segments. This "pushes bandwidth out to the user," says Jim Goede, a product manager at Lannet. "With switching, you can dedicate a full 10 Mbps of bandwidth to a smaller number of users or even to a single user," he adds. With some applications, such as providing compressed video to the desktop, the ability to supply a dedicated 10 Mbps of bandwidth to a small number of users means the difference between an application running on the network and its refusal to run.

Such segmentation is also possible with an ATM switch. In fact, most companies use ATM technology to connect collapsed-backbone routers or hubs in many buildings. However, in situations in which users require more bandwidth, or when time-sensitive traffic is running on the network, an ATM switch can be used as the center of a collapsed backbone (see the figure "ATM-Based Collapsed Backbones").

Several vendors, including Fore Systems and Ungermann-Bass, offer ATM switches that are designed with collapsed backbones in mind. The benefits of using ATM rather than router and Ethernet switching–hub technologies are scalability and its connection-oriented service. ATM can deliver more bandwidth to a LAN or a single user than Ethernet or FDDI can.

Also, the connection offered by ATM is inherently less delay-sensitive than those offered by the other technologies. With ATM, when two workstations want to communicate, they set up a session in much

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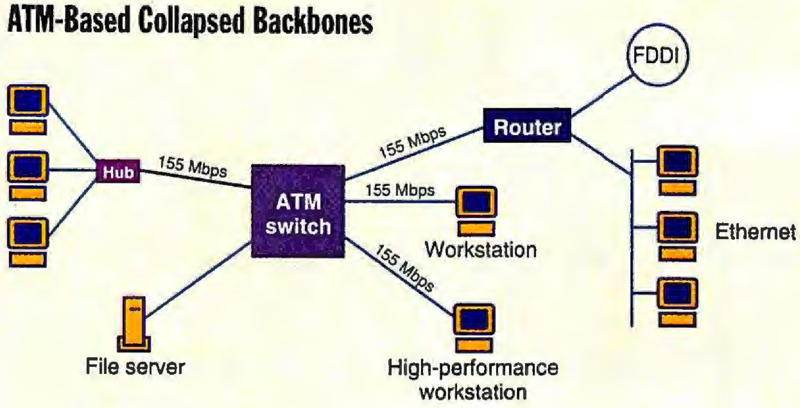
ATM-Based Collapsed Backbones



Collapsed-backbone networks based on ATM switches can deliver high bandwidth to LANs and individual workstations; this makes them ideally suited for bandwidth-intensive applications.

the same way a phone call is set up. Once the session is established, the data stream passes from one node to another. That can be useful in situations in which time sensitivity is important, such as in a multimedia application that must synchronize the delivery of moving images, data and graphics files, and voice traffic. (See "Connecting with ATM" on page 96DM 17.)

Future Considerations

Sometimes elements of all three technologies may be necessary to build a backbone network. Many vendors recognize this fact and have taken steps, through acquisitions or mergers, to acquire the technology they lack. This summer, Synoptics, a leading enterprise-hub vendor, and Wellfleet, a leading supplier of collapsed-backbone routers, announced that they would merge. The resulting company will have the Ethernet switching, ATM, and routing technology for any type of collapsed-backbone network.

Many hub and router companies have acquired companies with switching technology. For instance, Cisco Systems purchased switching-hub vendor Crescendo Communications (Sunnyvale, CA). Network Systems (Minneapolis, MN) acquired Bytex. 3Com acquired Synernetics, and Chipcom merged with switching-hub vendor Artel Communications (Hudson, MA).

But simply having the technology is not necessarily enough; these companies must now put it to good use. Fortunately, internetworking firms are starting to formulate long-term strategies for incorporating the elements of the three technologies into a single network. This is a crucial move for any company that pegs its network future on a collapsed-backbone architecture. ■

Salvatore Salamone is a New York–based freelance writer specializing in internetworking issues. He is the author of Reducing the Cost of LAN Ownership *(Van Nostrand Reinhold, 1994). You can contact him on the Internet or BIX at editors@bix.com.*

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Fast Ethernet Becomes Focused

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JOHN BRYAN

Last year, 100-Mbps Ethernet looked like a technology whose time had come, and, indeed, it has. But the technology is arriving just as switching for the 10-Mbps shared environment and ATM (Asynchronous Transfer Mode) are presenting alternative solutions to meet the bandwidth needs of end users. Nevertheless, Fast Ethernet has technological and pricing advantages that make it an attractive backbone for demanding networked applications.

The IEEE 802.3 Ethernet committee, which is responsible for standardizing a 100-Mbps technology based on Ethernet's CSMA/CD, has narrowed the field of proposed schemes to 100Base-X. However, a separate committee, 802.12, was formed to finalize a competing proposal called 100Base-VG, now called 100VG-AnyLAN. The 100VG-AnyLAN standard is being formalized in a separate committee because, although it has the same basic frame as that used in 10Base-T Ethernet 100VG-AnyLAN offers what is called Demand Priority Access, which lets users or applications developers assign a normal or high priority to a packet. Hewlett-Packard, a key 100VG promoter, argues that this method will better serve time-sensitive applications, such as full-motion video or other multimedia applications. Another advantage is that 100VG-AnyLAN lets users keep Category 3 twisted-pair wiring, if that is what they have installed. But full-duplex operation is not possible, because the protocol uses both pairs to transmit and receive.

As a finalized standard nears, Fast Ethernet offers increased bandwidth at a reasonable price

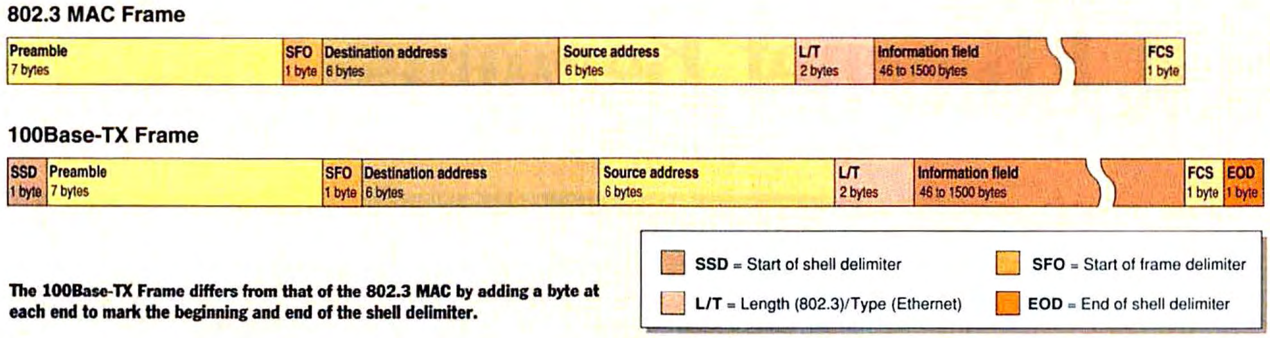
Fast Ethernet, or 100Base-X, is just that, a faster version of ordinary Ethernet. One significant improvement to the standard is that 100Base-T can handle full-duplex operation, which is especially helpful in a server connection, where the need for two-way traffic often arises. 100Base-X uses Ethernet's MAC (media access control) and CSMA/CD, as well as FDDI's (Fiber Distributed Data Interface's) PHY (physical) layer—another standard technology. The PHY layer is where data is encoded for transmission over the wires that make up the network.

Waiting for a Written Standard

Finalization of the 100Base-X standard appears to be nearing. In July, the 802.3 committee distributed the working-group ballot, and it expects the sponsor ballot to go out in November. The Fast Ethernet working group consists of those committee members responsible for resolving disparate technological and market viewpoints. The 802.3 committee expects all major and minor issues to be ironed out by the time you read this; after that, members have 30 days in which to review the text of the document and sign off on it.

The sponsor ballot addresses a wider audience. It goes out to members of the LAN, MAN (metropolitan-area network), and WAN committees, who review it with an eye toward spotting conflicts with the standards they oversee. Although approval is by

The 802.3 MAC and 100Base-TX Frames



The 100Base-TX Frame differs from that of the 802.3 MAC by adding a byte at each end to mark the beginning and end of the shell delimiter.

no means a "rubber stamp" process, the Fast Ethernet standard is largely composed of many existing elements, so possible conflict was minimized from the start. Still, it generally takes several months for the sponsor members to return the document and for the committee to reconcile comments and prepare the final document.

Once that happens, all that remains is acquiring the formal approvals, which happens fairly rapidly. In fact, for a standard effort of this scale and with such a potentially high impact, Fast Ethernet has come together in almost record time. From the first proposals to a finalized standard, the process took only about 25 months. In comparison, the standard for FDDI took approximately eight years to complete.

Is Fast Ethernet for You?

Most of the Fast Ethernet products are dual-standard, capable of operating at both 10 and 100 Mbps and automatically sensing which is in use wherever they are installed (see the text box "First Out with Fast Ethernet" on page 96DM 14). No standard exists for implementing the auto-sensing feature, but National Semiconductor has licensed its scheme, called N-Way, to the IEEE. It is available through IEEE for a nominal fee. Although some of the NICs (network interface cards) will go to the workgroup desktop, most will be installed—at least at first—as the links between server and workgroup switching hubs.

Intel (Santa Clara, CA) is among those companies that want to push this technology to the desktop, but John Middleton, a product manager for the firm's networking products division, concedes that early adopters of the technology will be using Fast Ethernet cards for server connections or other specialized uses. He expects to see "significant desktop penetration in the first half of 1995." Following that period, Fast Ethernet could become as pervasive as its predecessor, 10Base-T.

The type of high-speed technology you choose should depend heavily on the application demanding the bandwidth. Tony Lee, networking product manager for Fast Ethernet at Sun Microsystems Computer Company (Mountain View, CA) suggests that customers take a close look at their current and future needs. "If the customer is looking to upgrade a general-purpose network in order to boost overall performance, Fast Ethernet is a good option," he maintains. "If, on the other hand, [a customer has] some specific high-bandwidth needs, like videoconferencing or medical imaging applications, ATM would be a better solution."

In fact, some applications are not suited to the unpredictability and delay of the CSMA/CD structure. These include any that require real-time response, need to precisely understand delay, or must have a dedicated bandwidth of 100 Mbps or more.

Of the latter, few examples exist, but that underscores a catch-22 that currently exists within the industry. No one wants to go to the expense of upgrading large portions of existing networks when applications that make this move worthwhile aren't yet available. On the other hand, no one is writing commercial applications that require large amounts of intersystem bandwidth, because the means for implementing them don't exist.

So a high proportion of the initial installations of Fast Ethernet will occur in the server-switching hub link. As the demand for bandwidth grows, so will the penetration of 100Base-X at workstation sites, which is why the standard supports both 10- and 100-Mbps connections. Pricing of Fast Ethernet NICs is being kept competitive with that for 10Base-T EISA cards (they are less than twice the price) so that as management upgrades existing installations or builds new ones, Fast Ethernet is a logical choice. As Sun's Lee explains, "Users can install the card in existing nets, where they will work just fine at 10 Mbps until the rest of the 100-Mbps infrastructure is in place." One other reason that these products are a logical choice is that all the tools created for standard 10Base-T Ethernet may be used, with minor modifications, in the 100Base-X environment.

New Interconnects

Standards are being developed for three primary forms of physical interconnections. 100Base-TX, what might be called the basic standard, is specified for two-pair Category 5 UTP (unshielded twisted pair) with RJ-45 connectors. An implementation requires a hub, and the maximum cable run is 100 meters, with a maximum network diameter of 250 meters.

100Base-FX stipulates multimode fiber-optic cabling, which increases the cost of both the adapters and cabling. But it also requires greater distances between hub and node, whether the node is a workstation or server. If your cabling must span long distances, FX is the only way to go.

Both the TX and FX standards are completed and awaiting signatures. 100Base-T4, a standard that permits connection to Category 3, 4, or 5 UTP in a four-pair implementation, is not quite as well developed. One of its present stumbling blocks is that the connectors needed for either end of the wire don't exist. But that is fairly easy to remedy, and the 802.3 committee expects that the formal standard should follow on the heels of its counterparts.

Fast Ethernet also provides two options that are not available in 10-Mbps Ethernet. The first is MII (Media Independent Interconnect), a 40-pin D-shell connector that attaches to an external transceiver. The external transceiver provides the conversion to the appropriate wiring scheme, which generally is fiber.

The second option is full-duplex operation. Because standard Ethernet uses CSMA/CD, it interprets a concurrent trans-

First Out with Fast Ethernet

Given that its slogan is "The network is the computer," it's not surprising that Sun Microsystems Computer Company (Mountain View, CA) was the first to ship a Fast Ethernet NIC (network interface card). The SunFastEthernet Adapter is an SBus product compatible with the current draft of the 100Base-TX standard.

Sun Microsystems' SunFastEthernet Adapter

In addition to the RJ-45 UTP connector, the adapter also supports an MII connection, although Sun does not make an external transceiver. Sun is responsible for the CMOS implementation of the MAC (media access control), while its PHY (physical) layer protocol, like Intel's, is licensed from Synoptics. The MAC layer interface is handled by a chip called the Quad Ethernet Controller. Data between the SBus and controller is buffered by 64 KB of SRAM (static RAM). Like nearly every other Fast Ethernet product, the SunFastEthernet Adapter supports auto-sensing at either 10 or 100 Mbps.

The SunFastEthernet Adapter lists for $795, which makes it one of the more expensive Fast Ethernet NICs, though not particularly so for a SparcStation NIC. The card requires a SPARC/Solaris platform with a free SBus slot and Solaris 2.3 or higher. Sun's network services and protocols will work without modification.

Another Synoptics licensee is Intel (Santa Clara, CA). Its EtherExpress Pro/100 LAN Adapter is available in two models, one for the PCI bus and one for the EISA bus. Both models list for $499—$150 more than Intel's 10Base-T EISA NICs.

John Middleton, a product manager for Intel's networking products division, says that the company's MAC allows for more efficient use of the host CPU. He claims that the PCI card exhibits a 10 percent to 15 percent performance advantage over the company's EISA version, but CPU utilization is lower than competitive products for both overall. "For instance, using the Pro/100 EISA, with throughput at about 70 Mbps, CPU utilization is about 45 percent [with a 66-MHz P5-60 server and 33-MHz 486 PC]," he claims. "As bandwidth constraints are pushed back inside the box, this is going to be significant."

The EtherExpress Pro/100 LAN Adapters both use the same set of drivers, and they support the DMI (Desktop Management Interface) specification of the DTMF (Desktop Management Task Force). Information about an adapter's address, IRQ (interrupt request), packets, drivers, and more can be viewed from within a DMI-compliant application and used as a management tool for controlling the node level, rather than at the hub alone.

Besides licensing its CMOS designs to NIC vendors, Synoptics (Santa Clara, CA) sells switching hubs and external transceivers to put everything together. The LattisSwitch System 28000 is a family of switching hubs, available in four versions. Model 28014 ($8995) is an eight-port switch for 10Base-FL multimode fiber connections. The 28104 ($14,950) has the same basic design, except that it supports eight 100-Mbps ports, also over fiber. Model 28015 ($8995) is a 16-port 10Base-T switch; 28115 ($16,950) is a 16-port 10/100 100Base-TX model.

Intel's EtherExpress Pro/100

Each of these switches has two high-speed expansion ports for supporting full-duplex connections to a server, repeater, or another switch. The connection is made through an MII connector and appropriate external transceiver, either fiber or UTP. In addition, all expansion and attachment ports on these switches can be configured for full-duplex operation. The switching fabric of the LattisSwitch family can handle 2 Gbps, so you shouldn't encounter frame overruns or delays at any port.

Synoptics Communications' Lattisswitch 28000

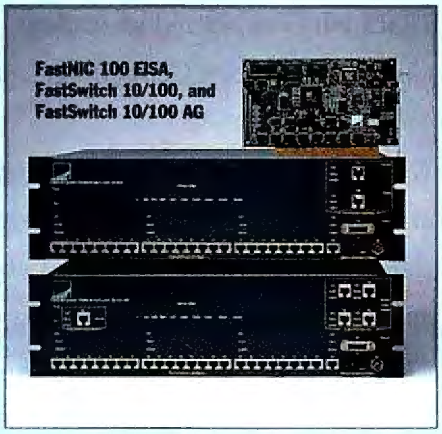
All models are also compatible with the latest release of Optivity, Synoptics' network management software, which can accommodate both shared and switched networks. Management connection is handled via an out-of-band RS-232 port.

With its Fast Ethernet PowerPipes client/server switch, NetWorth (Irving, TX) takes a similar approach to that used in Synoptics' model 28015. Scheduled for release toward the end of this year, the Fast Ethernet version of PowerPipes (an FDDI [Fiber Distributed Data Interface] model is already available) provides 12 10Base-T UTP connections that switch to a single Fast Ethernet connection.

NetWorth sees "pockets" within the Ethernet world that are severely bandwidth restricted, and the PowerPipes hub is designed to relieve at least one of them, the server-switch connection. The company does this partly by making the server and the switch more intelligent. Fairness algorithms in servers make them serve nodes in an equal fashion. If the individual segments served by a switch are not balanced, which is frequently the case, switch ports with more dependent nodes become flooded. NetWorth uses server-resident software and switch-resident firmware to help the pair "learn" more appropriate flow control.

Because of the dearth of applications requiring dedicated 100-Mbps connections to the desktop, NetWorth is betting that its switch will be a cost-effective way to deliver sufficient bandwidth to the end user for some time.

Grand Junction Networks (Fremont, CA) enjoys the distinction of having introduced what became the Fast Ethernet standard. Grand Junction's current family of products includes a card, the FastNIC 100 EISA, and two switch products, the FastSwitch 10/100 and the FastSwitch 10/100 AG (Aggregator). The card and the switches are compatible with the 100Base-TX standard, as well as with products from Intel, Synoptics, and DEC. The switches began shipping in May, while the FastNIC went to production in June.


FastNIC 100 EISA, FastSwitch 10/100, and FastSwitch 10/100 AG

In addition, the FastNIC 100 EISA is a 10/100 auto-sensing card designed for use with current Ethernet installations and software. This bus-mastering NIC uses a custom Grand Junction ASIC (application-specific IC) and has a 1-Mb packet buffer, the largest of any of the current crop of products. Priced at $499, its primary distinguishing feature is that it is a part of a family of products from the first vendor to offer one-stop Fast Ethernet shopping.

Although it has yet to introduce any Fast Ethernet products, 3Com (Santa Clara, CA) expects to offer a complete line of products. According to Paul Sherer, director of technology development, the company's line will include everything from NICs to port modules for the firm's enterprise-switch products. "The deployment we're seeing now is only the leading edge of the marketplace," he states. "3Com is looking to provide an easy and inexpensive migration path from a shared 10-Mbps technology to switched 10-Mbps to shared 100-Mbps to switched 100-Mbps."

3Com plans to ship its first product, 10/100 cards for PCI (Peripheral Component Interconnect) and EISA, in November. These cards will leverage the company's Etherlink III technology, which is used on the best-selling card in the world. Like others in this market, the firm's NICs will be capable of handling full-duplex operation. Perhaps the best feature of the 3Com cards, though, is their price, which Sherer says will be less than $400. While cards will appear on the market first, 3Com will also offer repeaters and hub products at the workgroup and enterprise level.

Another vendor, Standard Microsystems (Irvine, CA), is also slated to begin shipping Fast Ethernet products in November. SMC's first product, an as yet unnamed 100Base-TX EISA card, will have a MAC-layer CMOS based on FEAST (Fast Ethernet Advanced Silicon Technology) developed by SMC Components Division (Hauppauge, NY). Its PHY layer will be developed by the Irvine group. The company also expects to be shipping a PCI card in the first quarter of 1995, and its Enterprise Networks Business Units (Andover, MA) will announce other products in the same approximate time frame. SMC expects its NIC to sell for under $500.

Perhaps the only vendor, at least for right now, that has plans to introduce an ISA NIC for Fast Ethernet is National Semiconductor (Santa Clara, CA). Its ISA card will be bus-limited but reportedly will still provide twice the performance of other ISA NICs at a similar cost. FIFO (first-in/first-out) buffering will handle bus latency. This ISA product positions the company in the client market, at the desktop rather than the server. Lee Melatti, National's product manager for Fast Ethernet says, "Even if you are using [the company's NIC] in a 10-Mbps environment, you will be able to get 100-Mbps upgrade capability and DMTF standards, at a reasonable cost." National expects its ISA card to ship in December.

To ensure that all Fast Ethernet products work together in a seamless fashion, and that the auto-sensing products work in 10-Mbps environments, interoperability test labs are being set up on both coasts. One is located at the University of New Hampshire (Durham), while the West Coast lab is at the Technology Resource Interoperability Lab, in Santa Clara, California.

mit and receive as a collision, even though the operations occur on different pairs in the wire. Fast Ethernet provides a mechanism for turning off full-duplex operation, which enables cards and hubs to handle both functions simultaneously. This feature would generally be used in a server or switch-to-switch connection, where the wiring is dedicated and bidirectional operation is useful.

Although some question the practicality of full-duplex operation, most vendors offer it. One concern is that the type of bandwidth that this setup can deliver pushes CPU utilization to its outer limits. Whether or not that concern is justified, full-duplex capability nearly eliminates the network data bottleneck, but the performance gain might not be that dramatic. Paul Sherer, director of technology development at 3Com (Santa Clara, CA), says, "Our tests indicate that the performance boost [provided by full-duplex operation] will only be in the 10 to 20 percent range, not double, though in a server connection this could be helpful." ATM is even faster, which puts the onus of providing more horsepower back on the system side.

Winning Over Users

One of the primary differences between Fast Ethernet and ATM is the existence of standards development and tools. ATM doesn't have either yet, at least in the LAN environment, while Fast Ethernet can leverage a great deal of existing technology, infrastructure, and understanding (see "Connecting with ATM" on page 96DM 17). According to Sherer, many of the firm's customers merely want faster Ethernet—what he calls "bandwidth with no new headaches." Currently, he says, "ATM just can't offer that type of solution."

The other challenge to Fast Ethernet is AT&T's 100VG-AnyLAN. But some of the same arguments used against ATM apply here, too. The management and support technology will be a while in coming, especially from third-party vendors. At Grand Junction Networks, Jack Moses, vice president of marketing, draws an interesting parallel. "The driving force behind the explosion of 10Base-T," he states, "was the fact that literally hundreds of vendors were selling the product, while Token Ring, controlled by IBM, languished." This is not to say that Token Ring isn't viable, but it is estimated that over 30 million Ethernet nodes exist today; Token Ring, in comparison, supports about 5 million nodes. ■

John Bryan is a freelance technology writer and consultant. You can reach him on the Internet or BIX at editors@bix.com.

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Connecting with ATM

PETER WAYNER

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In the next few years, many networks will trade data using a collection of standards called ATM (Asynchronous Transfer Mode). These new standards promise to allow networks to blend real-time continuous streams of data, like digital video, with normal packetized transactions, without causing backups or delays.

Marketing professionals hype this hybrid approach with the seductive phrase "bandwidth on demand," or BOND. In truth, ATM networks have limits and can still become overloaded, but the technology undoubtedly will offer unprecedented flexibility and very appealing performance for both LANs and WANs handling a wide mixture of data.

ATM differs from many of the prior common networking protocols in four major ways. The first and most important physical difference is that ATM uses no shared wires or fiber. Each computer has its own direct connection to a switch. Older approaches, such as Ethernet, save money by letting several computers share one wire. This is less expensive, but the wire quickly becomes overloaded when everyone uses it at once.

ATM promises fast, flexible networks but won't deliver unlimited bandwidth on demand

ATM networks aren't directly affected by the other computers using the network, because no one else can use a computer's direct connection to a switch (see the figure "ATM Switching"). Users experience overloading only if they are competing with other machines for limited resources, such as time from a file server or bandwidth to sources outside the network. If you don't have shared wiring, you can eliminate bottlenecks like these by purchasing a larger outside network connection or another file server. Complete rewiring isn't necessary.

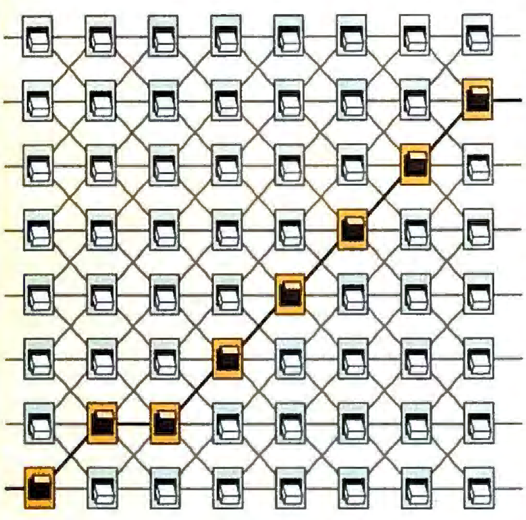
Second, data is transmitted over virtual circuits. This means that the switches between the sender and the receiver create a temporary direct link between the two machines. The link, which is virtual only because it happens in software, emerges after each of the switches in the path decodes the final address, chooses its internal switching connections, and matches this information with an address that is assigned temporarily.

At that point, each packet carries only this "predigested" address, and the switches can pass the information on faster because they can avoid complicated table lookups. Much of the routing work is done only once for each connection.

The third difference is the existence of service classes. When two computers initiate a link, they also specify a level of service that they will demand of each switch along the route. When the switches predigest the address, they also check to ensure that they can honor the commitment. An ATM switch can, for instance, promise to deliver 155 Mbps of data flowing at a constant rate, which is useful for transmitting video information. The switch prevents other users from grabbing this bandwidth after it is allotted.

ATM switches also offer variable-rate services for second-class data, data that does not travel with a time constraint. They

ATM Switching



In an ATM matrix, each switch has three entry and three exit ports. Each switch must shift a signal to an exit port as the signal moves across the matrix.

issue bandwidth promises for this class of data, but the constraints are much more flexible. This arrangement lets a switch overbook the bandwidth and try to interleave the different requests that it receives by delaying some packets.

In contrast, older technologies often just move bits from one location to another. Ethernet, for instance, has no concept of priority. Each node listens for free time on the network for a random amount of time, passing on its packets when time becomes available. This random approach may be egalitarian, but it does not offer the performance guarantees necessary to do constant-rate data movement. Performance fluctuates noticeably, for example, as people on the same branch of the network start and finish their work. By the time users get clearance for their connections and slowdowns disappear, data flow already has been interrupted.

Although ATM's book-ahead strategy successfully provides constant-rate data service, it has one drawback. If a network's bandwidth is promised to certain users, others will be locked out. You could hardly call that BOND. Still, those who get clearance under ATM receive better service than that provided under earlier systems.

The final—and most important—difference between ATM and earlier standards is that it provides a consistent standard that works on both LANs and WANs. Earlier systems use one networking protocol for local networks and another for long-distance connections. This can be efficient, but it is often inflexible and confusing.

Inherently flexible, ATM allows the switches and branches of the network to expand in unexpected ways. You can rearrange the long-distance and local connections of each ATM switch to adjust to the load patterns of a network. If you need more long-distance traffic, you may allocate more channels to these circuits by doing simple reprogramming. Or you may allocate the channel for local traffic to a LAN in the next building. The same equipment will handle both tasks.

The Basic Foundation

Each of these four features is available, in one form or another, in more specialized networks. But together, the four should provide the right balance for network users who want high-speed data traffic that mixes both constant-rate and variable-rate data streams. When the ATM Forum (Foster City, CA), the industry group responsible for setting standards, made its initial choices, it selected an interesting mix of technological approaches that solves many problems and provides a high level of service. At the beginning, it seemed as if the cost of these services would be high, but now it appears that costs will drop significantly, as several people jump on the standard's bandwagon.

The basic unit of data on the ATM network is still a packet. In this case, it is a fixed 53 bytes long (see the figure "An ATM Packet"). Out of the 53 bytes, 48 bytes hold data and 5 bytes hold the address of the destination. A number of recent network protocols have experimented with variable-length packets; however, the results have often proved unsatisfactory, because jams can occur when large packets are sent. Small packets are a compromise that makes sure that time-critical data, such as video, can always get through.

The 5 bytes in the header have six fields: GFC (Generic Flow Control), VPI (Virtual Path Identifier), VCI (Virtual Channel Identifier), PT (Payload Type), CLP (Cell Loss Priority), and HEC (Header Error Control). The most important fields, VPI and VCI, contain the predigested address for all the internal information the switches use to quickly route packets. For convenience, the address is broken into two parts.

Switches may set up their internal allocation of VPI and VCI numbers to aggregate many similar connections into one pipe. A switch might, for instance, assign a VPI of 3 to every connection that comes in via port 14 and leaves via port 2. Then the switch could effectively ignore the VCI for these connections.

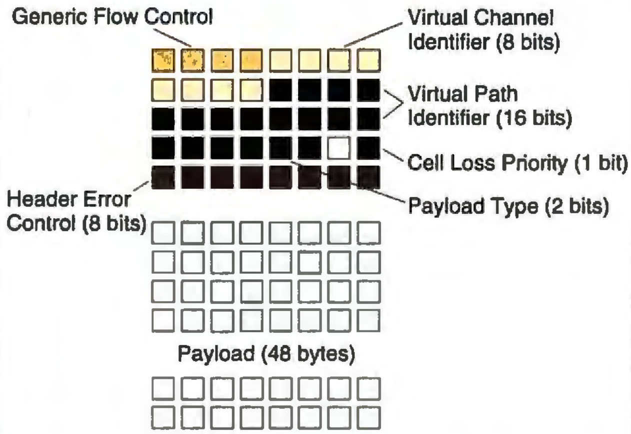
The CLP is a 1-bit field used to mark packets that can be lost. The switches flip this bit on when they discover that a computer is sending more data than it has reserved. This means that any switch can toss away this packet if it is swamped. The HEC is an 8-bit checksum of the other information in the header. At the time of this writing, the uses for the GFC are not standardized, but it could be used to provide flexible available-rate service.

Flexible Flyers

A key feature of ATM is a call-initiation process that lets both continuous streams of data and bursts coexist peacefully. When one computer wants to send data to another, it sends a request for a particular type of connection. If the computer plans on establishing a video link, it might request 100 Mbps of continuous data traffic.

Each switch along the way decodes the address and determines the ports through which the information will enter and leave. It then considers the request for bandwidth and determines if it has enough available on the outgoing port. (The demand for the incoming port was already determined by the sender.) If sufficient bandwidth is available, the switch assigns a pair of VPIs and VCIs to the connection and records them in

An ATM Packet



Each ATM packet has 53 bytes. The most important segments, the VCI and the VPI, contain the address for routing.

the pair's routing tables. The values of the VPI and VCI are different for each switch-to-switch hop along the connection. The tables contain the VPI/VCI pair of the sender and instruct the switch to replace them with a new VCI/VPI pair for the next hop and to send the packet from the correct port. It is at this point that some users might experience overloading.

One ATM switch may create a bottleneck between one half of the network and the other. If computers in one area create a bottleneck by booking all the bandwidth, then the other computers cannot get a connection; therefore, they must wait until the connections are broken. The simplest way to solve the problem is to reprogram the switches to allocate more bandwidth to the links to the bottlenecked switch. Because the switches often have an aggregate amount of bandwidth that they may use for any of their ports, you can often reallocate bandwidth from one port to another. When insufficient bandwidth is available, you may add another switch in the center of the network.

The Standard Issue

ATM standards are maintained by the ATM Forum (its Internet address is info@atmforum.com). The basic standard is the ATM UNI (User-to-Network Interface), which governs the size and structure of the packets, and how connections begin and end. The current version of the standard is well evolved, and the ATM industry met to construct an intervendor LAN at the 1994 Networld+Interop show in Las Vegas with Supercomm/ICA in New Orleans. Switches and interface cards from many vendors were connected successfully.

The standards are evolving, as the ATM Forum decides which solutions are best for different problems. At this point, version 3.0 is finished, and the ATM Forum is working on its next release, version 3.1. These new standards probably won't make existing ATM equipment obsolete. Because several ATM protocols are handled in software, it is possible to reprogram old switches for the new standards.

Another issue standards hope to resolve is a unified billing scheme for all the long-distance carriers. Although UNI already governs how switches interact, it does not yet include enough information for the long-distance carriers that offer ATM service to connect ATM LANs in different communities. These carriers would like to supply potential customers with information about billing and pricing so that they can sell the service more effectively. Right now, you have to buy ATM service from a single long-distance carrier at a time.

The next standard, the BICI (Broadband Intercarrier Interface) should change all that. Version 1.0 is finished, and it specifies permanent virtual circuits. Version 1.1 was scheduled to be completed by September and will cover switched virtual circuits. It will effectively be able to initiate ATM links that hop along several long-distance carriers. Billing information will find its way back to you.

Levels of Service and Guarantees

The great promise of ATM is that its standard format links all levels of a network. This factor, as well as the superior performance offered by switched circuits, should be enough to make ATM irresistible.

At present, two approved levels of service are available to applications looking to ship data across the network. The first, Class A (or constant-rate data) service, must get to its destination with little delay in delivery time. The other option is Class C service, also known as variable-rate service. It offers looser guarantees on delivery time, which might confound applications such as digitized video or digitized voice. The standard specifies the amount of sustained bandwidth, peak bandwidth, burst size, and the maximum delay.

The ATM Forum is debating whether to add a third class, known as available bit-rate service. It would give switches even more latitude to delay data if higher-priority data arrived. This class of service is quite desirable because much of the software in use today does not require guaranteed services to perform simple tasks such as moving files or blocks of data.

The new service class is not just an attempt to provide a lower and less expensive class of service. It is necessary because old software does not always interact correctly with ATM. It may, for example, dump a large block of data on the network at a particular time, without reserving a guaranteed level of service. This burst overwhelms the network. In some cases, the switches flag the packets by flipping the CLP bit. In others, the burst floods the buffers, and packets are lost.

The solution is to create a closed-loop system between both ends of the link. The sending end keeps track of the space in the buffers at the other end and transmits only when space is available. This tightly controlled approach seems a bit clumsy when compared to the lightweight, predigested addressing spaces that define virtual circuits, but it is the only practical way to handle large bursts.

Users of long-distance ATM connections will undoubtedly pay particular attention to each of these classes of service, because carriers will price their services at levels to maximize profit and ensure smooth use of their network. Carriers are certain to experiment with many pricing schemes, in part because the computerized nature of the business makes it tempting to do so. These schemes could vary from the simple (fixed cost per month) to something that outstrips airline pricing in complexity. Long-distance companies such as Ameritech, MCI, and AT&T cannot offer concrete examples of their pricing schemes, but all say that competition will encourage flexible schemes that target particular types of clients.

Inside the Switches

The switches that move information from one port to another port have a difficult job. For a switch to sustain data coming from each port, it must be designed so that it alleviates bottlenecks and prevents any interruption in data flow. The smaller switches of 16 or fewer ports are often largely serial implementations that service each port in turn, while larger switches have more complicated, parallel switching fabrics.

Smaller switches revolve around a high-speed bus. Each port has its own controller, which places packets on the bus when it is the port's turn. In the meantime, each port controller listens to the bus for packets that are intended to leave its port. The bus must be able to run at a speed that provides enough bandwidth for every port. There is a limit to the scale of this approach.

A more general approach uses a flexible "fabric" of small switching elements. The result is a matrix like the one shown in the figure "ATM Switching" on page 96DM 18. The packets from each port enter on one side of the matrix. At each step in the clock, the switching elements pass the packets to an appropriate neighbor. Each switching element is connected to a few neighbors, which means that a packet might need to be switched several times before it reaches the right output port.

A switching matrix scales nicely, and the design can sustain switches with 64 ports or more. Of course, problems may arise when several ports are sending information to one output port. If the traffic is low-priority data traveling in the available bandwidth, it may overload the output port. Each small switch has only a small amount of buffer memory to ride out temporary overflows. If the overflow is too large for the memory buffer to handle, the buffers on the input ports take over.

Pipe Size

Many parts of the ATM standard do not depend on the connection speed. It would be possible, in theory, to run ATM over a 300-bps modem line. The industry, though, is creating several levels of speeds for the connections between computers and ATM switches. The basic levels are 45 and 155 Mbps, but other standards may evolve.

Interface cards that operate at slower speeds are less expensive to produce. A faster interface card in a computer must have larger buffers and better bus-interface electronics to handle the higher speeds. Also, wires capable of handling faster speeds must be better shielded.

In many cases, existing wires are good enough to handle slow ATM, but to install a fast ATM network, companies must rewire their offices. For this reason, some companies are exploring a much slower 25-Mbps ATM service that would run successfully over today's lower grade wires.

Grand Unifier

The ATM Forum likes to refer to ATM as "The Grand Unifier." When it finishes the BICI standard, which allows long-distance companies to knit their networks into a seamless WAN, unification will really begin. As a next step, someone must produce the software layers that make it easier for the average developer to use video-class services without worrying about buffering and display problems.

When this work is finished, the main obstacle becomes political. Will a number of companies adopt the ATM standard? If everyone does, economies of scale will make ATM very inexpensive. Some users remain skeptical, pointing out that the last great unifier, ISDN, never really arrived.

The great promise of ATM, though, is that its standard format links all levels of a network. This factor, as well as the superior performance offered by switched circuits, should be enough to make ATM irresistible to a number of users with large, high-speed networks. Only time will tell whether ATM will prove irresistible enough to drive the technology to price levels that make it affordable enough for the average desktop. ■

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Connecting Remotely

LYN BOYER-NELLES © 1994

BARRY NANCE

Remote-access technology has advanced to the point that, no matter where you are, your computer can become just another node on a LAN. Different implementations of remote-access schemes vary in terms of performance, ease of use, interoperability, and security. However, all of them effectively turn your modem into a network adapter.

You don't need special knowledge of remote-control techniques to use remote access. You use applications on your remote PC as you would if you were in the central office. The applications see the LAN at the remote location in the same way they'd see a LAN if you were attached to it through a workstation (although the communications link is slower). This differs from remote control, where the screen image of a slave PC on the network is mirrored on the remote computer.

Remote control tends to do well with text applications, because the central slave PC can access large files on the server without transmitting them to you. Remote access performs well if you use graphically oriented applications (e.g., Windows) and the files you access aren't huge (see the text box "Five Ways to Connect Remotely" on page 96DM 22). Remote access is also appropriate for client/server applications, such as database servers (e.g., Oracle, SQL Server, or perhaps DB2 for OS/2). On the other hand, transferring large files through slow modem links doesn't make sense in a remote-control or remote-access environment.

Remote access is cost-effective for organizations that have a large network and groups of people who need remote LAN access. Unlike remote control, remote access gives you transparent access to the LAN, which can help you be more productive when you're on the road.

Your PC can become a LAN node from virtually anywhere, but remote-access products differ in performance, compatibility, and implementation

How Remote Access Works

A remote-access product consists of two major components: a connection point in the central office and software you run on your remote PC. The central connection point might be one modem or a modem pool, and you might connect through voice-grade telephone lines, ISDN lines, or another type of telephone service (see the figure "Remote Access").

Usually, remote-access products use either SLIP or PPP to manage the transmission of LAN packets through the telephone connection (see "From Here to There," June BYTE). To avoid unnecessary modem traffic, remote-access products also typically implement MAC-layer (media access control) bridges, with filtering, to keep the local network's broadcast traffic from clogging the telephone connection to your remote PC. Many remote-access products use a PC that is attached to the LAN as the central connection point (some vendors even supply the entire PC, preconfigured).

continued

FIVE WAYS TO CONNECT REMOTELY

1. **File transfer: The simplest but least satisfying method for establishing a remote connection. If one of the computers on your LAN runs BBS software, or if you transfer a file to someone on the LAN through an E-mail service, such as MCI Mail, your connection falls into this category.**
2. **Application-specific access: Downloading files from BBS software or transferring files from an E-mail service. Lotus's cc:Mail Remote is an example of application-specific access software.**
3. **Remote control: A connection in which you use a modem to access an in-office PC operating as a slave. Examples of remote-control products include Norton pcAnywhere from Symantec, Norton-Lambert's Close-Up, and Carbon Copy from Microcom, all of which control another PC by sending your keystrokes to a slave and echoing the remote PC's screen on your own screen.**
4. **Multiuser remote control: A remote-control connection that lets you handle several remote-control sessions at once. With this type of connection, the office PC must have a 386 or higher processor, lots of RAM, several modems, and multitasking software such as Novell's Access Server.**
5. **Remote access: A connection in which your remote PC dials up the central LAN and becomes just another workstation node.**

Other products consist simply of a modem that has an Ethernet or token-ring connector in addition to an RJ-11 connector.

The connection server or modem "virtualizes" your remote LAN session. Your application performs file I/O operations, which the network software on your PC turns into LAN messages. In turn, the remote-access driver on your remote PC converts these file I/O LAN messages into SLIP or PPP packets. The packets travel through the telephone line to the LAN.

At the central connection point, the PC or modem converts the SLIP or PPP packets into ordinary LAN messages that flow to the file server. Responses from the file server, encapsulated by SLIP or PPP, flow through the central connection point and through the modems back to your remote PC. The remote-access driver on your remote PC removes the SLIP or PPP envelope, and your redirector module receives the resulting packet. (See the figure "Remote-Access Protocol Stack".)

The redirector module isn't aware that the packet traveled a bit farther than most LAN packets do. However, the extra time taken to transmit and receive packets through the modem means that, for remote access to function properly, you might have to increase certain time-out parameters—those in the NET.CFG file or PROTOCOL.INI file, for example.

Performance

Modems that operate at 9600 bps, 14.4 Kbps, or higher transmission rates are inexpensive and popular. Even with built-in data compression, however, modems are orders of magnitude slower than Ethernet or token-ring network adapters, which operate at 4, 10, or 16 Mbps. Makers of remote-access products try to alleviate the modem bottleneck by using packet filtering to limit the LAN packets your remote PC sees to just those packets the remote PC has requested.

The central connection point forwards selected LAN packets to your remote PC, and it might even reply to certain LAN packets on your behalf, without causing any modem traffic. For instance, servers running NetWare periodically broadcast "Are you there?" packets to workstations. During your session, the central connection point can answer yes for you without sending data through the modem. All the central connection point needs to know is that the modem's carrier signal is still present. The central connection point doesn't have to bother your remote PC with the query.

Vendors of remote-access products are aware of the need to make your remote session appear to perform as well as it would if you were working at a locally attached workstation. A version of Intel's RemoteExpress product comes with an ISDN LAN adapter and ISDN Bridge Pack software that take advantage of ISDN's higher bandwidth. IBM's LAN Distance supports ISDN as well as X.25. Most remote-access products support 28.8-Kbps or faster modems and provide a way to exceed the speed limits that are imposed by V.32/V.42bis modems.

Ease of Use

Plainly, a modem is not a network adapter, and making it appear to be one is difficult. Modems have S-registers; LANs do not. And modems need a telephone number to dial before they can connect to a LAN. On the other hand, networking software makes demands that modems are not equipped to meet. When the NETX networking module is first loaded, for example, it broadcasts a request for file servers to identify themselves. NETX won't continue unless it finds a server to connect to.

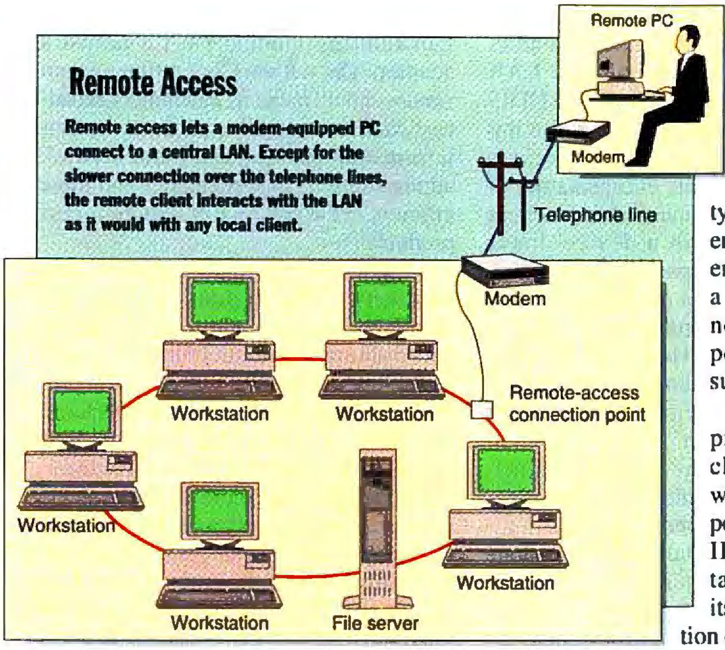
Does this mean you need to establish the remote connection at boot-up time and keep the connection active until you power off? Not necessarily. Microcom's LANexpress solves this problem by "spoofing" NETX into thinking a server is available, when in fact you haven't dialed into the LAN yet. Spoofing lets you load NETX when you boot up your computer, and connect to the central LAN at a later time. If, for instance, you are in the midst of running Windows applications when you decide you need to access the office LAN, you can dial up, log in, and continue your work without leaving Windows.

Another important ease-of-use issue centers around the simplicity of procedures for setting up and configuring the central connection point. Naturally, different products take different approaches to simplifying these tasks. For example, Shiva's NetModem/E and LANRover/T for Ethernet and token-ring LANs make it easy to set up and maintain connections because they contain Ethernet or token-ring adapters. You connect the modem to the LAN at one end, connect the modem to a telephone line at the other end of the connection, and visit a workstation on the LAN to run the setup software that lets you configure such things as authorized account IDs and passwords.

Shiva's NetModem/E and LANRover/T products.

Remote Access

Remote access lets a modem-equipped PC connect to a central LAN. Except for the slower connection over the telephone lines, the remote client interacts with the LAN as it would with any local client.



Interoperability

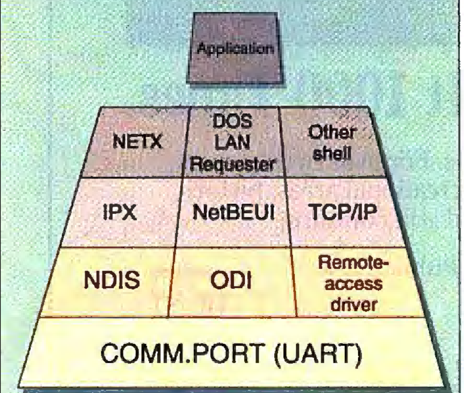
All remote-access products support DOS and Windows; some also support remote OS/2 or Mac workstations. For protocols and networks, all vendors support NetWare, many of them support DOS LAN Requester, and some of them support the OS/2 LAN Server Requester. Support also exists for other network operating systems, such as Artisoft's LANtastic and Banyan Vines.

This diversity of protocols and network operating systems creates the standard dilemma. If a vendor designs its remote-access product to work closely with a particular workstation networking package (e.g., NETX), performance will be strong, but the company will have a hard time supporting a variety of platforms. On the other hand, if a vendor designs a workstation component to be completely insulated from the type of network operating system present, it will support a greater variety of networks, but its performance will suffer.

With LANexpress, Microcom chose to tie the workstation component to NetWare. IBM's LAN Distance implements its remote workstation driver software as an ANDIS module. ANDIS extends the NDIS standard to encompass such modem-oriented functions as dialing the phone and keeping track of a modem's carrier signal.

ANDIS works with modems in the same way that NDIS works with network adapters, and generally you can use an ANDIS driver in place of a regular NDIS driver for a network adapter. This degree of interoperability means that you can run any NDIS-compliant workstation network software you wish on your remote PC, and you can attach to NetWare, LAN Server, Vines, or LANtastic networks from your remote PC. If you wish, you can also run LAN management agents (e.g., SNMP) over ANDIS.

Remote-Access Protocol Stack



Working through a communications port, a remote-access driver can let upper layers of a protocol stack treat a modem as a network adapter.

Security

Of course, you wouldn't consider using a remote-access product if remote-access technology compromised the security of your LAN. Fortunately, all remote-access products offer levels of security to prevent mischief over the telephone lines, and some go even further, allowing you to use third-party products from security database vendors.

Typical levels of security include account ID and password authorization (separate from and in addition to the network operating system's account ID and password scheme), PC address verification, preestablished telephone-number callback, password encryption, access-privilege levels, and valid log-on time intervals. Certain products support users group categories or require you to change your password at periodic intervals.

Network adapters have burned-in node addresses that uniquely identify each adapter. Modems generally don't have unique addresses like these. However, Microcom, probably better known for its modems than for its LANexpress remote-access product, offers modems that do a good job of integrating the security features of LANexpress. Those Microcom modems intended for use with LANexpress have burned-in node addresses that appear just like the node addresses for a network adapter. A modem's identifying node addresses can be queried and verified, and you can associate names with the node addresses. You also can restrict access via remote LAN to certain node addresses and find out which modems are connected to the LAN at any given moment.

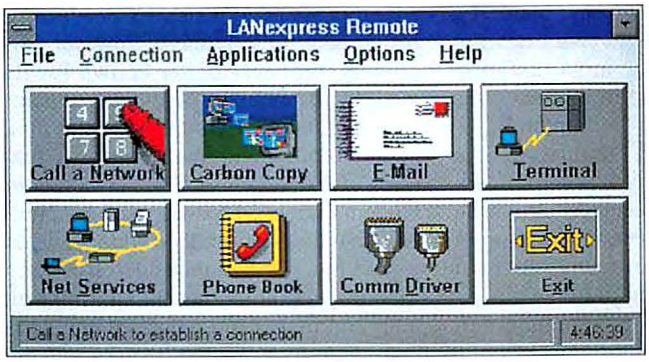
DCA's Remote LAN Node offers a similar feature. Its optional DCA remote-security adapter is a small DB-25 connector that plugs into the parallel port of a remote workstation (i.e., a dongle). When the remote workstation connects to the central LAN, RLN verifies the node address burned into the DCA remote-security adapter.

Other Issues

Noisy telephone lines can be a problem for remote access, just as for any other kind of modem connection. Error-correcting modems, designing error correction into the network's transport-layer protocol, and the very nature of remote access will keep you from noticing the noise in the midst of your remote session, as you might if you were using a terminal-emulation program without an error-correcting modem. However, noisy telephone lines can degrade the performance of your remote sessions. To avoid this problem, you'll need to get a sense of the usual length of time it takes a remote workstation to access a file of a given size, so that you'll know when a particular access takes an inordinate amount of time. When performance is sluggish, the solution is redialing the connection to try to get a telephone line that has less noise.

There are alternatives to a regular telephone line, of course. Establishing a remote office and using remote access to give that office access to your LAN might prompt you to add an ISDN or X.25 link to help performance. The number of salespeople or other business travelers in your organization will determine how many incoming telephone lines you need. However, people on business trips, connecting from hotel rooms, won't be able to take advantage of special telephone lines.

Remote access isn't always the best way to connect to a LAN. It does give the



Microcom's LANexpress comes with easy-to-use software.

appearance of being connected to a LAN and is generally easier to use than remote control. Nonetheless, you often can process huge files through remote control quicker than you can through remote access. If you need both technologies, be creative: Use a remote-access product to connect to the LAN, and use a LAN-based remote-control product, rather than one that is modem-based, to remotely operate an application that processes huge files.

In Search of a Standard

Remote-access technology currently does not have a standard interface specification to which all vendors may adhere. LAN Distance's ANDIS feature is quite impressive, especially its encapsulation of the modem functions in a device-driver package that makes a modem look like a network adapter. However, effective and easy-to-use remote access can't be completely hidden within a device driver.

You can equate the opening of a network adapter to the initialization of a modem. However, the remote-access product needs to defer dialing the telephone number until you log on to the LAN. And some network-operating-system functions should behave differently for remote access.

Ideally, vendors of modems, network operating systems, and remote-access products should provide both real- and protected-mode NDIS- and ODI-compliant (Open Data-Link Interface) communications port drivers to insulate, as much as possible, the network software from the fact that the modem isn't a network adapter. The network-operating-system vendor should make its handling of broadcast packets, keep-alive packets, routing-information packets, and other network administration packets smarter and more efficient in the presence of remote-access products.

Vendors could expand their use of standard network configuration files. You might, for instance, put telephone numbers inside the NET.CFG file or the PROTOCOL.INI file. The LOGIN.EXE program for NetWare users (or LOGON.EXE, in the case of DOS LAN Requester users) could, in a remote-access environment, signal the device driver to dial a telephone number. Manufacturers could specify these and other enhancements to the hardware and software components in a remote-access environment by agreeing on an open standard for remote access. ■

Barry Nance is a BYTE contributing editor and a programmer. He is the author of Using OS/2 2.1 *(Que, 1992-1994),* Introduction to Networking *(Que, 1992-1994),* Network Programming in C *(Que, 1990),* Networking Windows for Workgroups *(Wiley, 1992), and* Client/Server LAN Programming *(Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.*

State of the Art

GET THAT DATA!

Making business-related data available for computer processing is aided by some remarkable new tools for improved product design, production monitoring, and elimination of time-consuming paperwork

RUSSELL KAY

Not so long ago, data acquisition for business meant the tedious manual collection and entry on paper of machine and instrument readings and test reports and their later transfer to machine-readable form. This required armies of clerks, verification of all manual entries, and a significant amount of time.

The direct expenses of manual data entry are obvious; yet the hidden costs are likely to be even greater. The amount of time it takes for entries to be made and transferred means that managers are always working with old, out-of-date information. Communication with customers and suppliers is time-consuming and frustrates attempts to work faster and smarter.

Also, without real-time feedback on manufacturing processes and output, quality and performance are difficult to monitor and regulate efficiently. Finally, traditional product-design methodologies make it difficult to apply the hard lessons learned on the shop floor—not to mention environmental and safety regulations—to improve the design of newer products.

However, as more of our industrial processes and activities center around information-related products and services, and as even the traditional smokestack industries and manufacturing operations depend on electronic sensors and real-time data, the task of generating and capturing that data for automated processing and instant access becomes critical to continued survival in today's brutally competitive world. With this in mind, BYTE takes a look at data acquisition for business.

Faster than a Speeding Bullet

It is clear that automation today means replacing paper-based operations with machine processing, electronic telecommunications, and computer-aided methodologies. One of the first areas to benefit from the direct generation and use of electronic data is the administrative function. E-mail and local-area networking, have become critically important to many companies. EDI (Electronic Data Interchange) has made it possible for companies to maintain on-line links with customers and suppliers, cutting the time needed for order processing, inventory maintenance, and fulfillment.

In "EDI Moves the Data," Peter Wayner discusses the many ways that EDI can replace paper documents with electronic messages. Purchase orders, confirmations, manufacturing instructions, packing slips, invoices, and even payments are now travelers on the electronic highway.

To do this on a wide scale requires standards that ensure interoperability and mutual understanding. Other important issues include the need for digital clearinghouses to route and translate electronic documents; cryptography-based document notarization, time-stamping, verification, authentication, and legally binding digital signatures; and finally, digital cash—chump change for the toll booths and shopping malls along the Infobahn.

What's Happening on the Shop Floor?

As production and manufacturing operations become more automated, it is easier than ever to quickly capture the data needed to control these processes, improving quality control and monitoring output closely and accurately in real time. In "Process Control's New Face," Mark Clarkson shows how new object-oriented software tools make it possible to easily represent physical processes in diagrammatic form on a computer screen.

Such displays replace the complex and expensive panels used in nuclear power plants, chemical refineries, transportation and communications routing, and materials-handling systems, to name just a few. Computer-based process-control systems permit quicker development and modification of monitoring systems, as well as more efficient use of operators' time.

These new MMIs (man-machine interfaces) are becoming more affordable as they are made available on commodity-level PCs running Microsoft Windows. Formerly restricted to proprietary hardware and workstation-class systems, MMIs are likely to be used more widely once Microsoft brings out the next generations of Windows and Windows NT that can better support real-time and near-real-time applications.

The Design of a Lifetime

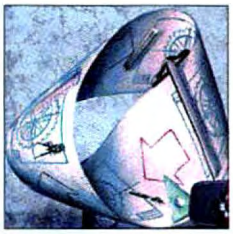
Perhaps the least-known aspect of data acquisition for business involves product design. Several new factors are coming into play as computer-based tools become more powerful and more widespread.

Sara Reese Hedberg, in "Design of a Lifetime," takes a look at a new generation of tools that capture not only the final design specifications and parameters but also the intermediate rationales and reasoning that went into a design process—why certain decisions were made at certain points, and why other choices were not adopted. This data—formerly available, if at all, buried in correspondence and engineers' notebooks—can be invaluable later in the life of a product, as modifications and evolutionary enhancements need to be made.

Another benefit of this new design approach is the early involvement of other company departments that will have to deal with the product later in its life cycle—manufacturing, marketing, customer service, and maintenance. This involvement translates into a better product for the ultimate user, because all areas of the producing company are in the best possible position to support the customer.

The newest design tools and methodologies also reflect the need for eventual recycling and materials reuse. Integrated design that considers a product's whole lifetime, including its ultimate disposal, is changing the nature of many products. Fewer different materials are being used, and products are being designed to be easily taken apart when no longer serviceable—which, of course, tends to improve their serviceability all along the way and thus may extend their usable life. ■

Russell Kay is a BYTE technical editor. He can be reached on the Internet or BIX at russellk@bix.com.



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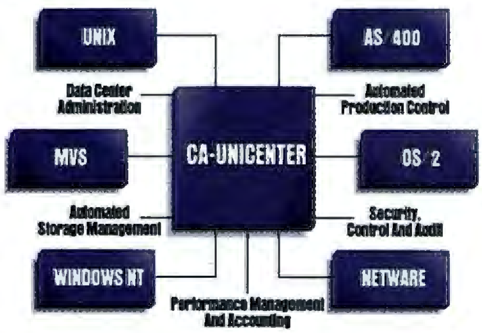

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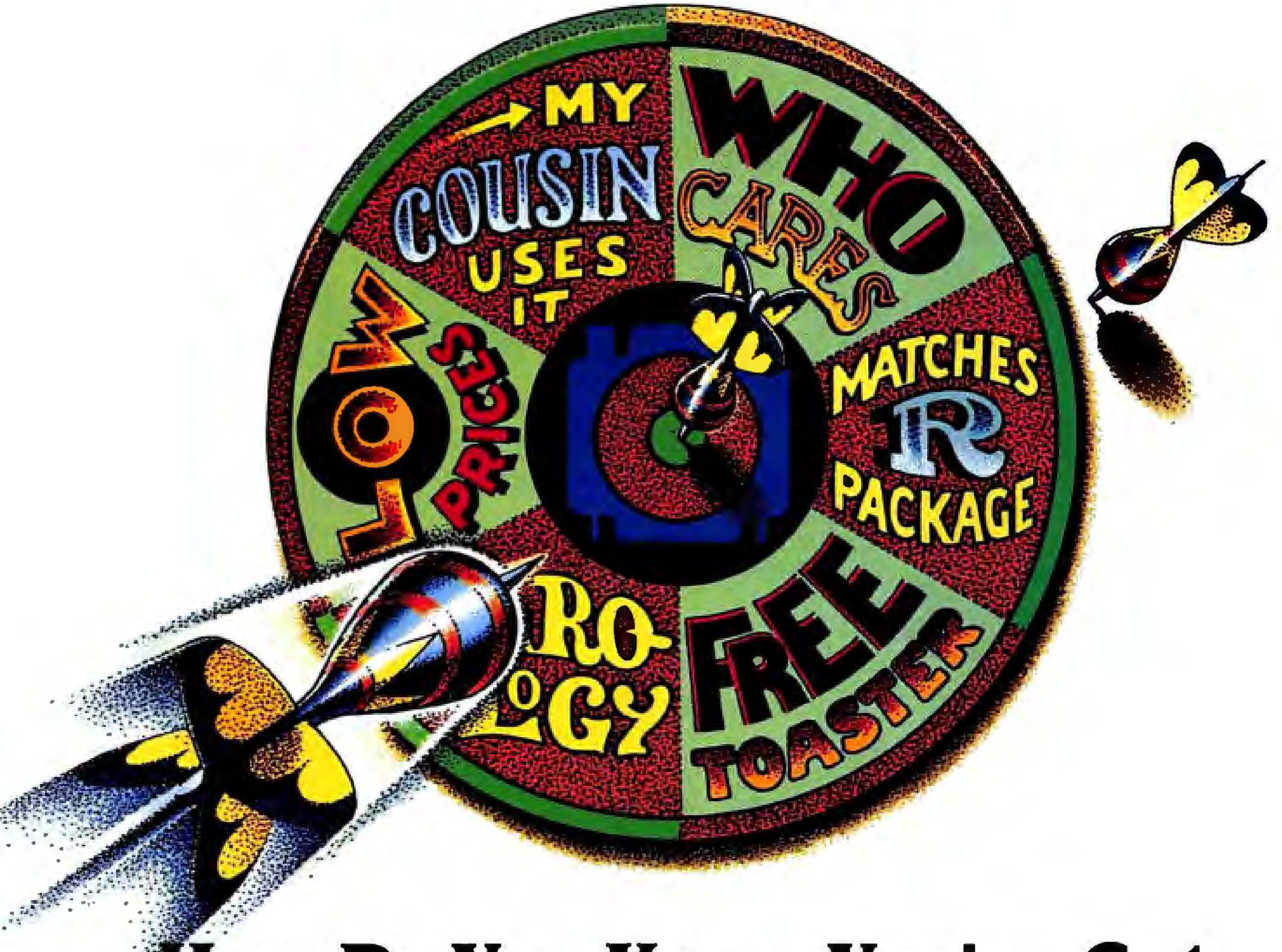

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DESIGN OF A LIFETIME

New computer-based tools will help product designers capture their design decisions and rationales, take the entire product life cycle into account up front, and facilitate collaborative design

SARA REESE HEDBERG

BOB DAHM © 1994

Today's global economy is pushing companies to get better products to market more quickly at reduced cost—and, increasingly, with the least environmental impact. The old sequential, linear style of operation is fading. The days are past when design engineers brewed up a design entirely on their own and then "threw it over the wall" to manufacturing. The barriers between different parts of the organization are dissolving as manufacturers think more holistically in terms of integrated business processes such as the introduction of new products.

"Manufacturers must evaluate as an integrated whole activities such as sales, order processing, design, assembly, shipment, invoicing, installation, and service," according to Mark Fox, director of the Enterprise Integration Laboratory at the University of Toronto's Department of Industrial Engineering. "Today's solutions span organizational boundaries. By integrating the components of each process, companies will be more competitive because they can get better quality products to market faster and take advantage of the economics of globalization."

Design—A Multidimensional Task

A new emphasis is being placed on design as the first step of manufacturing. Design engineers must take into account up front the entire life cycle of the envisioned product. Under this life-cycle approach, designers must meet the requirements of all the activities that are downstream from design—such as manufacturing, distributing, servicing, and recycling. But it's not even that simple. Design engineers must make trade-offs among competing requirements.

For example, the top of a soda can is made from a different aluminum alloy than the rest of the can. The top is slightly tapered to reduce the amount of this different alloy and simplify recycling processes. But if it's tapered too much, then fewer cans can be packed into a truck, and distribution costs increase. So a balance must be struck.

Today the design process is further complicated because it is often a collaborative effort, involving many engineers with different skills and responsibilities. The design team may be in one location or in various locations in the same city or around the globe. It may have members from more than one organization working for a "virtual company"—such as a consortium formed to build a complex product (e.g., an airplane). For large, complex products, there may be hundreds of design engineers involved. "It's physically impossible to get 200 automobile design engineers together," notes Fox. "So what technology or technologies can be used to achieve design integration?"

The U.S. DoD (Department of Defense) faces the problem of collaborative life-cycle design in-the-large. To develop and produce an airplane, for example, many vendors must cooperate in an international virtual manufacturing complex. How do you integrate the design work of two contractors working on different parts of a plane—say General Electric designs the engine, and Boeing designs the airframe—when each uses a different CAD tool? How can the two companies' designers collaborate so that their respective parts fit together?

Needed—New Modeling Tools

Several major technical issues must be addressed if computing tools are to help designers balance the multidimensional requirements of the entire product life cycle, as well as support collaborative long-distance design by different teams. One of the primary issues is how to represent not only a solid model but also the design decisions and engineering judgments that shape a design. This requires a rich means of representing information—often at high levels of abstraction. One area of research that is addressing this challenge is called *ontological engineering*.

Groups at Stanford University, the University of Toronto, and others are working to build rich ontologies (i.e., shared reusable knowledge bases) for representing highly complex data structures that can be shared among the different parts of the organization. The Enterprise Integration Lab has developed an experimental ontology of products using first-order logic that provides the ability to represent parts and assemblies, features associated with parts, and parameters associated with features. For example, a part may be a length of pipe, a feature is a bend in that pipe, a parameter of the bend may be the number of degrees it angles through. This ontology also includes the ability to represent design versions, revisions, requirements that lead to design decisions, design rationales, and more.

Closely related to modeling is the issue of finding and capturing the information that goes into the model. "We have to cross

MADE in the U.S.A.

While work is under way in the industry to develop internal tools that support life-cycle design, one of the largest efforts in the world is being funded by ARPA, the DoD's (Department of Defense's) research arm that sponsored the development of the Internet some 25 years ago. In 1995, ARPA will spend about $750 million on a massive, multiyear research effort to improve design and manufacturing. Part of this push includes the development of tools to support the design and manufacture of CEM (complex electromechanical) devices. These CEMs are often highly complex products that combine multiple technologies such as optics, electronics, microprocessor control systems, and electromagnetics.

One important piece of ARPA's push is MADE (Manufacturing and Automated Design Engineering)—to develop tools that will enable different steps and participants in the life cycle to talk to each other and share knowledge. Currently in the second of its three years of funding, MADE has three specific goals:

- provide better tools for life-cycle design
- integrate MADE tools with each other and with legacy systems such as CAD and CAM models
- distribute MADE tools via the Internet for collaborative research worldwide

The first phase of MADE is dedicated to developing the basic tools. To this end, ARPA is funding a number of AI researchers. "We want to be able to capture knowledge in its abstract form and do design at a high level," explains Pradeep Khosla, program manager of ARPA's SISTO (Software and Intelligent Systems Technology Office). "With today's tools, we do it at a low level—such as the mass has to be *x*. We can't design at a functional level, such as rotary motion," he explains. "There's just no way to abstract attributes with the tools now available," continues Khosla. "We are working to put in place a set of tools that allow the computer to come to the level of the human being instead of the human stooping to the computer." Khosla also believes that capturing the reasoning that goes into designs and design decisions is essential to the MADE effort.

Some of the tools currently being developed with MADE funding include a solid-modeling tool that reasons about geometries; a low-level, factory-floor control system; an autonomous assembly system that will take CAD input and automatically generate the assembly plan that drives the factory floor; and an engineering design notebook. MADE is also funding the Knowledge Sharing effort, a research consortium that is developing ways to communicate among groups. This project is forging languages and protocols for heterogeneous environments, such as an interlingua to translate between different representational languages and shared reusable knowledge bases.

One Knowledge Sharing project, for example, is the How Things Work program at Stanford's Knowledge Systems Laboratory. Researchers are prototyping support tools for simulating and analyzing device behavior in all stages of design. The prototype lets you describe a device—not just its physical specifications and functionality but also the design rationale for why given choices were made. Models built using this tool can be manipulated and used downstream in manufacturing, troubleshooting, and redesign.

A great deal of emphasis is being placed on making knowledge reusable—such as running simulations from the functional specifications and then storing away the results so that later in the life cycle someone can look at the simulation to see how the designer intended the system to work.

In addition to the new, advanced design tools, ARPA is interested in finding ways for its researchers to share their work, such as through the Internet's World Wide Web. All MADE participants are posting documents describing their projects, research papers, progress reports, demonstrations, address lists of participating scientists, and actual prototype tools. For example, using a Web browser such as Mosaic, Lynx, or Cello, you can access from the Internet the following MADE URL (universal resource locator): `http://elib.cme.nist.gov/made/made.html`. Or, if you want to explore Stanford University's MADE-related activities access, you can use `http://www-ksl.stanford.edu`.

A number of MADE technologies are now being put to the test designing a heat seeker that sits in the nose-cone of a missile and tracks target aircraft. The six-month project, called MADEFAST, was scheduled to end in August of this year and is the culmination of the MADE's first phase. "MADEFAST has two goals: first, to enable people to collaborate and, second, to show the capabilities of various MADE tools," says Khosla. A byproduct of MADEFAST is a legacy of life-cycle design services available on the Web.

The next phase of MADE will test whether these core technologies can be scaled up. Many of the largest corporations in the U.S. have expressed interest in this next phase. Companies like AT&T, IBM, General Motors, and General Electric have indicated that they want to be on-board.

the barrier between what is in engineers' notebooks, and what is in the computer systems," notes Fox. "We're taking for granted that the information is already in the computers." But this turns out to be a wrong assumption. Fox's Center for Enterprise Integration analyzed where aerospace engineers at one large company spent their time and found that about 50 percent of engineers' time is spent creating or looking for information. At most, only about 35 percent is actually designing, and much of that is spent re-creating information they couldn't find. "So the issue of capturing the information that goes into these systems and accessing it is absolutely critical," concludes Fox, "because that's where all the time is spent."

Communicating Among Groups

Another issue closely related to rich data models is that of having a mechanism for sharing a model among different parts of the organization. In many cases, different operating groups have their own databases, as well as different terms for the same object. "Is a part called a part in the manufacturing database," asks Fox, "or is it called a product, or is it called a piece, or is it called an SKU? Design and manufacturing may use totally different terminologies." So there needs to be a way to translate terminology among all the various groups that share the product model.

"It's just as if you were speaking French to somebody, and you're a native English speaker," continues Fox. "You would think about it in English and translate in your head into French and then communicate in French. And if another person you are speaking to is a native German speaker, he would take the French and translate it into German and then figure out what you had said. It's the same idea here." So at the very minimum, integration requires a shared language for communication. In most organizations, this means getting different CAD tools—such as AutoCad, CadKey, and Unigraphics—to talk to each other or getting a CAD tool to talk to a CAM tool.

"You may want the designers to ship the model to manufacturing, but each has a different system," explains Richard Fikes, professor of research at the Computer Science Department of Stanford University and coscientific director at Stanford's Knowledge Systems Laboratory. "Everyone is using their own languages in their systems. So we need to translate in and out of these standard languages. We need to define standard interlinguas for device models—common interlinguas with translators at both ends."

Coordinating Tasks

As if the rich modeling-language, data-acquisition, and model-sharing issues mentioned above aren't enough complexity for the life-cycle design problem, there is yet another layer—the need to coordinate the various requirements of the product life-cycle during design. This is a difficult proposition, because there may be complex interdependencies among parts and systems.

Take a simple case: for example, the design of a door handle, where you have a handle designer and a door designer. The handle designer decides that the handle will be 4 inches long. However, the door designer has been assuming it will be 3 inches long, so he or she needs to find out quickly that the other designer has changed the length of the handle. And what if the door designer has already designed a door that cannot accommodate a 4-inch handle?

The job of handling these types of problems is left to coordination technologies that are being developed to represent design-decision responsibilities and constraints. Design constraints can originate in the laws of physics or come from downstream processes in the product life cycle such as transportation. For example, there might be a requirement that the depth of the handle depression should equal the handle width. "Whenever one parameter changes in a design," explains Fox, "the effects of that change have to be propagated across that constraint to related parameters, and people have to then be made aware of the fact that there is a constraint conflict, or there's a change in that parameter."

Constraint technology is one of the most important technologies that is needed to support integrated design, Fox concludes. "It lets you represent how different parts of the design interact with each other. Based on that, we can do design-decision propagation and alerting. We can even automate part of the integrated-design process, because as one part of the design changes, we can propagate that change into other parts and make that change automatically."

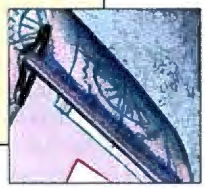
In recent years, research at places like the Concurrent Engineering Research Center and the University of West Virginia has spawned research tools that can enforce design constraints and allow data to be shared among geographically dispersed teams. The Product Design for the Environment Research Consortium at Carnegie Mellon University (Pittsburgh, PA) has been prototyping green engineering-design tools that look at the full life cycle of a product, from raw materials through use and ultimate recyclings. These tools will help engineers design products that balance environmental and economical constraints.

Technology Transfer Under Way

In recent years, ARPA has supported considerable research in the design process under its MADE (Manufacturing and Automated Design Engineering) technology program. MADE tools will enable communication among different stages in the life cycle so that knowledge can be shared. ARPA has also taken an active role in transferring this research out into the industry (for more information, see the text box "MADE in the U.S.A."). The University of Toronto's Enterprise Integration Lab, for example, is using MADE tools for the Supply Chain Management system it is developing and is adopting pieces for its Concurrent Engineering Design-in-the-Large projects that Spar Aerospace plans to use on an experimental basis by the end of the year.

Enterprise Integration Technologies (Menlo Park, CA) has begun offering MADE networking services on a commercial basis. So far, they have directory services available and expect to provide security and payment services later this year. The company is also working with RSA Data Security (Redwood City, CA) to market modules that allow Web users to speak Secure-HTTP (Hypertext Translation Protocol) for secure transactions. Enterprise Integration Technologies is also trying to peddle MADE-developed authoring tools, such as an engineering notebook.

A University of Toronto study found that aerospace design engineers at one large company were spending some 50 percent of their time creating or looking for information and only about 35 percent designing—and much of that design time was spent re-creating information they couldn't find.



Through efforts like these, the next generation of life-cycle design tools is beginning to see the light of day. But how long will it take these new technologies to percolate down into widespread use? After all, it took 25 years for the Internet to make the cover of *Time* magazine. However, the pressures of modern times and new transfer infrastructures will undoubtedly accelerate the adoption of MADE and related tools and technologies. Indeed, most experts guesstimate that this new generation of life-cycle design tools will have significant impact among major U.S. manufacturers in the next two to five years. ■

Sara Reese Hedberg, a freelance writer based in Issaquah, Washington, specializes in emerging software technologies. You can reach her on the Internet at hedberg@halcyon.com or on BIX c/o "editors."

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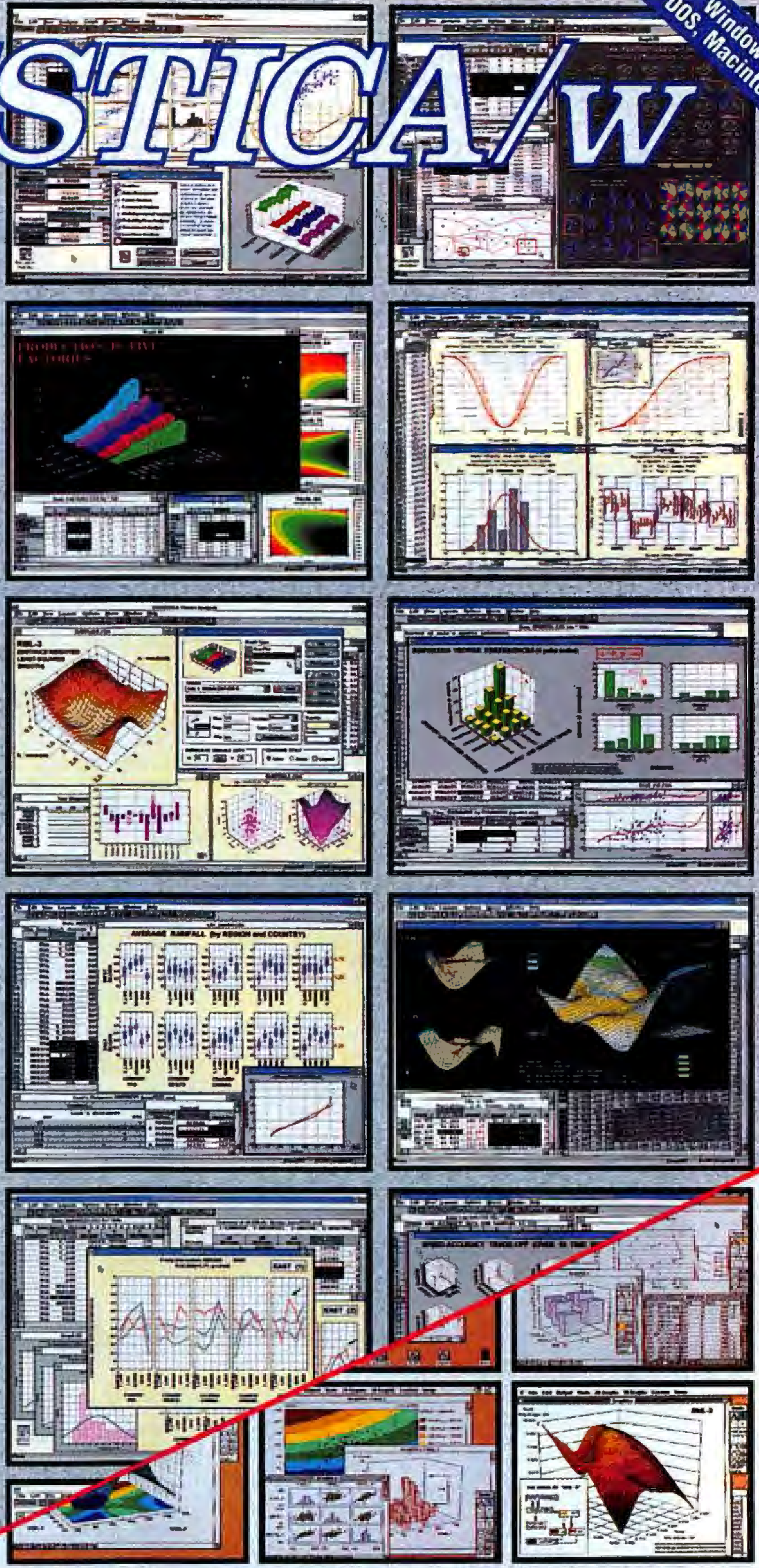

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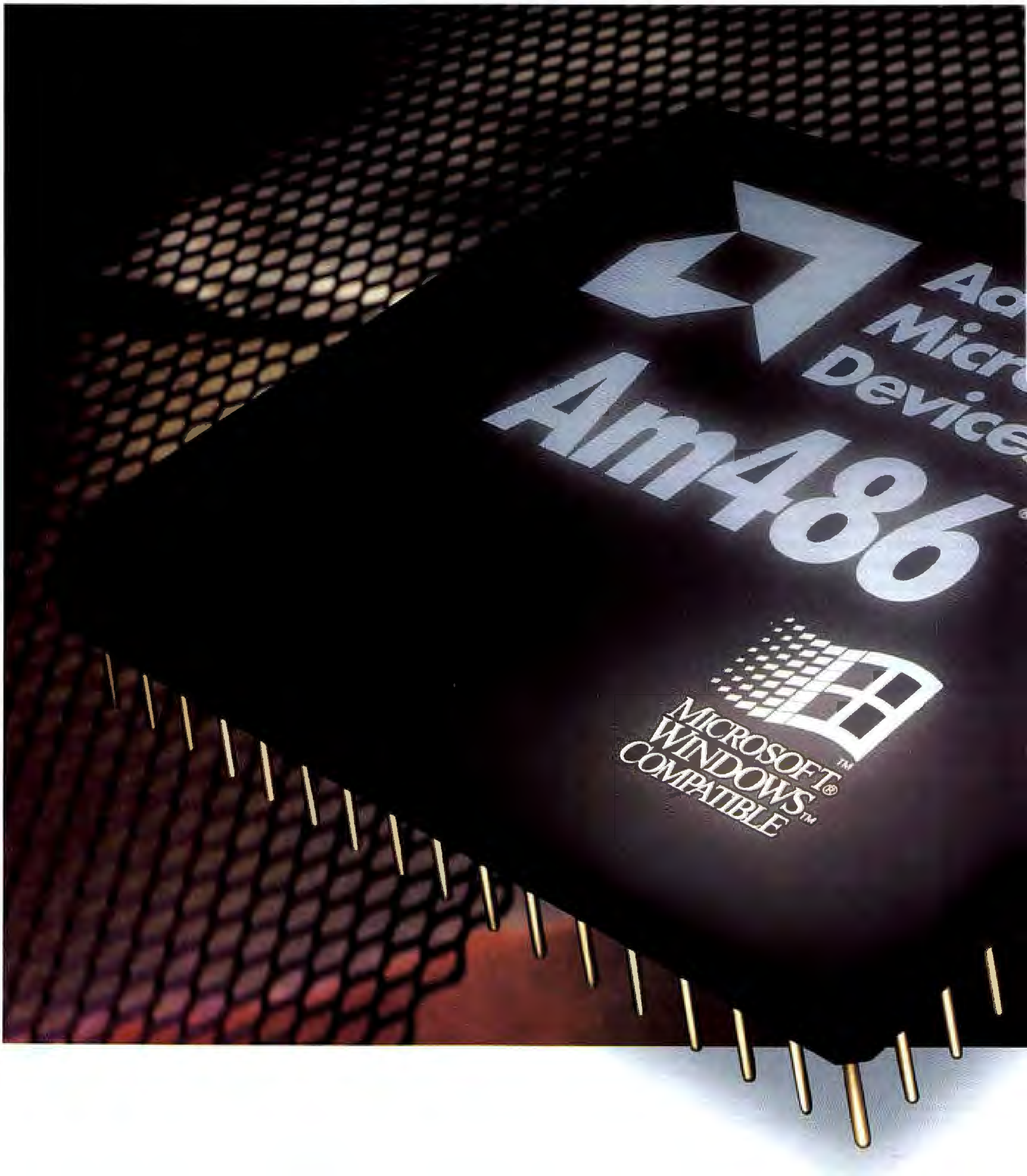

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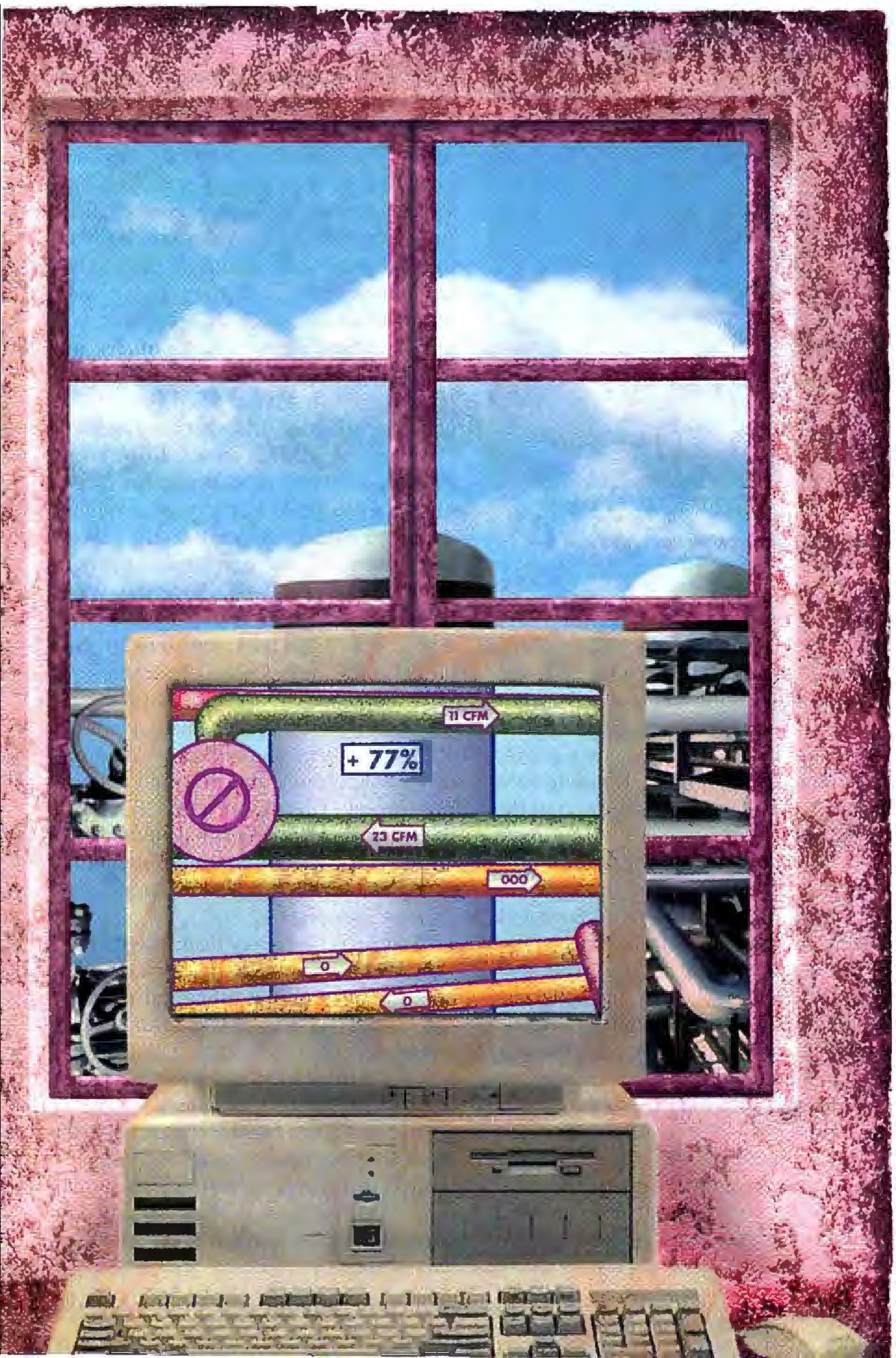

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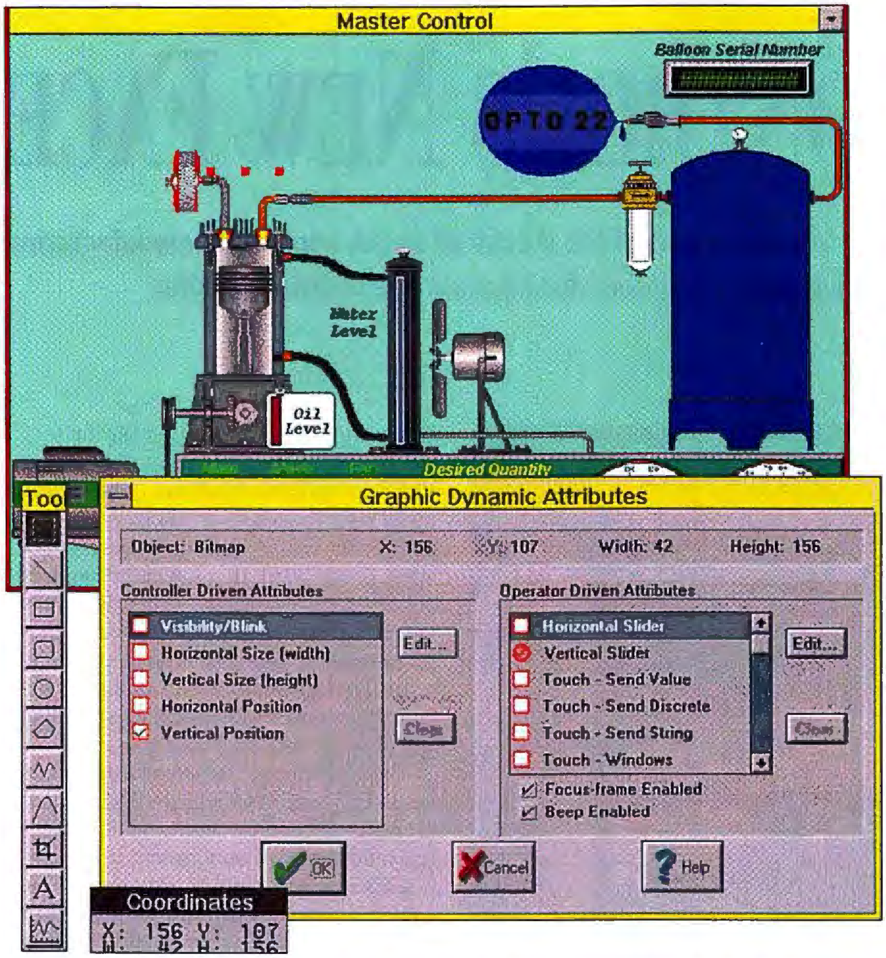
Things are changing on the factory floor. In the beginning, there were PLCs (programmable logic controllers), metal boxes packed with jumper wires and chattering relays, and they were good. Well, pretty good. If you wired enough of these boxes in exactly the right way, setting the relay jumpers properly, you could program them to handle the types of quick, repetitive tasks involved in stamping airplane parts out of sheet aluminum or filling and capping bottles of root beer.

The user interface for one of these beasts was a large metal panel called an *enunciator panel*, covered with cryptic gauges and industrial-size buttons in primary colors. The programming language, if you could call it that, was *relay ladder logic*. It was implemented by physically yanking and rearranging jumper wires to govern the sequence in which relays were tripped by sensors and other relays. Over the years, the industry accrued a large base of electricians and production engineers who spoke relay ladder logic; even as microprocessors replaced the relays inside PLCs, relay ladder logic was still used to program them.

Then, as now, PLCs governed mostly discrete processes—the mechanical actions found in stamping parts, folding boxes, or running vending machines. To control more-subtle analog processing, such as the distillation of huge vats of petrochemicals, there were DCSes (distributed control systems). Typically, these DCSes were operated from a single control room, isolated from the shop floor, and attended by a priest-like order of engineers and electricians. From this control room, lines snaked all over the plant, gathering information and sending orders.

The requirements on the factory floor are changing fast, says Gary George, director of marketing for Opto22, a maker of industrial-control systems for PCs. "People



This sample screen shows off some of the interesting kinds of graphical representations that can be used to monitor industrial processes with Opto22's MMI software.

now want to talk to third-party devices like bar-code wands, intelligent scales, and gas analyzers—things that DCS and PLC weren't designed for. People want integration, and these older architectures are only going to take you so far. The real future of control is the computer."

A Matter of Trust

When small computers first began to appear on, or near, the shop floor, they were not trusted to do very much. Early computers were notorious for all kinds of failures. At first, all they were used for was to replace those big panels of buttons and dials on the shop floor with on-screen representations of buttons and dials. Even that represented some big cost savings.

"You'd be surprised," says George, "at the cost of building those enunciator panels—the materials themselves, plus the cost of someone putting in push buttons, pulling wires, and assembling the panels. Now all that stuff is done in software. Now, you use a touchscreen or a light pen." To change the process, continues George, "you only need to go in and create a new window or move a gauge from here to there. There are no rewiring costs." In the control industry, this is known as MMI (man-machine interface). Running MMI software is still the major function of PCs on the shop floor.

A PC running MMI software is probably not actually turning on pumps or opening and closing valves. According to George, traditional control elements, such as PLCs, still typically perform those tasks. What MMI offers is a new and better way of talking to those traditional control elements. If a valve opens, the computer may turn an icon red. If you click on a button, the computer tells the PLC to start or stop a process.

Even though the PLCs are still there, you can program them through the MMI. Today's programming languages are much easier to use than relay ladder logic. For example, Opto22's programming language is based on flowcharts. People understand flowcharts, says George. "They're intuitive. We go right from the flowchart into the controller. It eliminates a whole step in the programming."

Real Objects

MMIs have grown far beyond cartoon enunciator panels, although the emphasis on modeling physical hardware in the real world has remained. Today, a typical MMI display looks like a factory diagram drawn in Harvard Graphics, with colorful cartoon fluids pouring into cutaway vats or streams of widgets rolling down animated assembly lines. Lights wink on and off, numbers change, and gauges fluctuate. (The screen shot to the left shows examples of this.)

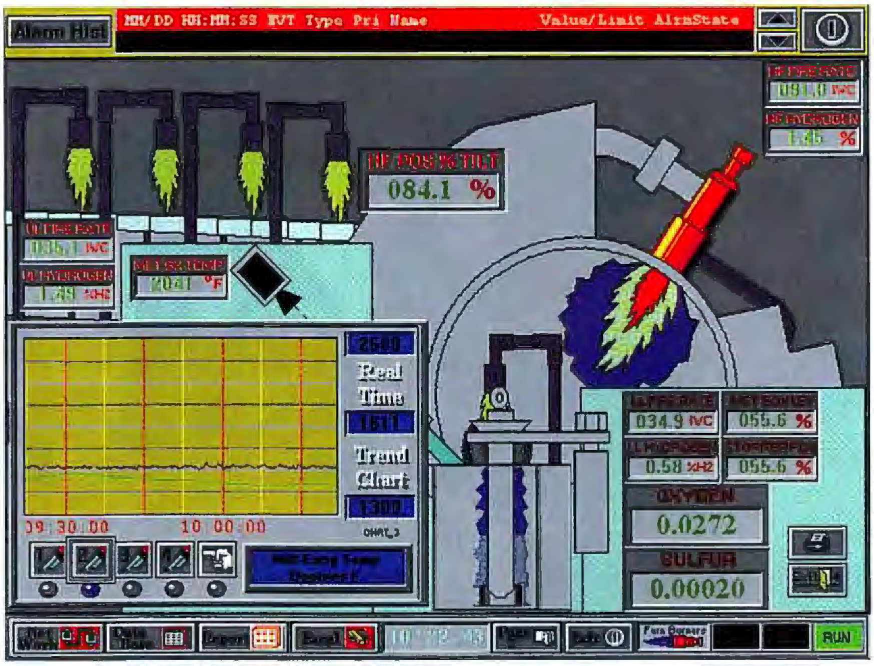
The best MMIs are strongly object-oriented. You can move, duplicate, edit, and copy objects (e.g., gauges, vats, and conveyer belts) on the screen from application to application. When you copy or move objects, their characteristics and behavior go with them. If you copy a picture of an industrial cookie-dough mixer, you get the whole element (e.g., timers and animated beaters). If the second mixer differs from the first, you can edit only those characteristics that differ between the two.

The latest MMI software from Wonderware of Irvine, California, for example, lets you build libraries of complex, animated objects such as meters, valves, and pumps and configure them quickly in the shop environment. Dave Smith, Wonderware's vice president of marketing, says that an object that took you 20 to 30 minutes to configure before will now take only 20 to 30 seconds. If you have a meter with a scale of 0 to 100, and you need a scale of 500 to 5000, you simply click on the dropdown box, change the scale, and create a new object. This can save much time in programming the control system for 53 similar vats of acid or similar manufacturing stations at a dozen different locations in your plant.

"People on the factory floor," says Smith, "would like to follow the process as it really operates—to see tanks filling, valves opening, pumps pumping, and so forth. Instead of looking at numbers, they'd like to see a tank being filled and to see an alarm change color when it reaches capacity."

And that's the big difference between MMI and presentation graphics—objects in the MMI represent real objects in real time. MMI software is object-oriented in the most literal sense. For every animated

Process Control's New Face



This model of a gasoline engine, showing valves, pistons, and spark plugs in motion and carrying out their functions, was created with the Wonderware MMI, using complex, animated objects.

vessel that is 58 percent full of cartoon petrochemicals, a real vessel exists that is 58 percent full of real petrochemicals.

Power for the People

Outfitted with slick new click-and-drag animated interfaces, industrial MMI is going places it's never been before—most significantly, out onto the factory floor. In the past, engineers and technicians programmed controllers. Today, thanks to sophisticated MMIs, many people on the shop floor who have never worked directly with computers are doing the programming themselves.

When dealing with such novice programmers, ease of use is a premium. "For the latest version of our MMI software," says Ralph Rio, manager of product marketing for Intellution, "the design objective was to enable a new user to go from opening the shrink-wrapped box to being truly productive within one hour. And we've done tests to make sure we achieved it."

Once users are comfortable with the new technology, companies begin to derive benefits they never expected. Companies shopping for automation-control software are initially interested in improving yields, reducing waste, or making processes more effective. They get those things, Rio says, but the real benefits come from empowering the workers. "Typically," he says, "the person on the production floor is not empowered at all. They're put in front of a machine and told to push a button every so often. They don't have the information needed to make high-quality decisions. By giving them information in a usable, digestible form, you empower them." Rio adds that this does more than make them feel good; it makes the companies they work for stronger.

He cites an example from an Intellution customer. "A guy on the plant floor—in his 50s, high-school education, not a computer jock at all—learned to use our software and started drawing his own screens, because he wanted to see the information a little differently. He found a relationship between things that were happening in the production process that no one had seen before. It turned into a $250,000-a-year cost savings for the manufacturer."

Windows onto Factory Automation

From the beginning, Windows has been the platform of choice for PC-based industrial MMI. As a graphical operating environment, early versions left a lot to be desired. Still, says Smith, Windows had one important thing going for it: It didn't tie you to a specific brand of hardware.

Until five or six years ago, companies providing hardware and software for industrial-process control dealt in proprietary systems. Each system spoke its own particular language, and it was hard to incorporate other product lines. The manufacturer was often the only source for maintenance, service, parts, and programming. Once your company made the commitment to a particular line of products, you were stuck with them for a while.

The result was captive markets and high prices. Until recently, says Smith, control-system suppliers were paying $50,000 to $100,000 for a hard-wired graphics workstation. The PC has pretty much put an end to that by offering the industry something it's never had before: open architecture—a ubiquitous, open platform for developers of both hardware and software. Nowadays, there are scores of companies selling cards that plug into your PC to program, communicate with, or replace current control systems. A small but thriving software industry is growing around PC-based industrial control.

Even better, PCs are produced by the tens of millions all over the world. By investing in PCs, the industry, too, can reap the economies of scale, replacing those $50,000 graphics workstations with $2000 PCs. If someone invents a faster parallel port or a bigger monitor, you just buy one and plug it in. And Windows offered a relatively ubiquitous GUI for the PC.

In addition to graphics, Windows offers one other tool that has proved essential: DDE, which Windows applications use to pass data back and forth as they run. Software can use DDE to take data from other programs or, with the proper drivers, from hardware such as network cards, serial ports, and PLCs. Industrial-control programs send and receive their data via DDE.

"The beauty," says Smith, "is that customers can use those same DDE servers to move data into other Windows applications, such as Excel. They love the opportunity to do that." By wrapping DDE drivers and interfaces around other systems (e.g., VAXes), you can make their data available to the PC without having to do a full-scale port of your software to those other systems. To facilitate moving this data around, Wonderware wrote a network version of DDE, called Net DDE, which it subsequently licensed to Microsoft for use in Windows NT.

Speed Bumps Ahead

Anyone introducing new technology into an existing factory must be prepared to integrate it with an array of preexisting legacy hardware, both dedicated control systems and minicomputers—the latter consisting largely of DEC VAXes running VMS and Unix. "Corporate America," says Smith, "has a huge investment in these systems, not only in terms of the hardware but also in terms of the software written for those environments. They won't give that investment up easily."

Windows often serves as a universal client, letting users implement complex multiple-system solutions including PC, VAX, Unix, and DCS systems. The PC stands, like the robot C3PO in the movie *Star Wars*, as a translator between human and machine—and sometimes between humans and other humans—fluent in the myriad languages and dialects of the industrial-control machines. Factories can migrate toward less expensive distributed PCs at their own pace, without throwing away the millions invested in their older control systems.

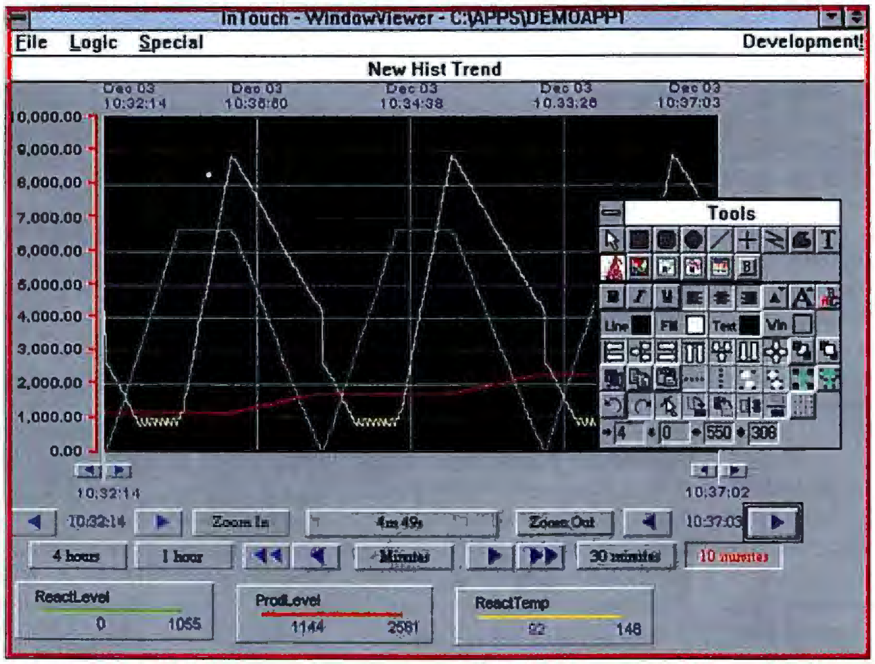
Once you have linked these disparate systems together, they still require some sort of common language to talk to one another. SQL is the lingua franca of the database world. Given sufficient fluency in SQL, a program on your PC can access data from mainframes, minicomputers, and other PCs. Effective industrial-control software must speak SQL. On the PC side, ODBC (Open Database Connectivity), a nephew of SQL, is fast becoming important as well.

SCADA

Once you've started to implement a distributed system of PC clients and assorted hosts that are networked together and can speak to one another, the implications are enormous. Consider the lowly statistician, toiling away in a cubicle, analyzing data. To gather the data, he or she may have walked down to the factory floor and taken samples off the line or may have taken it from periodic reports issued from the factory floor. In any event, the data is cold. The statistician is not seeing the process as it's happening now but rather as it was in the past—several hours or several days ago. Now he or she must enter the data into a statistical program and study the resulting graphs.

Consider the statistician's boss, who waits for the analyses. By the time he or she gets it, the data is colder still. Consider the contract-process engineer, who works on the opposite coast, trying to fine-tune a process he or she's never seen running.

Now, give each of these people a PC plugged into the company network, with graphical software that shows the process running in real time. Let them redesign the screens, just like the industrial MMI users, to show the data they need the way



The application of MMI tools in a somewhat different direction resulted in creating this chart showing historical trends in a manufacturing process. It, too, was created with Wonderware's product.

they want it. Provide them with statistical control charts that update in real time. Add software that tracks inventory across the shop floor, that will show you where every component of a given order is and in what stage of completion at any given second. Make some of these PCs read-only, allowing certain people (e.g., accountants) to watch a process without being able to meddle with it. If people along the line speak different languages, say Spanish and English or German and French, then you should provide each user with data in the language of his or her choice. State-of-the-art software does all this.

Traditionally, this type of high-level software is known as SCADA (supervisory control and data acquisition). On the PC, the distinction between SCADA and MMI is ceasing to exist. Many vendors service both areas with a single, reconfigurable product.

Bigger, Better, Faster, and Safer

Windows may be a well-accepted graphical interface, but it has never been a paragon of stability. A general protection fault at the wrong time can crash your whole system, and a crash on the shop floor can be very costly. "People in the office may not like it when a piece of software burps," says Smith, "but they're more forgiving than the guy who's making a million dollars' worth of chocolate."

Also, industrial MMI is driven on real-time data, and Windows makes a lousy real-time environment. The smallest resolvable clock-tick is too large for finely timed processes. Even worse, Windows is a shared, multitasking environment that relies on every application behaving politely and not hogging resources. If a database takes an extra few seconds to close its files, other applications must wait in line. In the industrial-control environment, those seconds can mean disasters ranging from a ruined batch of cookies to a melting nuclear core; that's just not acceptable.

In the past, vendors of industrial-control software were forced to "fix" Windows to achieve the performance and reliability they needed—writing patches and DLLs or hacking into Windows' multimedia drivers—or they had to use a less widely accepted operating system. But evolving operating environments and faster processors promise some relief. NT and the upcoming Chicago are slated to provide a more robust, fault-tolerant environment with true preemptive multitasking—

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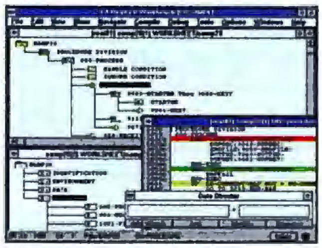

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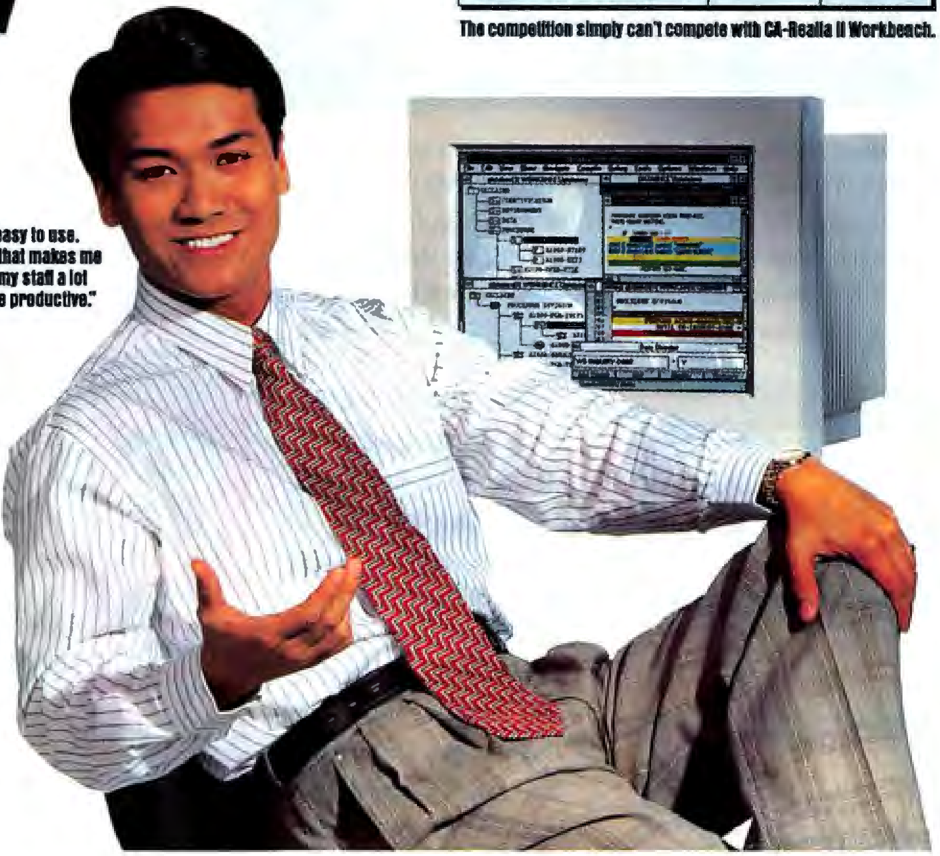

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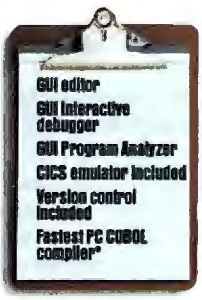

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something an industry weary of patching and tweaking sorely needs.

In addition, the new generation of microprocessors (e.g., Pentiums, Alphas, and PowerPCs) will make everything go faster in general. This will be a big boon to developers trying to make their products work successfully in real time.

As PCs become faster and more stable, they're winning the trust of the industry. Although there will probably always be two-box systems with dedicated PLCs controlling the machinery and PCs providing the interface to humans, more factories are giving over control of their manufacturing processes completely to PCs.

"We recommend that our customers use our software to actually control the line," says Intellution's Rio; "we're that confident. Our software runs in many mission-critical applications, including controlling nuclear power plants, so it's certainly safe to use it to make cookies."

Automated Process Control

Industrial-control software is showing up in areas far from the factory floor. Opto22 is wiring up the East German city of Leipzig (population 650,000) for the local water utility. The system has thousands of data points with multiple remote links, and it's all handled with PCs.

Industrial MMI is being used in security and climate-control applications for museums, banks, and prisons, which might have thousands of sensors of all types. While a typical home-security system is fairly dumb, systems with thousands of components require considerably more intelligence—if for nothing else than dealing with the inevitable failures. "When you have thousands of sensors," says Rio of Intellution, "it's a lot more likely that one will go off accidentally. So the system might look for groupings of two or three alarms going off at once and *then* call the police," Rio adds.

Wonderware's software controls rides at Walt Disney World and monitors the worldwide flow of money for one Federal Reserve bank. "We realized a few years ago," says Wonderware's Dave Smith, "that this isn't about industrial MMI anymore. This is about getting real-time data from point A to point B, so you can make real-time decisions that affect your business." ■

Mark Clarkson is a freelance science writer living in Wichita, Kansas. He can be reached on the Internet or BIX at mclarkson@bix.com.

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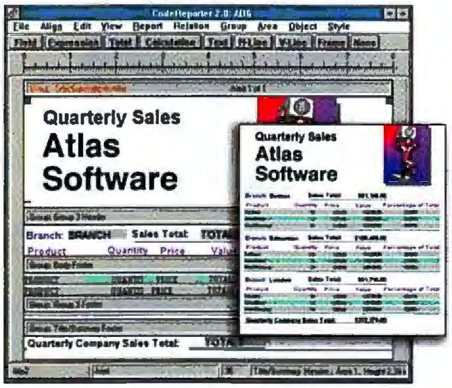

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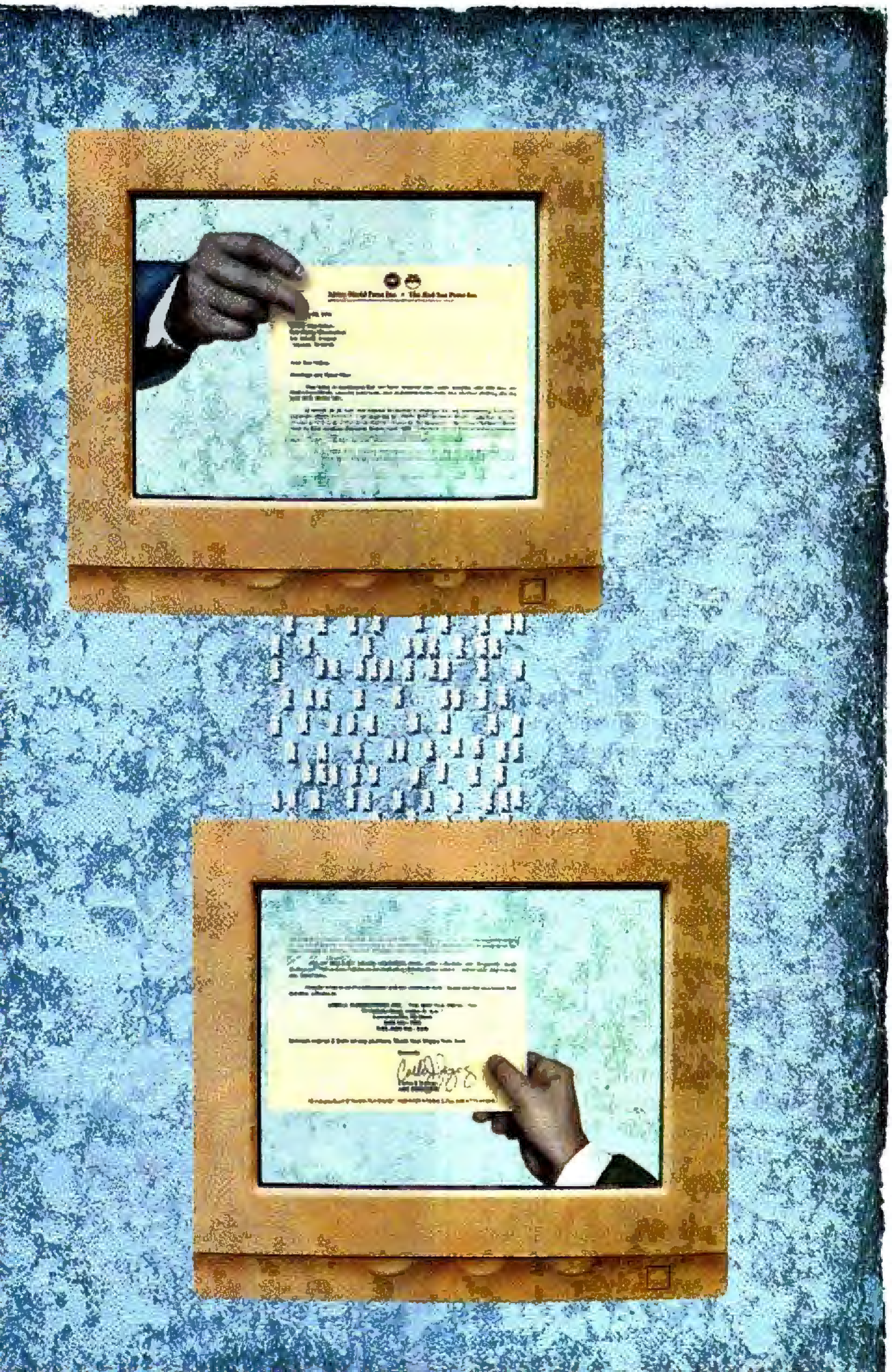

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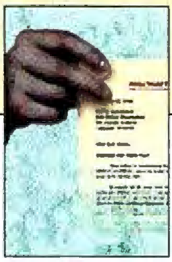
In this age of Infobahn hype, many people forget that computers and networks are more than just toys for pursuing the great electronic harmonic convergence of video games, virtual reality, sports, and romance—they are also important tools for businesses. The fact is, a second, relatively hidden convergence is joining many businesses and providing a simple, standard way for these organizations to exchange data about such important transactions as orders, supplies, and parts availability. The emerging collection of standards that governs how this data is transferred and interpreted between computers is called EDI (Electronic Data Interchange). Many companies investing in the technology are hoping to save millions—if not billions—of dollars.

The acronym *EDI* embodies several distinct concepts and buzzwords like E-mail, networking, software agents, and interoperability. Also, in several cases, EDI is used as a synonym for *computerized* or *digital*. For instance, one member of the EDI standards committee uses the term *judicial EDI* to refer to standard text file formats that lawyers might use to file documents in court. The term itself emerged from business schools and corporate MIS departments, so it is not surprising that the acronym usually carries the additional implication that the electronic domain will offer new and better efficiency.

EDI provides a collection of standard message formats that can be sent via any electronic messaging service. This approach saves money by replacing the standard paper documents that cement businesses. The amount of paperwork to be simplified and automated can be substantial. Although many people are used to the simplicity of reciting credit-card numbers over the telephone, the standard procedures for doing business involve many different slips of paper that help account for everything of value. A typical transaction might include a purchase order, a purchase order confirmation, a packing slip, and an invoice. Each of these involves using separate sheets of paper, and in some companies, several levels of management must approve the documents before they are legally binding. Many small- and medium-size companies still do business by mailing or faxing these documents around the country.

> **Emerging standards and practices for EDI include verifiable digital signatures, anonymous digital cash, and timestamps that provide incontrovertible proof of a document's existence and content at a particular time.**



Simply replacing the paper with electronic messages can save the cost of creating the paper and the time required to move it from the printer to the fax machine or through the postal system. The greatest savings, though, lie in making the entire company more efficient and in reducing the amount of inventory kept in stock. For example, many manufacturers are discovering that careful, efficient electronic inventory systems allow them to reduce the number of spare parts they must keep available. The savings can be enormous. An internal study by a Fortune 500 firm showed, for example, that the company could save $500 to $700 million with a corporatewide EDI system.

EDI Standards

EDI messages are just E-mail messages that come in a preset format so that inventory and accounting software can process the data successfully. Some of the biggest public standards are the ANSI X12 collection and the United Nations EDIFACT (EDI For Administration, Commerce, and Transport) standard. A number of different companies use each of these standards. There are also several other standards—both public and proprietary—developed by companies that are large enough to impose the standards on their trading partners. These standards often exist in defined niches for particular industries.

Each message created according to one of these public standards must begin with a code that specifies the nature of that particular transaction. Under the X12 standard, for example, all purchase orders must begin with the code 850, while invoices have to start with an 810. For each type of document, a number of information-containing fields are also specified. The 810 invoices are described in the X12.2 standard, which defines the required fields, including address, transaction information, and total monies due.

The standards were developed with flexibility intentionally built in. Many data fields are either optional or conditional. Also, when two companies decide to use a particular standard, they must agree on the way that certain fields will be used. For instance, a company might describe its parts in any of several different ways. Four tires for a car could be entered as four separate items or as one set.

Thus, EDI does not remove the need for negotiation and synchronization—it just offers a simple framework for the messages so that users can choose off-the-shelf software that will do most of what they need and then begin customizing it so that it meets their specific requirements.

EDI Clearinghouses

Many businesses subscribe to on-line EDI clearinghouses, which essentially provide E-mail services that transmit data in the standard format. Many also offer to translate the data from one standard to another, which saves individual companies from having to program their computers to understand and speak the various standards that their trading partners use.

Also, the clearinghouses offer many other services as a way of differentiating themselves from one another. Some offer archiving. Others offer to convert EDI messages to plain paper faxes automatically so that EDI systems can communicate with humans. Some also include plain E-mail, so users can transmit messages.

EDI-capable banks are an important subset of the clearinghouses. They also move packets of bits defining transactions, but their transactions are based on money and other securities. Many commercial banks offer EDI to their customers as part of their array of services. Some retail banks are also trying to interest the public in using systems for automating their bill payment.

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Circle 168 on Inquiry Card.

The basic transactions in monetary EDI are handled in the same way. A host of different standard formats (e.g., X12.820) are used by different groups of people, and the banks will often translate these requests automatically. One important difference is that these financial EDI standards also include protection against eavesdroppers and thieves by encrypting messages and authenticating both their origin and their content. While these features are also often available to other EDI users, they are often ignored because the information shuttling through the system doesn't represent something as obviously valuable as money. (For a look at how money can be handled, see the text box "Digital Cash" on page 126.)

More, Better EDI

The basic transactions in EDI are often just digital versions of their paper equivalents. The primary difference is that they travel by wire instead of by mail truck and thus arrive faster. Some people might be tempted to dismiss this use as simple and straightforward. But some of the more exotic standards and practices emerging promise to bring new and potentially valuable features to EDI, features that can't be duplicated with paper. These newer realms include digital signatures that can be verified by anyone in any place without the need for identification, digital cash that can move anonymously without forgery, and digital timestamps that can provide practically incontrovertible proof that a document existed at a certain time.

The most important standard for commerce is a digital signature that certifies that a particular person signed an electronic document. When such a standard emerges, the signatures will add much strength to EDI transactions because they will make it much easier for two parties to conduct business without negotiating a preliminary agreement. The digital signatures will act in the same way as a normal signature on a contract.

Digital signatures are long numbers bundled with a file. They are generated by a cryptographic algorithm designed to make it easy for everyone to verify the signature but difficult for anyone to forge one. The strength of these signatures depends on certain mathematical problems that no one knows how to solve efficiently. Only the owner of the signature holds the secret number that allows them to create a signature.

Such a signature behaves differently than paper-based signatures, and in many cases, it is a substantial improvement. A digital

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Circle 131 on Inquiry Card.

signature can be verified by someone who has never met the party; they can verify this signature at a distance by using a simple algorithm. The signatures are just as valid for copies as they are for originals.

The digital-signature system needs a central authority that issues certificates of authenticity, guaranteeing that message originators are who they say they are. Unfortunately, this public-key infrastructure needs to be as common as phone books for the system to work efficiently, and that won't happen for some time to come. The EDI standards committees are investigating the area and hope that a good standard will emerge soon (see the text box "Whose Authentication Systems?" on page 128).

One of the best digital-signature software implementations available today comes with the Mac System 7 Pro. This system lets you sign a document by merely dragging it to the top of the icon and typing in a secret password that only you know. The document file then stores in its resource fork a signature that can be verified at any time. Apple provides a public-key certificate infrastructure that you activate before beginning by taking a printout from your machine and presenting it to a notary public with three forms of identification. You need only to do this once. Apple binds this information with your file, and thereafter, anyone who receives a file that you signed knows that you generated it.

Many other companies such as Sun Microsystems (Mountain View, CA), Microsoft (Redmond, WA), and Novell (Provo, UT) are also including several levels of digital signatures in upcoming operating systems.

Digital Timestamps

Can you guarantee that a paper document existed at a particular time? The traditional technique is to get a notary public to verify a signature by countersigning the document and entering the time and date into their records. While this may often be effective, it certainly can be error-prone. How can you be certain that nothing was changed in the document?

The digital notary service promises to solve many of these problems and, in fact, offers a significant improvement over traditional paper-based systems. You will be able to notarize a document by signing it with a digital signature and then sending a copy of this signature to an electronic notary, who will keep a file of all the signatures generated that day. At the end of a predetermined period, the notary service will sign this file and store it away.

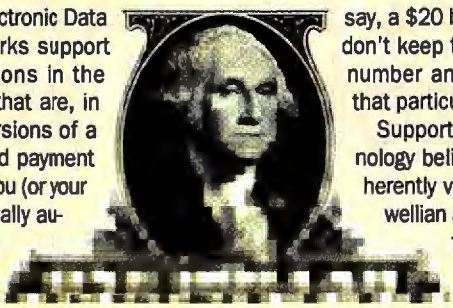
The key feature of the digital timestamp is that it uses a cryptographically secure hash function that converts a large file into a small one known as the hash value. This process is also used in the digital-signature algorithms. The algorithm must be constructed in such a way that it is highly unlikely that someone will be able to create another large file that generates an identical small file. This means that you can reliably use the small file as a proxy for the big one. If a big file generates the same hash value as the original, then the contents are almost certainly unchanged.

The digital notary service uses hash functions to tie the signatures it is notarizing into one big chain of trust. Imagine that Alice, Bob, and Carol send in signatures to be notarized. The notary service would place the signatures in order in a file and compute the hash value of the three signatures.

What if someone questions Bob's signature on a document because they just don't believe it arrived at the notary office on a certain day. The notary organization would have to dig up all three signatures' hash values for that day and prove that Bob's signature existed. To do this, the notary organization demonstrates that the only way that a particular hash value could have been generated on that day is if all three signatures were at the notary's. In several cases, the notary office might publish the hash value for a certain day (or time unit) in a trusted third source, like a newspaper.

continued

DIGITAL CASH



At present, EDI (Electronic Data Interchange) networks support financial transactions in the form of messages that are, in essence, digital versions of a bank check. To send payment to a given supplier, you (or your bank) create a specially authenticated message authorizing the transfer of funds and then send that to the supplier. The supplier "deposits" that into his or her account by sending the message to the bank. The bank authenticates the original message, credits the supplier's account, and notifies your bank that the transfer has been made. This method is fine for many transactions, but it isn't cash.

An inventive use of cryptographic technology now promises to provide the digital equivalent of cash. David Chaum in the Netherlands has recently formed a company called DigiCash (+31 20 66 52 611) that offers a form of digital cash that can be used for commercial transactions. The company's software lets you create and trade packets of data that act like currency (i.e., when you give a packet to someone, that person can turn around and spend it somewhere else). All transactions are anonymous if neither party keeps a record of the transaction. For example, when you spend paper money—say, a $20 bill—you normally don't keep track of its serial number and who you gave that particular bill to.

Supporters of this technology believe privacy is inherently valuable in the Orwellian age. But it is easy to understand why such a system would make law-enforcement officials nervous; illicit activities often rely on cash.

The digital-cash technology relies on public-key encryption systems. Each "bill" is, in essence, a file with an amount, a serial number, and ancillary information that is signed with the digital signature of the issuing bank. Chains of digital signatures are needed to prevent copying.

Guarding against forgery is an important problem. After all, each bill is just a packet of bits that can be copied quickly and easily. What is to stop, for example, someone from spending this money twice?

The chains of signatures buried in the digital cash let the bank or clearinghouse resolve these issues later. If two bills with the same serial number appear, then the mathematics of the system lets the bank uncover the identity of the cheater. In practice, you can only break the chains of signatures if the cash is spent twice. Then the two different chains will break each other.

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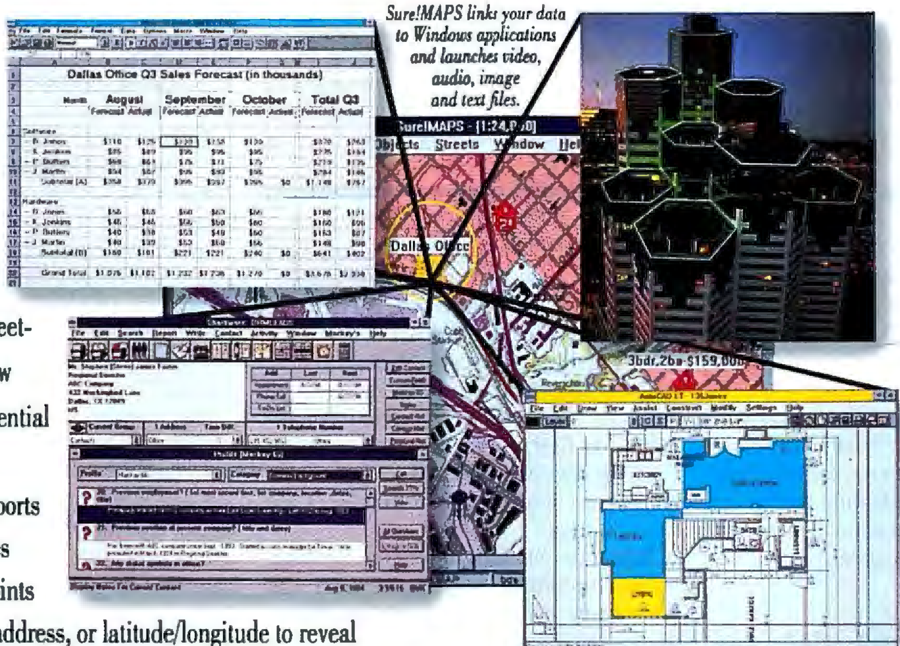

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Whose Authentication Systems?

Who provides the accepted standard of authenticity to the network world? Is it the U.S. government, as represented by the National Institute of Standards and Technology (Gaithersburg, MD)? Or is it RSA Data Security (Redwood City, CA), a small Silicon Valley company? NIST holds a mandate from Congress to develop digital-signature standards for the rest of the government, but RSA holds what it calls significant patents, and it wants to be paid for their use. Who will win this battle over the digital-signature standard?

The battle arose because you can use RSA's system not only for creating digital signatures using the RSA (Rivest-Shamir-Adelman) algorithm but also for encrypting messages, thus establishing secure communications channels. This system is ideal for businesses and anyone with private information, but it presents a problem for the police and the national security infrastructure (represented primarily by the National Security Agency). For this reason, the U.S. government has encouraged digital-signature standards that could be used only for authentication but not for secrecy. Companies that used simple signature algorithms that couldn't be used to hide information could export their software freely; however, those who included the RSA algorithm were banned from shipping the software outside the U.S. and Canada.

This past Spring, NIST announced a final DSS (Digital Signature Standard). Even though NIST establishes standards only for U.S. civilian government agencies, its choices often become de facto standards because of the federal government's large impact on the marketplace. It established the standard and then, in a confusing statement, said that the standard could be used without royalties.

This statement seemed strange because RSA's trump card is a strong portfolio of patents that it claims covers the DSS. According to RSA, anyone who uses the DSS would need to get a license from the company. As of this writing, the standoff continues. RSA is sticking by its patents, and the government is offering to pay the litigation bills of any government contractor sued by RSA.

Surety Technologies (Chatham, NJ) is one company that is planning to develop digital timestamps it has patented. It plans to offer software for all major platforms that will allow companies to register their files for timestamping at regularly scheduled times. It hopes that timestamps will become as common as backups for important data. At this writing, the company had no firm pricing schedule set for its services, but it plans to announce one by the time you read this article.

Lawyers Come to Eden

If EDI is already used extensively by some of the largest companies in the world, then you might assume that the legal foundation for electronic transactions was well established. This is far from the truth. The system works but largely because companies sign carefully drafted legal agreements before commencing electronic relationships. These paper contracts bind them to the agreements and promises that were made electronically over the EDI networks.

The courts have not provided any firm foundation for recognizing electronic transactions. This is, in large part, because the carefully drafted preliminary agreements anticipated any problems. Michael Baum, a Cambridge, Massachusetts, lawyer who heads an American Bar Association committee on EDI, says everyone is waiting for a big lawsuit that would settle the matter. But, according to Baum, "the Big Case hasn't hit yet."

When the big case does come, it may be an anticlimax for technologists. The law already includes plenty of flexibility in the establishment of business practices. For instance, the notion of a signature was originally defined to include any mark made to act like a signature (this included the scratched "X" made by people who couldn't write). Digital signatures, it would seem, fall into this realm.

New means of exchange also gain standing as they are used more frequently. A person may not simply use EDI for three years and then, in the middle of a dispute, claim that the EDI had no standing because it wasn't based on paper. This flexible nature of the commercial code is bound to allow EDI to be incorporated into established legal precedent without major shock to those who use it successfully.

What Kinds of EDI Will We See?

For the first several decades, the realm of EDI was largely the private tool of large companies that could afford to invest the millions in computer systems for maintaining electronic relationships. Over the next several years, the base is going to grow substantially as the network tendrils offered by the Internet and other on-line services reach out to the smallest entities. These small companies will grow on-line, and they will be bound to create new and exciting possibilities.

One company, Enterprise Integration Technologies (Palo Alto, CA) is experimenting with building a digital trading floor where companies can meet and do business for the first time without establishing complicated EDI preliminary agreements. They plan on using technologies based on RSA Data Security's (Redwood City, CA) Rivest-Shamir-Adelman algorithm to seal contracts. The system will be available on the Internet through a Mosaic-based interface.

Other new technologies will be more adventurous. General Magic (Mountain View, CA) is touting its Telescript language, which it says will allow people to dispatch software agents to remote computers to do their bidding. This is a substantial leap beyond field-based EDI standards like the ANSI X12, because users can incorporate substantial intelligence into the free-ranging programs.

The world of EDI is going to change rapidly over the next several years as these newcomers dive in. The newer participants are sure to bring substantial changes to the arena. Consumers traditionally demand a greater mixture of features and a more carefully debugged system. They are also interested in different goals. Consumers typically do many transactions with people they've never met before, but businesses often set up long-term relationships with suppliers and customers. This means that the broader world of consumer-based EDI will need to have greater safeguards and legal standards before it can succeed. ■

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SQL Front Ends for Windows

NSTL evaluates three high-end SQL applications development environments

MARK HETTLER AND SCOTT HIGGS

Client/server architecture combines the benefits of powerful database management software, running on sophisticated server hardware or even minicomputers or mainframes, with the user friendliness of graphical desktop environments such as Windows. Because virtually all client/server database management software uses the SQL language, client tools for working with these databases are commonly referred to as *SQL front ends*.

This month, NSTL evaluates the three leading high-end SQL front-end development packages, all offering advanced programming capability: ObjectView Enterprise 3.0 from KnowledgeWare, PowerBuilder Enterprise 3.0a from Powersoft, and SQLWindows Corporate Edition 4.1 from Gupta. By the time you read this, Gupta will have released version 5.0 of SQLWindows (see the text box "SQLWindows 5.0"), but a stable prerelease version was not available in time for testing. We tested SQLWindows using an add-on product, SQLRouter for SQL Server, to allow the program to access the test database. The other products include connectivity software in the base package.

All the tested products include programming languages to supplement the visual design tools. Although intended primarily for working with data on a remote server, each of these products includes a local database engine so that prototype applications can be developed locally before being deployed. Each product provides some degree of support for development by teams of programmers; at a minimum, this includes a checkout/check-in facility to prevent multiple developers from overwriting one another's revisions. All the products can produce run-time applications so end users need not have the full development system installed.

A Bundle of Tools

SQLWindows is actually a combination of products, some of which are available separately. The package includes not only the applications development system but also the SQLBase local database engine for Windows; Quest, a form, report, and query design tool; ReportWindows, a report designer that can use data from a variety of sources; and TeamWindows, a powerful set of tools for managing applications development and storage based on a client/server repository database.

SQLWindows applications access data on database servers via software modules called *routers*. In the past, you had to separately purchase the router for the particular database engine the application needed to access. Router software will be included with the SQLWindows 5.0 package.

ObjectView also combines a number of components. The main package consists of the software for developing and distributing applications and for connecting to various database servers. Also included is Workgroup Library, a set of tools for managing applications and objects stored in a client/server repository database. And two third-party products are bundled in: ClearAccess, a report generation program from ClearAccess, and Gupta's SQLBase, the same local database engine that's included with SQLWindows.

PowerBuilder consists of an integrated set of interfaces, called *painters*, for developing applications, managing database connections, preparing executable files for distribution, and managing the libraries in which application components are stored. It also includes Application Library (a collection of predefined objects that you can incorporate into applications) and the Watcom SQL local database engine.

Smaller businesses may want the applications development capabilities of these packages without the sophisticated facilities for managing work by development teams. All three products come in scaled-down packages offering various subsets of the full packages. SQLWindows Network Edition retails for $1995, PowerBuilder Desktop sells for $695, and ObjectView Desktop costs $499 (compared to over $3000 for the full enterprise versions).

Database Engine Support

The first requirement of a SQL front end is to be able to access the database a company's data resides on. Most businesses are already committed to a specific database platform or will choose one based on data storage and management features, rather than first choosing a front-end tool and then an appropriate database. All the tested products can access the leading client/server databases, such as Oracle, Sybase, and IBM's DB2 and DB2/2, as well as others. ObjectView and PowerBuilder greatly expand the number of databases that can be accessed by offering support for ODBC (Open Database Connectivity); SQLWindows 5.0 will add ODBC support.

PowerBuilder and SQLWindows can be configured to take advantage of specific features of the database engine being accessed. PowerBuilder uses database profiles to tell the application whether to use certain database features, like scrollable

OVERVIEW

NSTL RATING		VERSION	PERFORMANCE	VERSATILITY	EASE OF LEARNING	EASE OF USE	REQUIRED MEMORY	PRICE
★★★	PowerBuilder Enterprise	3.0a	▲	▲	▲	■	8 MB	$3395
★★★	SQLWindows Corporate Edition	4.1	■	▲	▲	▲	4 MB	$3395
★★	ObjectView Enterprise	3.0	■	▲	■	■	4 MB	$3200

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

SQL PERFORMANCE

PowerBuilder performed fastest on most tests. It's slowest on the string-parsing test, which measures nondatabase processing. Results are in seconds.

	OBJECTVIEW	POWERBUILDER	SQLWINDOWS	TEST DESCRIPTION AND ANALYSIS
Bulk update	2623.3	2457.1	2288.4	Differences between the products are minor because most of the activity takes place on the server, in terms of query optimization and database reading and writing.
String parsing	13.6	20.6	20.2	Does not interface with the database at all; useful for measuring performance of the front end only. ObjectView performs faster because it can add a full row of multiple values to a table in a single operation.
ISBN search	1.4	1.2	2.4	Retrieves one record from a table, creates a two-record result set based on a joined query, displays this information on the screen in master-detail format, and adds a record to a temporary area on another screen.
Author search	3.1	3	5.2	Includes several more queries than the previous test; query results cannot simply be displayed on-screen, but also in a form that allows you to select one result record for further processing.
Post order	2.4	1.3	2.5	Virtually no screen writing; consists entirely of moving data from form fields into SQL statements that are sent to the database.
Query orders table	110.8	58.3	10.8	SQLWindows retrieves only those records needed, not the full result set. PowerBuilder can also retrieve only the records needed, but this option slows subsequent operations (so we retrieved the full result set for this test scenario).
Scroll to last record	0.8	0.6	114	Having retrieved the full result set on the previous test, PowerBuilder and ObjectView can move to the last record quickly. SQLWindows must retrieve the remaining records in the result set to reach the last record.
Update record	5.7	0.8	1.2	PowerBuilder and SQLWindows let you make changes to multiple records and write them in a single operation. ObjectView writes changes to a record when you move to the next record.
Search	1.4	2.1	318.5	ObjectView and PowerBuilder each have a feature to search a table column for a specified value. In SQLWindows, a program script must manually loop through a table and compare the field value in each row with the search value.
Complex report (preview/print)	154/102	58/14	57/105	SQLWindows' preview has advantages over PowerBuilder's, but formatting each page slows it down. PowerBuilder also prints faster from preview mode. ObjectView uses ClearAccess for reports, which must establish its own SQL connection.

cursors or automatic committing of transactions. Based on the profile contents, PowerBuilder sends the necessary commands to the database to take advantage of the desired functionality. SQLWindows lets you set database-level options in the SQL.INI file. Each of the tested products also includes a local database engine that lets you produce, test, and refine prototype applications before deploying them in a client/server environment.

Object Management

In choosing a SQL front end (or any other applications development package), a business must consider not only the features that can be incorporated into applications but also the facilities for managing the development process. As application requirements become more complex, you need facilities to coordinate the work of multiple developers, organize the various modules in the application, and store components in a way that makes them accessible for reuse in future applications.

Objects are the components that make up an application. An object can be anything from a complex form to the specific items it contains, such as fields or command buttons. In object-oriented programming, the program code associated with an object (e.g., the routine initiated when a button is clicked on) is encapsulated, meaning it is included as part of the object. ObjectView stores program code associated with form objects in a physical file separate from the form itself, but SQLWindows and PowerBuilder encapsulate object code.

Developer productivity is enhanced when objects can be developed once and then reused repeatedly, either in their original form or with minor modification. The most rudimentary method for object reuse is to copy and paste an object using the Windows Clipboard. SQLWindows has the most powerful and flexible object-copying facilities of the tested products. Selecting an item in outline view automatically selects all subordinate items in the outline, including all contained objects and associated programming code. You can copy and paste this entire selection into the same window, into a different window in the same application, or into another application. Selecting an object in visual design view selects exactly the same contents as selecting its corresponding line in the outline view.

PowerBuilder's Library Painter makes copying an entire window from one application to another easier than in the other products, but PowerBuilder has no facilities for copying objects from one window to another. A Duplicate option in the Window Painter makes a copy of an object within the same window, but only its appearance is duplicated, not the encapsulated program code.

ObjectView uses the Windows Clipboard to copy and paste objects within a window or between windows and makes

Highlights

	Strengths	Limitations
ObjectView	Excellent performance on nondatabase operations C language interface Good performance on non-database operations	Poor reporting performance Poorly integrated report writer Difficult to implement event handling Limited reporting features
PowerBuilder	Outstanding performance Intuitive application-design interfaces Easy to create powerful data-access forms	Limited reporting features No repository database No built-in version control
SQLWindows	Object-oriented programming features Powerful team development support Excellent event-handling features	Inferior performance No built-in graphing Steep learning curve

DATABASE ACCESS AND SUPPORT

	OBJECTVIEW	POWERBUILDER	SQLWINDOWS
Engine support			
Microsoft/Sybase SQL Server	●	●	●
Oracle	●	●	●
SQLBase	●	●	●
Interbase	○	○	○
Informix	●	●	●
Ingres	●	○	●
IBM DB2/2	●	●	●
DB2	●	●	●
Rdb	○	●	○
XDB	○	●	○
ODBC	●	●	○
SQL language support			
Generic SQL	①	②	●
Engine-specific native SQL	●	●	●
Generic and native in same transaction	○	②	●
Access database from DLL within transaction	③	●	○
Use program variables in SQL	●	●	●
Use form fields in SQL	●	●	●
Generic DDL commands	○	①	○
Generic data dictionary information retrieval	●	●	○
Generic cursor management	④	●	●
Forward/backward cursor scrolling	④	●	⑤
Update/delete where current	④	⑥	●
Generic grouped queries and aggregate functions	①	①	●
Generic joined queries	①	①	●
Generic subqueries	①	①	●
Outer joins	●	①	①
Engine-specific features			
SQL Server scrollable cursors	○	●	○
SQLBase scrollable cursors	○	●	●
Oracle array bind variables	●	●	○
Simulate process/execute via stored procedures	○	○	○
Engine-level referential integrity	○	●	○
Engine-level validation rules	○	○	○
Bulk load/unload	○	○	⑤
SQL Server browse mode	○	○	●
SQLBase isolation levels	○	●	●
SQLBase ROWID validation	○	○	●
Data integrity features			
Begin/commit/rollback	●	●	●
Autocommit on/off	●	●	●
Lock current form record	●	○	●
Optimistic concurrency with screen refresh	●	●	●

● = yes; ○ = no.

① Generic visual facilities, engine-specific SQL syntax.
② Extensions to native commands for processing query results.
③ C subroutines can be linked into application executable.
④ Updatable result set browsing via panels.
⑤ SQLBase databases only.
⑥ Available only on engines that support it.

excellent use of drag and drop for moving and copying objects. Because program code is stored separately, it is not copied with the object. Each window is stored as a separate file in the operating system, so you can copy windows easily with operating-system commands, taking care to copy the associated program code file for each window as well.

Object Classes

Using classes further facilitates object reuse. A *class* is simply a type of object; all objects of a given class have certain common characteristics. All visual design tools employ classes, even if they're not referred to as such. For example, buttons are a class; all objects of the button class have common characteristics, such as simulating the appearance of being pushed when clicked on. The concept of classes is most useful when you can create your own classes based on existing classes.

A class based on another class *inherits* the characteristics of the class from which it is derived. For example, you might create a class called *next button* that inherits all the characteristics of a generic button and also contains the program code to scroll a form to the next record. You might then create a class called *master-detail next button* that inherits all the characteristics of a next button and also contains the program code to synchronize detail records with the current master record. One of the most powerful features of inheritance is that if the characteristics of a class are changed, all objects and classes previously derived from that class automatically reflect that change.

SQLWindows supports the creation of classes with some significant additional capabilities. Instead of creating a class and then creating objects from that class, you can create an object and then save that object as a class. For example, you might create navigation buttons and then decide to retain their characteristics permanently as reusable classes. SQLWindows also allows *multiple inheritance*, whereby an object or class can inherit the characteristics of multiple classes.

PowerBuilder offers *user objects*, which are similar to SQLWindows' classes but with some significant limitations. Derivation and inheritance are trickier with user objects. For example, you cannot derive a user object from a button; you'd create a user object containing a button and then need to keep track of distinctions between the user object as a whole and the button contained in it when referring to them in application code. User objects are created in a separate interface from the windows where they will be placed, and they cannot be derived from previously created custom objects. PowerBuilder does allow individual objects to be derived from existing objects and inherit their characteristics.

Reusable objects and classes are most useful in the long term when they can be stored in libraries separate from individual applications. SQLWindows lets you maintain classes in libraries that can be accessed in applications in much the same way that include files can be accessed in C programs. PowerBuilder allows instances of user objects maintained in one library to be placed in applications maintained in another library, and its Application Library offers a variety of predefined objects for placement in applications. ObjectView does not support user-defined classes as described in this section, but its Workgroup Library facility allows maintenance of individual objects that can be copied into applications. Unlike when copying objects within or between ObjectView applications, you can copy associated program code along with an object when copying the object from Workgroup Library into an application.

continued

Workgroup Management

Large businesses often have teams of developers working on the same application. This creates a need for safeguards to ensure that developers do not overwrite one another's changes. In addition, changes to an application inevitably introduce new problems, and, to produce a stable executable, it is frequently necessary to backtrack to a point in the development process before the problems were introduced.

All the tested products support checking out and checking in individual application components. When an application or component is checked out, the original version of it, maintained in a central location, is locked while the developer works on a copy in another location. The original is still available in read-only form for testing the application or producing an executable, but no other developer can modify the application until it is checked back in.

SQLWindows and ObjectView also include built-in version control, maintaining multiple versions of applications and their components as revisions are made. PowerBuilder does not have built-in version control, but it includes links to PVCS, a popular version-control system used in many large-scale development environments. These links let you use PVCS to maintain version control on the contents of PowerBuilder libraries. SQLWindows and ObjectView can optionally be used with PVCS, rather than with their own built-in version-control facilities.

Client/Server Repository

A client/server database makes the ideal repository for applications, for the components making up existing applications, and for reusable objects. A database is much better than a flat network directory tree for storing and managing the development environment. Most leading client/server databases allow storage of binary objects in database tables, letting you store not just information about an application but the application itself, using binary object fields for such components as source code modules or form designs.

ObjectView's Workgroup Library and SQLWindows' TeamWindows make use of a client/server repository database in managing workgroup applications development. Both products' built-in version control and checkout/check-in facilities maintain applications in the repository database, and you can store reusable objects there as well. Both can build run-time executables from components stored in the repository. PowerBuilder does not use a client/server repository database; its Library Painter works with files residing on a local or network drive.

SQLWindows' TeamWindows has the more powerful repository implementation. In addition to storing the components making up an application, TeamWindows stores data dictionary information about the database on which the application is based. Even though SQLWindows 4.1 requires the repository to run under SQLBase, it can read and store data dictionary information from any engine platform. The information is then used for developing forms based on the structure of the data that will ultimately need to be accessed. TeamWindows maintains historical information as modules are revised and development proceeds, and it generates a variety of predefined status reports.

Deployment

Once an application has been developed, it must be deployed on users' systems. Normally, the full development software used to produce applications and the application source files aren't needed. All the products tested support deployment of run-time executables, and their license agreements allow unlimited distribution of run-time

APPLICATION FEATURES

	OBJECTVIEW	POWERBUILDER	SQLWINDOWS
Quick form			
Quick form generation	●	●	●
Move fields after generating	●	●	●
Quick master-detail form	●	●	●
Built-in record browsing	●	○	●
Interactive query			
Visual query builder	●	●	●
Visual grouped query	●	●	●
Interactive generic SQL	●	○	●
Build SQL commands at run time	●	●	●
Data dictionary information in form pick lists	●	○	●
Quick-result grid at run time	●	●	●
Form design features			
Edit mask for database fields	●	●	●
Customizable multiple-record display	●	●	○
Multiple records across page	●	●	○
Vertical scroll bars in fields	●	●	●
Dynamically build lists at run time	●	●	●
Check boxes for program options	●	●	●
Check boxes for database field values	●	●	●
Application control features			
Multiple-button message boxes	●	●	●
Assign procedure to button	●	●	●
Form can call another form	●	●	●
Return multiple values to calling form	●	●	●
Event handling			
Procedures triggered by events	●	●	●
Keystroke detection	●	●	●
Detect mouse-click	●	●	●
Detect mouse right-click	○	●	●
Detect mouse double-click	●	●	●
Record update	●	●	○
Record insert/delete	●	●	○
Arrive field	●	●	●
Depart field	●	●	●
Prevent update	●	●	●
Object orientation			
Methods associated with objects	●	●	●
Encapsulated procedure code	○	●	●
Objects contain other objects	●	●	●
Objects detect events of contained objects	●	○	○
Objects act on other objects	●	●	●
Object-level keystroke detection	○	●	●
Object-level mouse events	●	●	●

● = yes; ○ = no.

APPLICATION MANAGEMENT

	OBJECTVIEW	POWERBUILDER	SQLWINDOWS
Advanced functionality			
Incorporate VBX controls	○	●	●
OLE 1.0 objects	●	●	●
OLE 2.0 objects	○	○	○
Store OLE objects in database	●	●	●
Pictures in form definition	●	●	●
Pictures stored in database	●	●	●
Store/play sound recording	○	○	●
Drag and drop	●	●	●
Report generator			
Quick report within application	○	●	●
Specify selection criteria at run time	●	●	●
Specify record sort order at run time	●	●	●
Print user-specified page range	●	○	●
Preview before printing	●	①	●
Crosstab reports	○	●	●
Conditional page break	●	○	●
Eliminate blank lines	●	○	●
Eliminate spaces between fields	●	○	●
Predefined mailing-label formats	●	●	○
Application repository			
Repository database	●	○	●
Store data dictionary information	○	②	●
Store application components	●	○	●
Store external files	●	○	●
Store reusable objects	●	○	●
Maintain project management information	○	○	●
Workgroup features			
Checkout/check-in	●	●	●
Built-in version control	●	○	●
Links to external version-control system	●	●	●
Version control of external files	●	○	●
Maintain revision information	●	●	●
Programming language			
User-defined functions	●	●	●
Shared subroutines	●	●	●
User-defined data structures	●	●	●
Call DLL	●	●	●
Accept parameters at run time	③	○	○
Object management			
Reusable object classes	○	●	●
Subclasses with inheritance	○	●	●
Override inherited characteristics	○	●	●
Multiple inheritance	○	○	●
Application deployment			
Distributable run-time software	●	●	●
Compiled EXE	④	●	●
Break large executable into components	○	●	○

● = yes; ○ = no.

① No WYSIWYG page preview.
② Maintained in PowerBuilder system tables in database.
③ Applications produced with C have C capabilities.
④ Executable contains programming routines only.

applications without paying royalties.

In addition to the application executables or run-time files, certain vendor-provided software is also required for applications to run. SQLWindows installs deployment files in a separate subdirectory on development systems so that you can easily copy them along with an application for distribution. Router software must also be installed on target systems.

PowerBuilder provides separate setup disks for deployment files (including software for connecting to databases) so that they can be installed without the development software. ObjectView also supplies separate deployment setup disks, but we were unable to run applications after installing just the deployment files; the system claimed that necessary files were missing. ClearAccess must also be installed on target systems if an application includes ClearAccess reports.

The SQL Decision

PowerBuilder provides user-friendly interfaces for all aspects of the development process, from designing form layouts to maintaining components in libraries. Its DataWindows facility is a powerful yet easy-to-use mechanism appropriate for almost any situation in which users need access to the database. PowerBuilder also provides well-organized and readable documentation and produces outstanding performance. It falls short of SQLWindows, however, in the smoothness and straightforwardness with which complex functionality can be incorporated into applications. Its reporting features are more limited than those of its competitors.

Although the interface where you work is less user friendly in SQLWindows than in PowerBuilder, SQLWindows is easier to use when it comes to making an application behave as desired. The more complex an application's requirements, the more likely only SQLWindows offers sufficiently flexible customization options and clear implementation instructions. Its facilities for event handling and passing data between forms are at a level above its competitors'. TeamWindows exploits the benefits of the client/server environment to provide the best facilities for managing the development process. Its performance is significantly slower than its competitors' on most interactive operations and is slower than PowerBuilder's in reporting.

While it presents no glaring deficiencies

About the Products

ObjectView Enterprise 3.0 .... $3200
ObjectView Desktop $499
ObjectView Model Connection $2500
KnowledgeWare, Inc.
3340 Peachtree Rd. NE
Atlanta, GA 30326
(800) 338-4130
(404) 231-8575
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PowerBuilder Enterprise 3.0a $3395
PowerBuilder Desktop $695
PowerMaker $349
PowerViewer $199
Powersoft Corp.
561 Virginia Rd.
Concord, MA 01742
(800) 395-3525
(508) 287-1500
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SQLWindows Corporate Edition 4.1 .... $3395
SQLWindows Network Edition $1995
Gupta Corp.
1060 Marsh Rd.
Menlo Park, CA 94025
(800) 444-8782
(415) 321-9500
Circle 1087 on Inquiry Card.

rendering it inadequate for developing complex applications, ObjectView falls short of its two competitors in almost every area of comparison. It offers outstanding performance on certain individual tests, particularly nondatabase operations, but this benefit is offset by poor report-writing performance. Documentation is sketchy and poorly indexed, integrating reports into applications is difficult, and the mechanism for implementing event handling is cumbersome. It does offer sophisticated facilities for integrating applications with C programming, as well as a client/server repository that can be implemented on any database platform. ■

SQLWINDOWS 5.0

By the time you read this, Gupta should be shipping version 5.0 of SQLWindows. Among the enhancements are the following:

- **A new compiler facility generates code in C. Gupta's benchmarks (which have not been verified by NSTL) indicate that the compiler reduces execution time by nearly half on a local database query and by more than two-thirds on a real-life application.**
- **A new usability technology called QuickObjects delivers predefined components with built-in functionality, letting you produce sophisticated forms with just a few mouse-clicks instead of the program coding required in version 4.1. You can modify vendor-provided QuickObjects to produce custom QuickObjects according to the needs of your business.**
- **SQLWindows' powerful application repository can now run on Oracle and Sybase databases as well as on SQLBase. QuickObjects not only access the various client/server database platforms supported but can also be integrated with Lotus Notes. Applications can also directly access E-mail systems such as Lotus cc:Mail and Microsoft Mail.**
- **The number of database types that can be accessed is expanded through the addition of ODBC (Open Database Connectivity) support. Router software for accessing specific database engines, previously purchased separately, is now included in the SQLWindows 5.0 package.**

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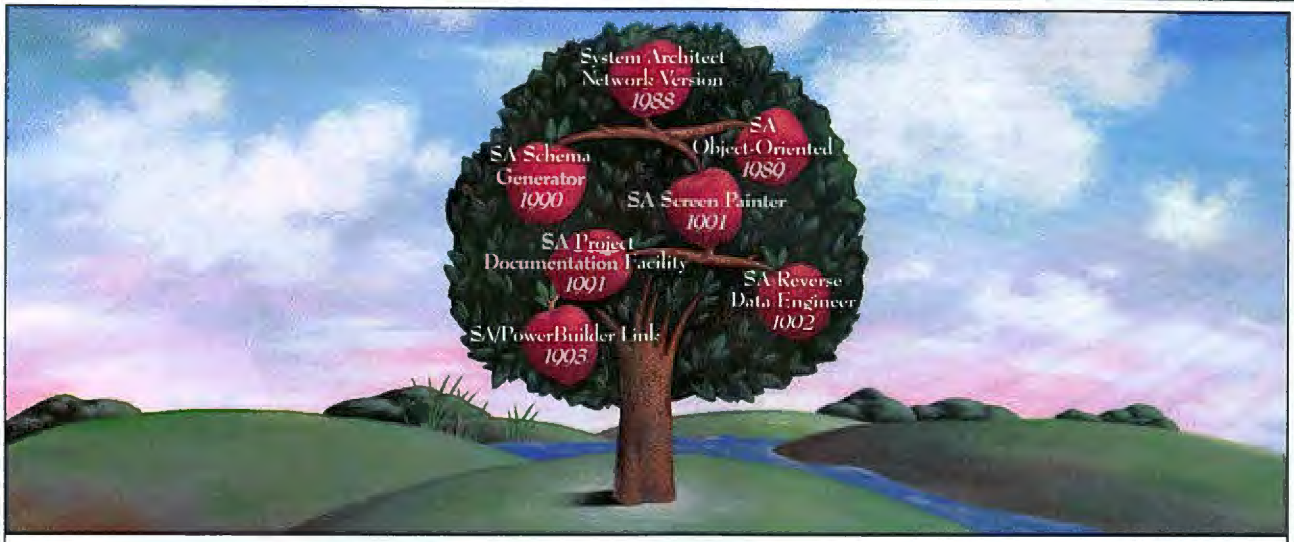
Oracle 6.0 & 7.0 XDB ANSI SQL SQL Base OS/2 PM INTERBASE



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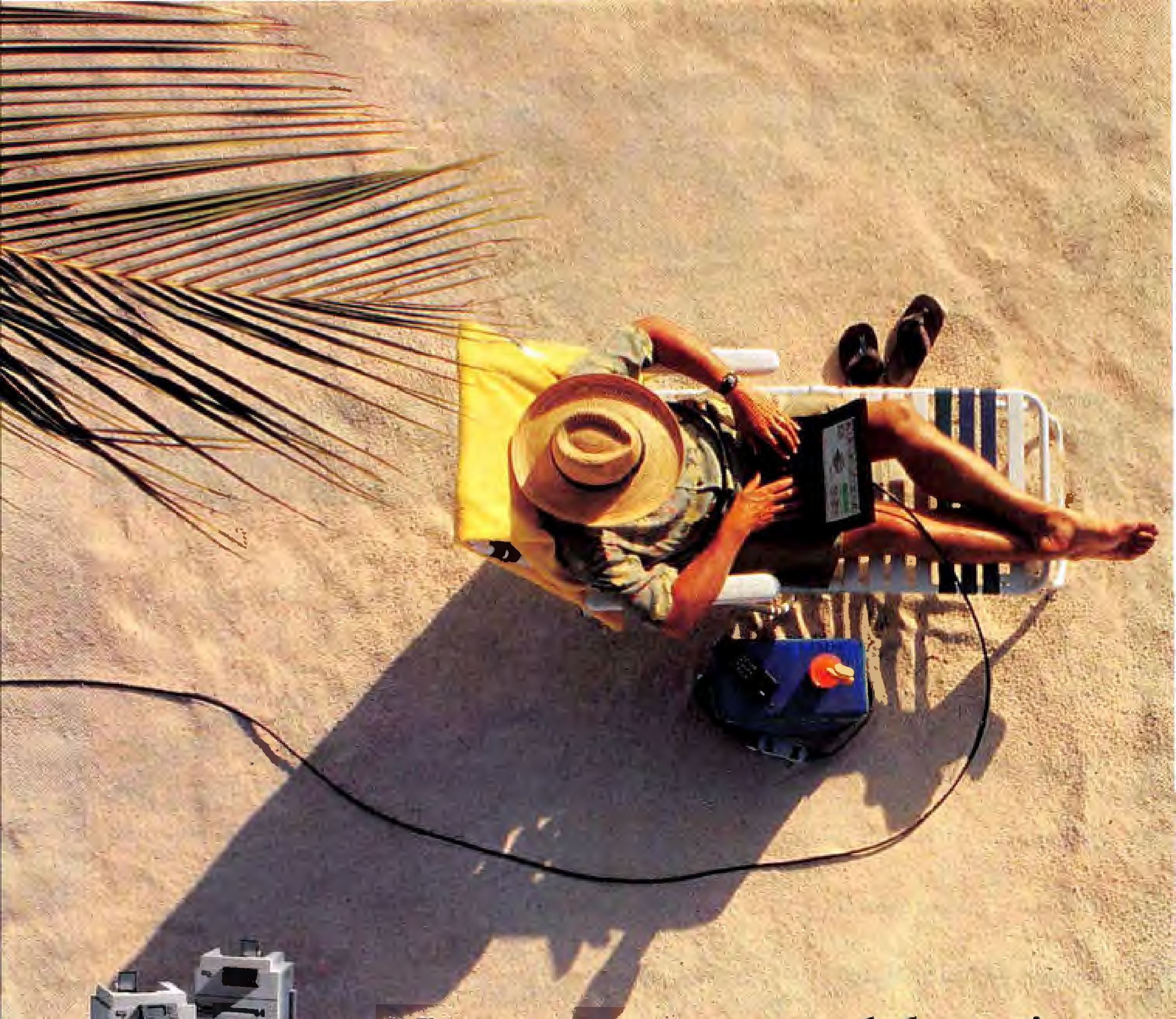

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Networking on a Beam of Light

Photonics' wireless networking uses infrared to link your computers

HOWARD EGLOWSTEIN

Wireless networks are attractive where running cable is inconvenient or impossible. Establishing a temporary workgroup with portable PCs in a meeting room is a good example. Or perhaps you're leasing your office space and don't have the flexibility of running wires. Many wireless network products, including the Photonics infrared LAN reviewed here, also let you connect wireless nodes to wired networks through wireless access-point devices.

If you decide to go wireless, which technology should you look at? Radio technology can reach through walls, allowing you to effectively bring walled offices into your network. Some can also reach across large open areas, such as factories, where cabling may be inappropriate. The difficulty is that if someone in an office can see your data, perhaps someone outside your building can, too. Microwaves solve this security problem fairly well because they won't penetrate through most exterior walls, but mounting the transceivers in the right locations can be tricky.

Spread-spectrum radio LANs may also have problems with interference once such networks become common. While the currently developing wireless LAN standard (see "Universal Wireless LANs" in the May BYTE) provides avoidance mechanisms that let multiple networks coexist, sharing the same broadcast space reduces transmission speed.

IR (infrared) networking provides a reliable means of sharing data within a small space without opening up your network to the security problems you might have with radio systems. In short, your network traffic modulates an array of infrared LEDs, which bounce your data off the surfaces in the room. Receivers on other modules pick up the reflected energy and convert it back to data. Because the IR signals don't leave the room, there are no security or interference problems.

Photonics has developed two product lines based on this technology. The Photonics Collaborative line is a series of PC-based products that connect through ISA cards, PCMCIA cards, or parallel ports to share data between PCs at rates up to 1 Mbps. The Cooperative line is based on the same transceiver technology, but as applied to Macintosh LocalTalk, and so is limited to 230 Kbps. Because Photonics was updating the PC line at the time of this review, I looked only at the Cooperative (Mac) product. (IBM also offers PC products using Photonics technology.)

Two Cooperative transceivers. Each cord provides both LocalTalk and pass-through ADB (for power) connections. The optional Access/Power unit (base of left transceiver) can serve as an access point to a wired LocalTalk network.

A Cooperative Effort

Building a Cooperative network is extraordinarily simple. The $349 infrared transceiver is less than 3 inches square and weighs about 4½ ounces. A thin, hinged plastic base lets you adjust the angle of the transceiver for best operation. With its 2-foot cable you attach the unit to the LocalTalk port of any Macintosh computer, printer, or file server. To power the Cooperative, you connect a pass-through plug to the ADB (Apple Desktop Bus) port on your Mac and connect your keyboard or mouse to the back of the Cooperative plug.

By connecting a Cooperative transceiver to an optional Access/Power unit ($129), you create an access point that can connect a roomful of Macs— wirelessly connected to each other—to conventionally wired Mac resources. The access point snaps onto the transceiver in place of the standard base. Besides holding three AA batteries, it provides an ADB connection (for powering the transceiver), LocalTalk connections for both the transceiver and a wired LocalTalk network, and a plug for a 5-V AC adapter.

If you are using a portable Mac that does not have an ADB port (e.g., the Macintosh Duo series) or would rather not increase the drain on your portable's battery, the optional access point can also serve as a power supply. It can power a transceiver for 24 hours with alkaline batteries or for about 12 hours with rechargeable batteries. One advantage of IR technology is that it draws less current than some of the radio-based solutions—typically less than 250 milliamperes.

To receive data, the IR receiver must be able to "see" the transmitter. Like conventional light, IR doesn't bend around objects to any significant degree. Photonics' products therefore rely on the walls and ceiling of the room to bounce the energy from one place to another. As with the light from a lamp, there will be few areas in a room that don't receive some illumination. Within reason, a Cooperative transmitter can flood a 30- by 30-foot room with enough energy to send its signal from one corner to another.

When you install the transceivers, you should place them as centrally in the room as possible, with the transmitter/receiver unit pointing up toward the ceiling. I tried installing my test pair of transceivers in a variety of rooms, and standard acoustic office ceiling tile worked quite well as an IR-reflective surface. I encountered difficulties in only one room, where the ceiling was blocked by a decorative lattice of dark wood strips. In that case, I had to aim the transceivers directly at each other.

Performance

If you've just started working with Macs and have never experienced LocalTalk, or

INFRARED VS. RADIO

A comparison of some of the advantages and disadvantages of these two types of wireless LANs.

	INFRARED	RADIO
Transmission speed	Photonics limited to 230 Kbps on the Mac, 1 Mbps on PCs	Many spread-spectrum LANs support 2 Mbps; some other radio LANs, more than 10 Mbps
Range	30- by 30-foot room alone; unlimited with access points	100 feet to 1000 feet alone; unlimited with access points
Interference	Interference from bright sunlight limits use to indoors	Electromagnetic interference from other electronic devices or neighboring radio LANs can reduce transmission speed
Security	Transmitted information stays in room	Can be monitored with modified receiver; tight security requires encryption
Access through walls	Limited to use in one room or enclosed space unless rooms are connected by wired backbone	Many radio LAN products work through walls
Power requirements	Low	Moderate
Cost per node	$349	$500 to $800
Cost per access point	$478	$1500 to $5000

if you just don't remember how slow it is, it runs at a maximum data rate of 230 Kbps, or about 20 KBps. Ethernet on a bad day is at least four times that speed and often faster. To put it another way, a LocalTalk server shared among several active users may make you appreciate how fast floppy disks can be.

With that in mind, the IR section of Cooperative runs at a maximum data transfer rate of 1 Mbps—easily fast enough to handle LocalTalk (the PC versions are expected to run at the full 1-Mbps rate). According to Photonics, a Cooperative network will run as fast as that same network running over standard LocalTalk wiring. I had only two nodes, but I tried a number of tests to confirm Photonics' performance claims.

To begin with, I connected one node to a Mac PowerBook 170 (which had a 25-MHz 68030 processor) and the other node to a Mac SE/30 (with a 16-MHz 68030). I enabled file sharing on both of these machines under System 7 and then copied files in each direction. The IR nodes managed a data transfer speed of approximately 16 KBps. When I replaced the IR nodes with two Farallon PhoneNet connectors wired together, the same file transfer test yielded the same 16 KBps.

I then reattached the PowerBook to the IR node and attached the other Photonics node through its access point to the BYTE building's LocalTalk wiring. The building has an extensive network of interconnected wiring that includes two active LocalTalk hubs (Farallon StarControllers). Through the StarController, a Mac can find the BYTE network's Cayman GatorBox, which then provides access to any of the AppleShare or NetWare for Macintosh servers. To complete the connection, I attached the Mac SE/30 to a thin Ethernet connection.

To get data from the PowerBook to the Mac SE/30, the traffic now had to brave BYTE's bustling building-wide network. In that environment, the effective data transfer rate dropped to between 10 and 11 KBps. I disconnected the IR node and attached the PowerBook directly to the LocalTalk wiring, and the transfer rate jumped back to 16 KBps.

What happened? According to Photonics, the access point gives a higher priority to traffic coming from the IR node than to traffic from the wired LocalTalk port. The company suggested that I should have put a LocalTalk-to-LocalTalk bridge between the access point and the wired network. This is an added expense, but it's not an uncommon performance fix even for wired LocalTalk networks.

I was also curious about the effective range of the transmitter. We have one large conference room that's a tad over 50 feet long. One wall is packed with windows, the ceiling is acoustic tile with a dark-wood decorative lattice mounted to it (mentioned previously), and the other walls are dark paneling. I thought the Cooperative wouldn't have a chance. To my delight, I was able to set the two machines at either end of the room and, by pointing the transceivers toward each other, get excellent communications from 50 feet. Even when I walked back and forth between the machines, the transfer didn't slow down. Photonics' 30-foot range claim is quite reasonable.

Warming Up to IR

While I started out unsure that these tiny transceivers could perform as well as the company said they would, working with them has made me a believer. They're not perfect, however. For the transceivers to work well, you need a fairly small, somewhat confined area with reflective walls and ceiling. Photonics recommends a practical maximum of 40 or so units per network. Although I tested with only two, I spoke with folks at a test site that is currently running 30-plus nodes in a room simultaneously. While they wish that the technology were faster, they're happy with the solution.

In addition to these limitations, the Photonics system has trouble with bright light sources blinding or confusing the receivers. The transceivers don't work outdoors and may have difficulty in a bright, sunny conference room.

At $349 per machine (plus an additional $129 for transceivers used as access points), the Photonics system is not an inexpensive solution. A LocalTalk network node runs about $25 in any computer store, and wiring a temporary network using LocalTalk is assuredly less expensive than the Photonics solution. But considering how easily these units connect and how well they work, the Photonics Cooperative network could be the right answer for some sticky networking problems. It offers adequate performance (as good as LocalTalk ever gets) and connections that are secure from eavesdropping, and it works reliably.

For situations in which radio solutions are inappropriate, IR might be just the answer. Photonics' Cooperative is a shining example of a technology with a bright future. ■

About the Product

Cooperative
LocalTalk transceiver $349
Access/Power unit $129
Photonics Corp.
2940 North First St.
San Jose, CA 95134
(800) 628-3033
(408) 955-7930
fax: (408) 955-7950
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Four OCR packages for Windows that deliver speed and accuracy

HOWARD EGLOWSTEIN

After much discussion a few years ago about the paperless office, a quick look around would convince anyone that corporate America has a long way to go before it even comes close to that ideal. Each week, BYTE's Peterborough office recycles enough paper to fill a large dumpster. And until we lose sight of paper, we often need to get the printed, photocopied, or faxed data back into electronic form. OCR (optical character recognition) software lets you do exactly that.

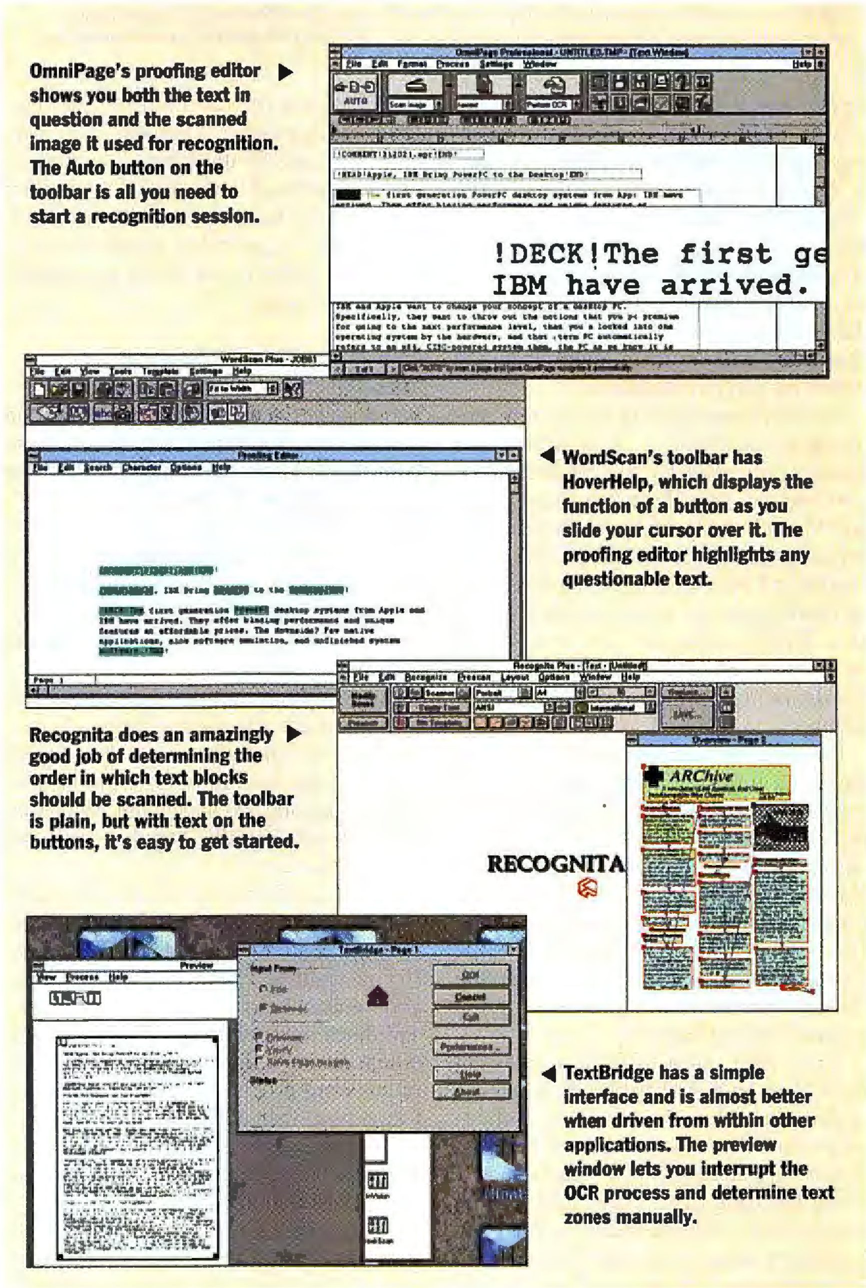
With a scanner attached to your personal computer, OCR software converts an image of a page into columns of text and graphics, determines how the text flows from column to column, and delivers formatted text to standard applications. This has an advantage over image-archiving systems because it lets you interact with the data, performing search and text retrieval or statistical analysis. Plus, data as text occupies much less memory than data that's scanned and left as graphics.

I tested the Windows versions of four products: Caere's OmniPage Professional (available for Macs and Windows machines), Calera's WordScan Plus (Windows), Recognita's Recognita Plus (CTOS, DOS, Windows, and OS/2), and Xerox Imaging Systems' TextBridge (Mac, Power Mac, and Windows). In the U.S., OmniPage and WordScan Plus have always been the undisputed champs for speed and accuracy. TextBridge delivers excellent performance at an extremely attractive price, and Recognita offers support for over 80 languages. With the exception of WordScan Plus, all these products offer some level of multilingual capability out of the box; none, however, comes close to the extensive support found in Recognita's international edition.

A Good Character Reference

BYTE's last major group review of OCR products was in April 1991. Then, we were faced with the prospect of scanning hundreds of pages of test documents using 14 OCR packages. To automate the process, I wrote a text-matching utility that compared the output of an OCR package to the original ASCII text file. The utility became part of our testing arsenal, and I deployed it again for this review.

To run the test, you print an ASCII file on a variety of output devices, run the output through the OCR package, and let the utility run the comparison. The utility takes into account missing text lines, extra blank space, and stray characters. For each line, it runs a statistical analysis to determine which line from the original file it is supposed to match. It then tries to find each word from the original line in the scanned input. Any word from the original that does not appear correctly in the test input is counted as an error. The score is given as



OmniPage's proofing editor shows you both the text in question and the scanned image it used for recognition. The Auto button on the toolbar is all you need to start a recognition session.

WordScan's toolbar has HoverHelp, which displays the function of a button as you slide your cursor over it. The proofing editor highlights any questionable text.

Recognita does an amazingly good job of determining the order in which text blocks should be scanned. The toolbar is plain, but with text on the buttons, it's easy to get started.

TextBridge has a simple interface and is almost better when driven from within other applications. The preview window lets you interrupt the OCR process and determine text zones manually.

OCR Accuracy

	OmniPage	Recognita	TextBridge	WordScan
Daisy-wheel text	99.3%	97.0%	99.3%	98.9%
Ink-jet text	99.3%	96.2%	98.7%	99.0%
Tiny text	88.6%	97.2%	95.6%	97.3%
Times text	99.2%	99.1%	98.9%	98.4%
Copied text	88.9%	92.3%	96.4%	95.3%
Fax	98.8%	87.4%	78.1%	98.0%

Accuracy is measured by counting the number of words that scanned correctly and dividing by the total number of words in the document. The daisy-wheel text (perfectly formed characters) should be the easiest to recognize, so scores should be close to 100 percent. The fax and photocopy pages are the hardest. For a product to be usable, you want the accuracy rate to be at least 95 percent to 97 percent; anything less may require too many corrections. While OmniPage often did a little better than WordScan, it did poorly on photocopied documents and documents with small laser print. TextBridge did well, except with faxed pages.

correct words per minute, or throughput.

Most OCR vendors count *character* errors instead of word errors. Either approach is valid. In making corrections to the scanned text, however, you're likely to use a word processor's spelling checker, correcting complete words rather than individual characters. Keep in mind, though, that counting word errors as opposed to characters will result in lower accuracy scores for a given package.

The test documents in this review represent an assortment of pages printed on a Smith Corona daisy-wheel printer and on a 600-dot-per-inch Hewlett-Packard LaserJet IV in a variety of fonts; photocopied versions of the same documents; and pages created in Lotus's Ami Pro and faxed to a thermal-paper fax machine using Delrina's WinFax software. A typical document consisted of approximately 11,500 words, or roughly 80 KB of text in 30 pages.

I ran the 200-plus pages on each product through a Fujitsu 3096G flatbed scanner connected to a 66-MHz 486 desktop computer with 16 MB of RAM. If you're serious about OCR, you need a reliable scanner that scans quickly, has a document feeder, and produces good, clean output. The figures "OCR Accuracy" and "OCR Throughput" show the results of scanning the test documents and performing OCR accuracy and speed tests.

Since 1991, most of the improvement in OCR technology has been in its ability to decipher "dirty" documents—documents that have been through multiple generations of photocopying or that have been faxed multiple times. Consider that an error rate of 1 percent means you have to correct one word out of every 100, or up to five or six errors on a typical laser-printed page. A good rule of thumb is that anything much below 95 percent to 97 percent is essentially unusable. A number of the packages that we reviewed three years ago achieved less than 60 percent accuracy. The low score in this round of testing was 78.1 percent, for faxed documents with TextBridge.

Caere's OmniPage Professional 5.0

OmniPage's accuracy has improved tremendously. Except for its performance on bad photocopies, OmniPage held its own admirably against the competition. It also offers a number of new features: a toolbar that includes a one-touch Auto OCR function, and several technologies that it collectively refers to as Caere 3D AnyFont technology: True Page format retention, 3D OCR, Caere AnyFax 2.0, and the Language Analyst.

Auto OCR converts the entire process of scanning a document into a simple click on one button. After you select the settings you want, the Auto function scans the document, finds the text and graphics zones on the page, performs OCR on the zones, and formats the text.

True Page formatting takes great pains to preserve the document's original format and reproduce it in the final output. If you want to scan text from a memo you've used before, change a few names and dates, and reprint it, True Page will produce a word processor document (within the word processor's ability to handle formatting) with all the text and graphics positioned exactly as they were in the original, or so Caere claims. True Page even includes 24-bit image-editing software.

To use True Page, you need a scanner with gray-scale capability and HP AccuPage technology. The Fujitsu scanner I used didn't support AccuPage, so I connected an HP IICX scanner to test True Page. In my tests using pages of formatted newsletters, closely positioned graphics tended to become confused with nearby text, large fonts (e.g., headlines) were often interpreted as graphics, and boxes or dashed lines sometimes disappeared. In each case, bringing the document into Microsoft Word for Windows 6.0 resulted in a document that would require a measure of reformatting before it could be considered identical to the original.

3D OCR takes advantage of a scanner's gray-scale capability and uses a Compound Neural System (a learning facility) for more accurate recognition. Since this analyzes the depth of gray in each character's pixels, 3D OCR technology increases OmniPage's chances of recognizing faded or broken characters.

AnyFax increases recognition by employing image enhancement on characters it perceives as broken, joined, or jagged. It also attempts, by reengineering the fax image's CCITT code, to reconstruct missing lines in faxes that have suffered from noise on the phone lines.

The Language Analyst compares the text to lists of common three-letter sequences and word groupings to determine a likely match. It also checks for common OCR errors and attempts to correct them. All this slows down the recognition process but seems to greatly improve OmniPage's accuracy.

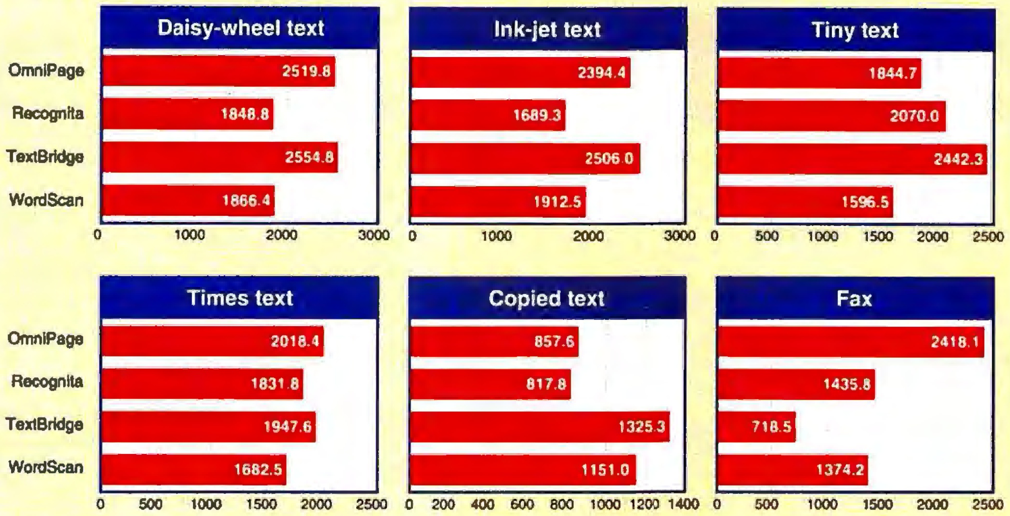
Calera's WordScan Plus 3.0

WordScan Plus was the top performer (in terms of accuracy) in the 1991 review, and the latest release is even better. Like Caere, Calera uses neural-network and image-enhancement technology for improved dirty-document support. It can also retain page formatting and offers a one-touch OCR function.

WordScan Plus includes support for scanning stacks of two-sided documents, provides automatic deskewing of images that may be tilted on the copy glass, has excellent document-template support, and has an OCR Aware function (a macro for starting up WordScan from within other applications). It also supports HP's AccuPage 2.0 technology and includes a handy help feature, HoverHelp: As you bring your cursor near a toolbar button, a window at the bottom of the screen describes what that button does.

A design goal for Calera has been to integrate WordScan Plus seamlessly with Windows suite products. WordScan's

OCR Throughput



Throughput is measured by counting the number of words the software scanned correctly (total – errors) and dividing by the time it took to scan the document. An accurate package that runs slowly can have a better throughput measurement than a fast one that makes lots of errors. In general, accuracy is more important than speed. TextBridge was remarkably fast and reasonably accurate; in most cases, it beat the other three packages on throughput. While OmniPage and WordScan almost tied on accuracy, OmniPage was faster, giving it a higher throughput rating. Recognita scanned quickly but made a lot of errors.

Chameleon toolbar mimics the style of your Windows suite word processor's toolbar. Support for OLE 2.0 allows you to drag and drop images of scanned or faxed documents directly into an OLE 2.0–compliant word processor, initiating the recognition process. Mail enabling then lets you send the processed text out directly via any VIM- or MAPI-compliant mail application.

Templates in WordScan Plus let you easily define regions on a page where text is likely to be, store these region definitions, and reuse them for every page in a document. You may find this especially useful for scanning in database listings, financial reports, or other highly formatted text. Overseas customers can purchase an international version of WordScan Plus for the equivalent of $745.

Recognita's Recognita Plus 2.0

Recognita Plus is another package that has improved significantly in the last three years, but it still lacks the overall accuracy and throughput that you'll find in the other packages. Recognita's particular strength is its superb language support. Out of the box, the international version recognizes text in 80 languages and handles documents that use multiple languages on a page. The company also offers an Americas version that allows you to choose among interfaces in English, French, Spanish, or Portuguese ($395), as well as an English-only version ($295).

All the common functions in the Windows interface on Recognita are located on a large toolbar that, unlike most toolbars, supplies text to tell you what modes are selected and what the buttons do. I usually have to look at a program's documentation to figure out which buttons to push on most toolbars; not with Recognita. The package also offers the ability to start an OCR process from within other applications by selecting from a menu or pressing a hot key.

The only difficulty I had in testing Recognita was that the international version includes a hardlock copy-protection device for your parallel port. I connected an HP laser printer through the device and tried to get the Windows drivers to print through it. At best, I got spotty character output and numerous time-out errors; at other times, the system acted like the printer wasn't even attached. Printing works fine if you're using a network printer; otherwise, make sure you have a second printer port on your machine. Fortunately, the other versions don't require the hardlock.

At press time, Recognita released version 2.0a of its products. The new version has better handling of inconsistent spacing and support for HP AccuPage 2.0.

Xerox Imaging Systems' TextBridge 2.0

This was the first time I'd seen TextBridge, and considering its low list price ($99), I wasn't expecting very much from it. I was pleasantly surprised. Still, compared to the more expensive products covered in this review, TextBridge doesn't offer much of a user interface, has a minimum of features, and requires you to rely more heavily on your other applications for editing and proofing the final text.

You can launch TextBridge from within your word processor, E-mail, or spreadsheet using the TAS (TextBridge Application Server), which is invoked by an OCR command that TextBridge adds to your application's file menu. The TAS handles the entire scanning/recognition process and imports the results directly into your document.

TextBridge's recognition is fast—often faster than that of the more expensive products—but the product falls short on accuracy. It did well on clean daisy-wheel output and adequately with the clean ink-jet and Times Roman text, but poorly with faxed documents. This hurt its overall throughput rating, but for applications that primarily involve good, clean documents, considering the price, it's hard to beat TextBridge.

Get Yourself Recognized

Thanks to faster scanners, fancier processors, and better algorithms, OCR software is easier to use than ever. A good typist may achieve 100-plus words per minute, but any 486 clone can easily beat that by an order of magnitude using modern OCR. And it doesn't have to cost you an arm and a leg.

Scaled-down versions of these high-end products are available at substantially lower prices. These include OmniPage 5.0 ($495), OmniPage Direct (for background OCR; $119), and WordScan 3.0 ($249).

At just $99, TextBridge is less than one-fifth the price of the major players. It does not offer some of the convenience features of the more expensive products, and it didn't fare well on the faxes in my tests, but it should do the job for many common OCR applications. While Recognita Plus's extensive language support is impressive, the package did not do as well as I would have expected on the test documents, and the copy protection on the international edition could prove to be a problem for non-networked machines.

It was no surprise that the two strongest packages were OmniPage Professional and WordScan Plus. While the two ran almost neck and neck in accuracy, WordScan did much better on difficult items, like tiny text and bad photocopies. OmniPage was faster, and its speed contributed to making it the more efficient (i.e., it had the higher throughput) of the two. Remember, however, that speed is largely dependent on your system's processor and available memory.

If I knew that most of my documents were clean, I'd probably opt for TextBridge and enjoy the savings. Otherwise, I'd take the safe bet and stick with WordScan. It's not the fastest, but it's fast enough, and it's accurate—which should save making a lot of corrections. ■

Howard Eglowstein is a developer for Penmanship, Inc. (Incline Village, NV), and a BYTE consulting editor who works with handwriting software for education. He can be reached on the Internet or BIX at heglowstein@bix.com.

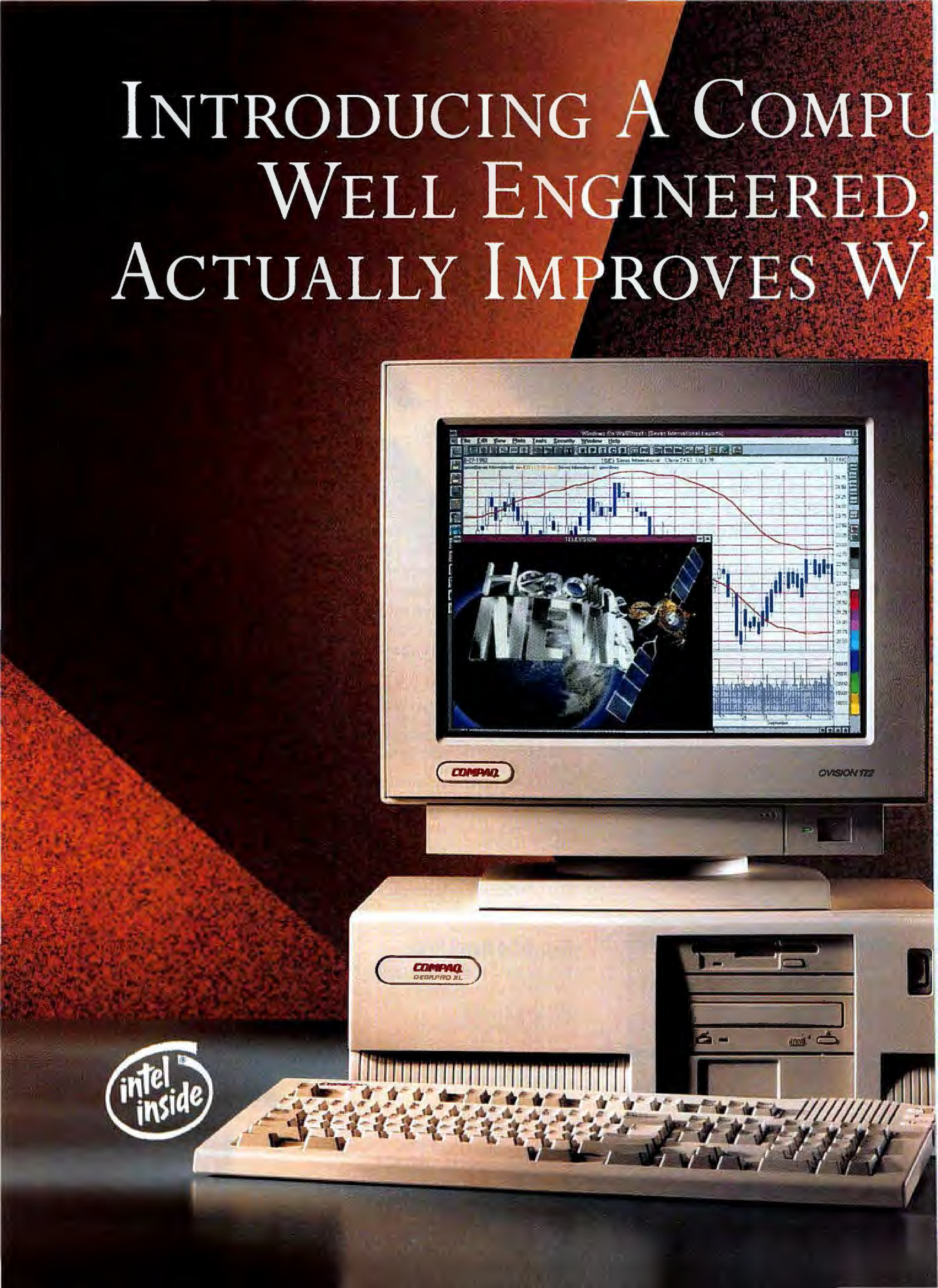
About the Products

OmniPage Professional 5.0 .... $695
Caere Corp.
100 Cooper Court
Los Gatos, CA 95030
(800) 535-7226
(408) 395-7000
fax: (408) 354-2743
Circle 1079 on Inquiry Card.

Recognita Plus 2.0 International $695
Recognita Corp. of America
1156 Aster Ave., Suite F
Sunnyvale, CA 94086
(800) 255-4627
(408) 241-5772
fax: (408) 241-6009
Circle 1080 on Inquiry Card.

TextBridge 2.0 .... $99
Xerox Imaging Systems
9 Centennial Dr.
Peabody, MA 01960
(800) 248-6550
(508) 977-2000
fax: (508) 977-2435
Circle 1081 on Inquiry Card.

WordScan Plus $595
Calera Recognition Systems
475 Potrero Ave.
Sunnyvale, CA 94086
(800) 422-5372, ext. 22
(408) 720-8300
fax: (408) 720-1330
Circle 1082 on Inquiry Card.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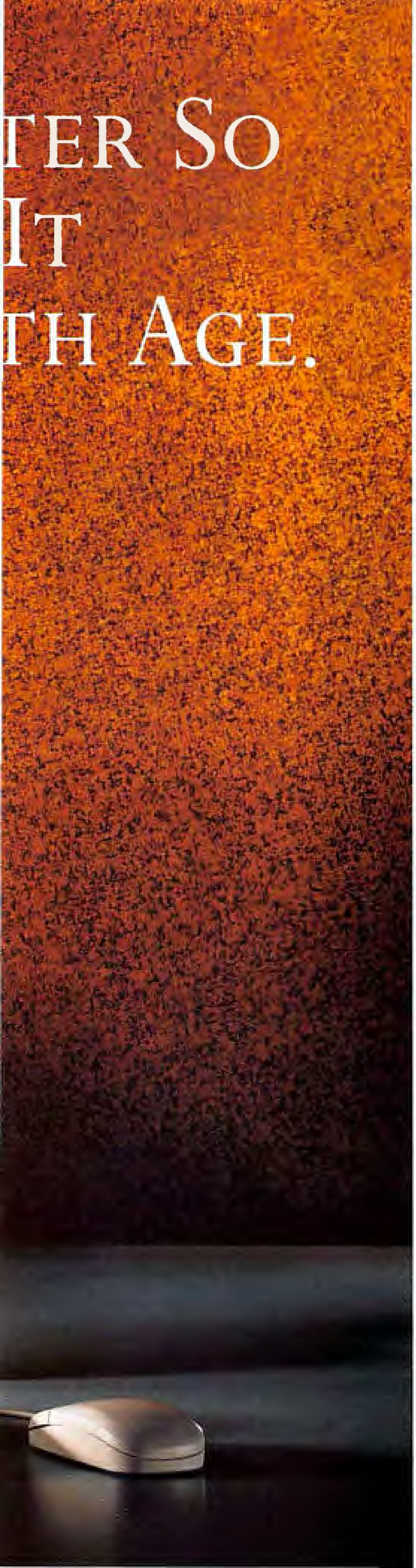

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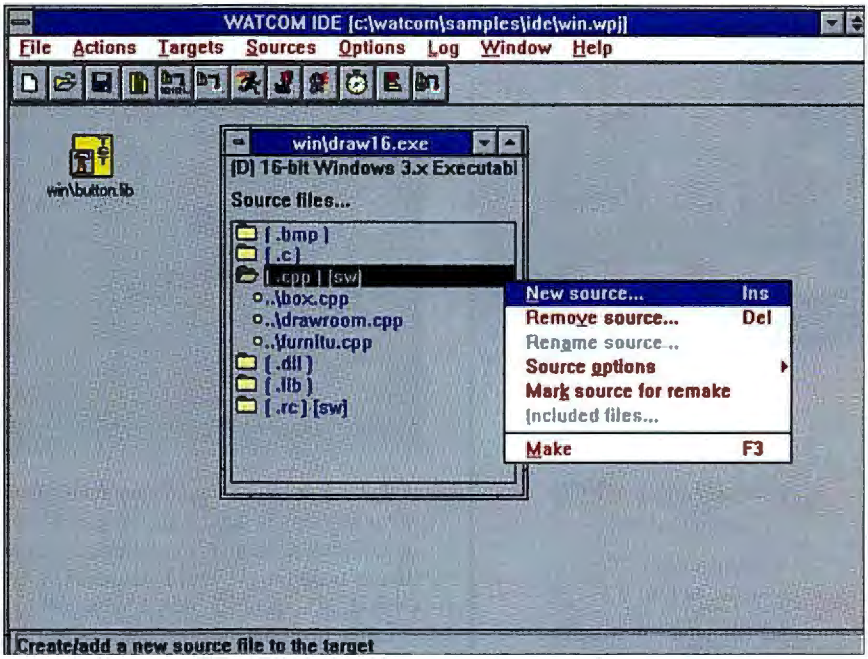
Watcom C/C++ Gets a New Face

Version 10.0 delivers a graphical development environment and an impressive cross-platform solution

RICK GREHAN

Watcom C/C++, already a formidable compiler, has become even more impressive in its new version, 10.0. Die-hard Watcom users will be happy to know that Watcom hasn't reduced its compiler's cross-platform capabilities; if anything, they've been enhanced. And possibly the biggest crack in the Watcom C/C++ edifice, its lack of any graphical development environment, has been plastered shut.

Watcom's C/C++ compilers were always solidly built products. When BYTE last did a C++ compiler roundup ("C++ Does Windows," September 1993), Watcom's 32-bit C/C++ 9.0 generated some of the best-performing code on the benchmarks we used. Even back then, Watcom was producing an ANSI-compliant C++ compiler with full support for templates and exceptions. Those strengths, along with the compiler's ability to produce executable files for so many targets, made it a valuable development system for anyone creating cross-platform applications.



The Watcom IDE, showing the open dialog box holding the sources for a sample target. Note the icon for another target on the left (a single project can have multiple targets). The IDE groups sources within a target into logical folders. A pop-up menu appears to the right of the selected source; this menu lets you manipulate, delete, or make the selected source, or add a new source.

As You Like It

Watcom C/C++ 10.0 is even more of a chameleon than its predecessors. You can run Watcom on DOS (command-line), OS/2 2.x, Windows 3.x, or Windows NT. From any of the host platforms, you can generate executables for DOS, Windows 3.x, OS/2 1.x and 2.x, NT, Novell NetWare, and AutoCAD. I ran Watcom hosted on a 66-MHz 486DX2 running Windows for Workgroups 3.11.

In the past, Watcom released its 16- and 32-bit compilers as separate products. Not so with version 10.0: From a single host, you can produce both 16- and 32-bit code. The bundled DOS4G/W from Rational Systems lets you create 32-bit DOS-extender applications up to 32 MB in size (you can distribute the applications royalty-free). On the Windows side, you can create either Win32s applications or, using a kind of Windows 32-bit extender unique to the Watcom compiler, 32-bit Windows applications that can run under Windows 3.x without using Win32s. (Such an application can run under Windows 3.x as well as in a WinOS/2 session under OS/2.)

I'm still not finished listing Watcom's output formats, because within each target platform you can select among a variety of deliverables. For example, under 32-bit DOS you can create executables for the DOS4GW extender, PharLap's extenders (TNT and 386DOS), the FlashTek extender, or a library file. The full list would take more room than I have here.

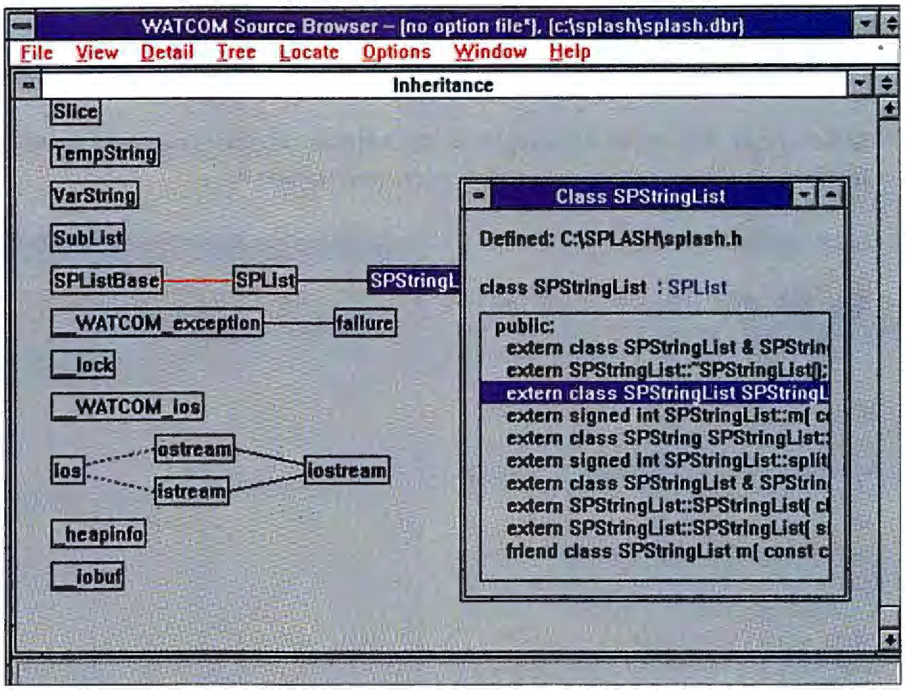
What You See

Watcom C/C++ 10.0's most visible addition is its suite of graphical development tools. This is good news on the one hand, because—like it or not—compilers in the PC realm are often judged more on the basis of their GUI development environments and less on the technical strength of their compiler cores. New users' first impressions of Watcom C/C++ 10.0 will certainly be better than with C/C++ 9.0. On the other hand, it's not-so-good news for those of us who appreciated that we could install Watcom in a reasonable amount of time and disk space. GUI-based C/C++ development systems are becoming legendary disk-space consumers, and Watcom's 10.0 won't be left out of that lore.

Watcom C/C++ 10.0 arrives on a CD-ROM. A full installation will annex over 170 MB of disk space. You can significantly reduce this requirement if you install a subset of all potential target platforms. You can reduce it even more if you opt, as I did, to keep the help files on the CD-ROM. Unfortunately, I paid a price for such disk-space reduction tactics. In particular, the development tools search for their help files in the local directory, so the help entry on all tools menus simply responded with a "Cannot open help file" error. I had to access the help files from their individual icons on the desktop.

Watcom's IDE (integrated development environment) and other graphical development tools are so nice, however, that I quickly overcame my disk space anxieties. If you've worked with earlier versions of Watcom C/C++ and you're like me, then you've built up collections of make files or compiler/linker batch-file templates. In

Reviews Watcom C/C++ Gets a New Face



The new class browser, showing inheritance hierarchy. When you double-click on a class name, a dialog box appears, listing all member functions and instance variables.

defense of Watcom 9.0, it wasn't a difficult arrangement to live with: When I was developing several 32-bit command-line-driven programs, I could create DOS extended, NT, or OS/2 versions by just executing the appropriate link batch file; recompilation was unnecessary.

The Project Paradigm

Watcom C/C++ 10.0 makes life even easier; I don't need those batch files anymore. Watcom 10.0's IDE is built around the now-ubiquitous project paradigm. A *project* is a collection of one or more *targets*, a target being the final result of a compilation—.exe, .com, and .lib files are examples. In turn, a target is composed of *sources*—usually header, C, or C++ source files, but they can also be resource files, libraries, bit maps, and so on.

Once you create a new project, you begin building a target by populating the subwindow with sources. The IDE examines source file extensions and gathers files accordingly, placing those with the same extension into folders within the target subwindow. So, all .c files go into one folder, all .bmp files into another, and so on. You can close or open folders in a manner similar to the directory representation you find in the Windows File Manager.

This provides better control over the many tools that work together to build the final application. You don't have to remember which compiler to unleash on which source file (e.g., C compiler for .c files, C++ compiler for .cpp files, and resource compiler for .rc files), nor do you have to worry about deducing file dependencies; the IDE does all the worrying for you. Often, you don't even need to know which compiler switches to set. Simply put, Watcom's IDE makes your make files for you. (If you enjoy operating the compiler, linker, and so on from the command line, you can still do that.)

Furthermore, if you double-click on a .c or .cpp filename in the target subwindow, the IDE launches Watcom's editor for Windows and loads it with the source file. Likewise, if you double-click on a .bmp file, you are whisked to Watcom's image editor, and the bit map is loaded automatically. (I'm describing the IDE from the perspective of a Windows user. There are some differences depending on which platform you use as the host development system. For example, if you're running OS/2 2.x, double-clicking on a resource file will launch IBM's resource editor.)

Watcom's IDE also makes use of the right mouse button to launch context-sensitive pop-up menus. For example, when you right-click on a source's filename in the target subwindow, the IDE summons a pop-up menu that provides access specific to that source file. If it is a C or C++ source file, the pop-up menu lets you modify the file's unique set of compiler switches. In this way, you can have some source files compiled, say, for speed, while others are compiled optimized for size. Another selection from the pop-up menu presents a pick list of all include files; double-click on one, and it's off to the editor again.

Browser and Assembler

Many of Watcom C/C++ 10.0's tools were already available in earlier versions of the compiler package. These include the heap walker, the spy, a spy for DDE events, and the Dr. Watcom crash-analysis tool (although now there's also a Dr. Watcom NT). Some tools, however, are brand-new to 10.0.

The C++ compiler now includes a class browser. Perhaps it's improper of me to ascribe the browser to the compiler; I do so because it's the compiler that (based on a switch setting) emits the database that the browser reads.

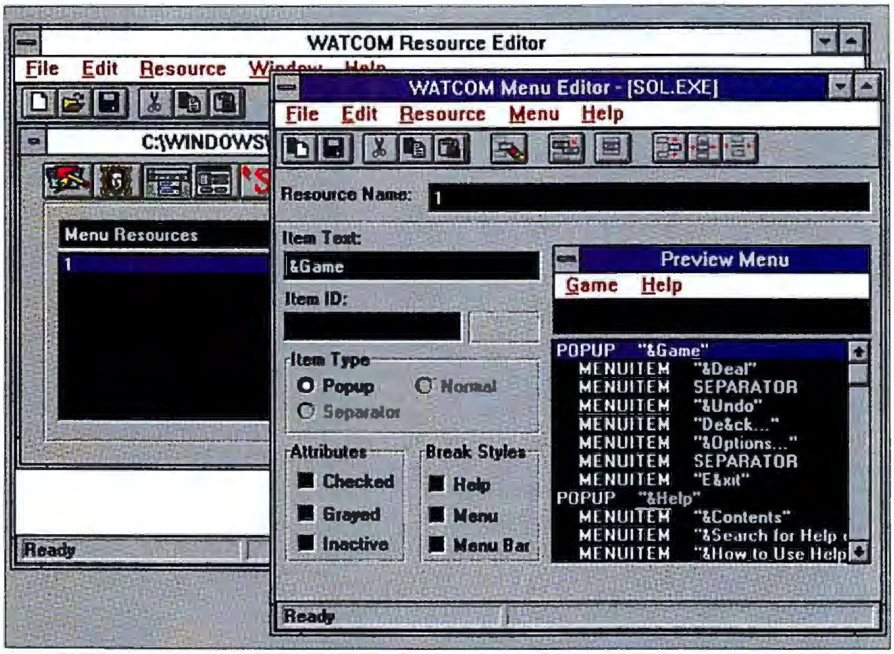
Opening the browser reveals a graphical flowchart view that shows inheritance hierarchy. When you double-click on one of the graph members, a dialog box pops up, showing in a scrollable list all member functions and instance variables of that class. Everything is thoughtfully grouped into public, private, or protected areas. Clicking with the right mouse button in this dialog box opens yet another pop-up menu; this one offers to ferry you to the source code where the class is defined (again, by launching the Watcom editor and auto-loading the file) or provide a list of all locations in the source code where the particular class is referenced.

Then there's the Watcom assembler, WASM. WASM is Microsoft-compatible and handles all PC-based Intel processors from the 8086 up to the Pentium. Unfortunately, I was unable to completely investigate all the details of the assembler. Its help file had a bug in it that caused a system error whenever I scrolled past a certain point. When I reported the bug, it turned out that the people at Watcom were already aware of it. A corrected version of the file was available from Watcom's BBS, free for the downloading. But since I was running my help files from the CD-ROM, my choices were to download the file and redirect the help-file icon to the new file on disk, try to guess my way through the assembler, or wait for a new CD-ROM. Since most of my work was with C/C++ code, I opted for the last choice.

Debugger and Profiler

Watcom's debugger has a redesigned, configurable interface. Graphics-mode versions of the debugger exist for OS/2 2.x,

Reviews Watcom C/C++ Gets a New Face



Watcom's resource editor, with the menu editor window launched, having excised the menu bar from the Windows solitaire game.

Windows 3.x, and NT; you can run a character-mode version under DOS, as well as under the operating systems mentioned above. New features in the debugger include a replay capability: Depending on how much memory you have available, the debugger allows you to step back in time, actually undoing the effects of instructions as you go.

You can also unwind the stack. This capability lets you step up and down through the nested hierarchy of calling routines. Local variables are updated accordingly, so no matter what level you're at, you're always seeing a correct view of the local environment. And if you enjoyed the extensive programmability of Watcom's previous debugger, Video, you'll be glad to know Watcom has carried the command-line capabilities into the new debugger.

Finally, code-tuning freaks will enjoy Watcom's new profiler. This tool is actually two components, a sampler and a profiler. You run your application within the sampler, which collects statistics of the execution and deposits the results in a file. When execution is complete, you enter the profiler to explore the results.

The profiler works pretty much the way you'd expect. You're given a window that lists the modules within your program. Double-click on a module name, and you step down a level in detail. At each level, bar graphs appear adjacent to each item within a module, indicating relative and absolute time spent in that item. You can continue this stepping-down process to the assembly language level. At this point, the results of the sampler become almost meaningless, since on most 486 or Pentium systems, a lot of instructions will be executing within a millisecond—beyond the accuracy of the sampler's clock.

Yet More

Additional gimmees with the Watcom compiler are not visual, but hard-core developers will find them invaluable. First, there's support for MFC (Microsoft Foundation Classes) 2.5 (for building 16-bit applications under Windows 3.x) and MFC 2.1 (for building 32-bit applications under Win32s or NT). Next, Watcom has licensed components of the OS/2 2.1, Windows 3.1, and NT toolkits. Specifically, these components amount to API libraries and on-line help. The compiler also comes with all the header and import files you need to build an NLM (NetWare loadable module), and it's bundled with components from SOBObject's developer's toolkit for OS/2.

After I've sounded so enthusiastic about the Watcom C/C++ compiler's new look, here's a quick dose of perspective. Users of similar Borland, Symantec, or Microsoft products can reasonably ask: "What's the big deal? We've been using graphical development tools for years now." All I can do is hope that the programming energy Watcom diverted into the GUI building doesn't reduce the capability of the compiler itself. As new versions of compilers from Microsoft, Symantec, and Borland become available, BYTE will do comparative tests of the quality of generated code.

Also, I did log a number of bugs in various IDE components. The source code browser appeared confounded about just where in the code a given class definition appeared. It seemed to think that a "friend class <classname>" declaration was the actual class definition. And sometimes edit boxes in one of the compiler switch dialog boxes failed to appear; I would have to shut down the IDE and restart to get them to show up.

The Watcom package has no C or C++ language manuals, so novice C programmers should beware. Even for seasoned programmers, I'm not sure how convenient it is to have supporting documentation in the form of help files.

One thing this package needs is a cumulative index. It's often a real spelunking job figuring out in which file hides the answer to a particular question. That said, I must mention that, if you'd rather have your documentation in paper form, Watcom will make it available to you at extra cost (currently $120 purchased separately). The additional fee also gets you Bjarne Stroustrup's *C++ Programming Language* (possibly the best reference work for the C++ language) and a C language guide.

In spite of the above caveats, I've had so much good experience in the past with Watcom products that I am optimistic that the company will be able to iron out the wrinkles. Watcom C/C++ has always been a top choice for a multiplatform compiler, and 10.0 looks like another winner. ■

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

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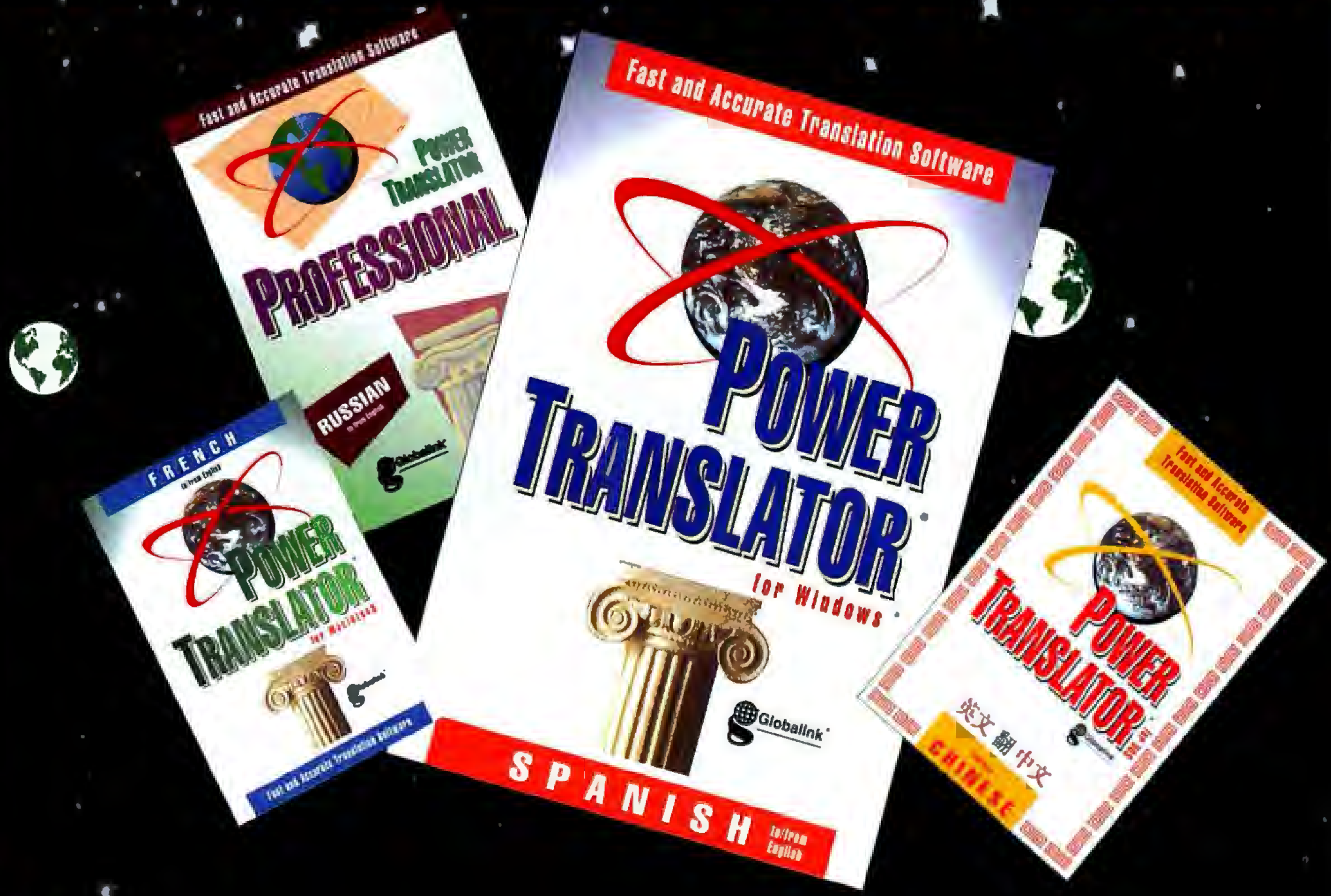

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Mac SCSI Utility Sampler

Two software tools that let you add third-party SCSI devices to your Macintosh

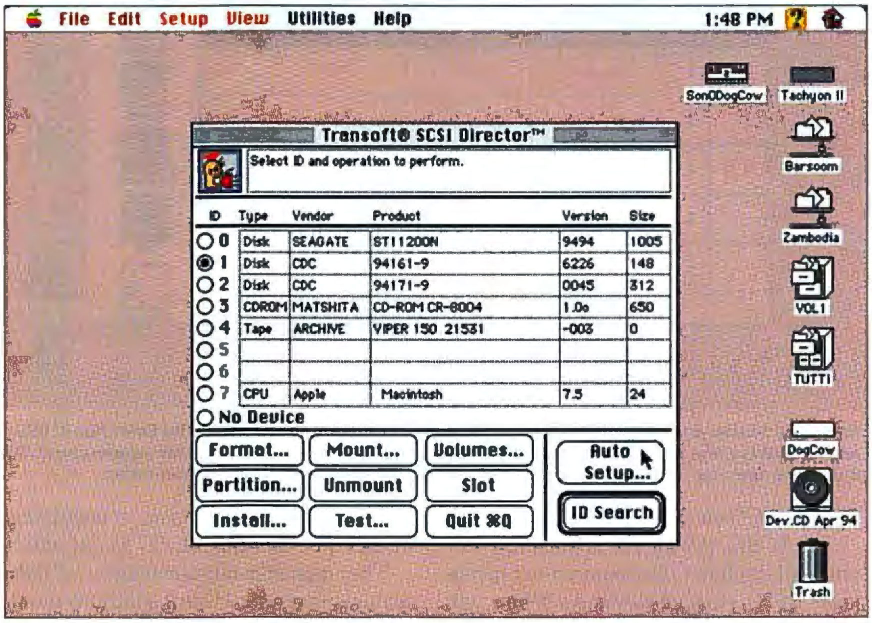
TOM THOMPSON

There comes a point in the computing life of your Mac when you want to expand its storage capabilities. You might need a bigger hard drive to hold all those files you've accumulated, or a removable cartridge drive for file backups. A CD-ROM drive could also be pretty useful to access development software, digital dictionaries, or (admit it) all those cool CD-ROM games.

You're in for a surprise if you rush into this project and buy just a mail-order SCSI drive and cable. The Apple HD SC Setup application, which you use to format and initialize the Mac's Apple-brand internal hard drive, ignores third-party hard drives and other SCSI storage devices. The HD SC Setup application operates only on SCSI devices that contain Apple-installed firmware. In short, it wants nothing to do with that third-party SCSI drive.

While it's understandable that Apple might want to keep its disk utility software as simple as possible, restricting it to drives with a certain type of firmware creates problems. It eliminates any choice in third-party wares, such as a SCSI hard drive larger than any offered by Apple. It also complicates things if you want to back up and retrieve data on removable media such as SyQuest cartridges or MO (magneto-optical) disks, all of which are made by third-party vendors. It's the same if you want a fast quad-speed CD-ROM drive: Apple's CD-ROM Extension recognizes only its own dual-speed CD-ROM drives.

The good news is that enterprising software vendors have a solution for you: utility programs that query the Mac's SCSI bus and operate almost any third-party SCSI peripheral connected to it. Note that these utility programs don't operate certain SCSI devices, such as scanners and tape drives. They manage storage devices such as hard drives, SyQuest cartridge drives, and MO drives. Some also provide support for CD-ROM drives. These capabilities alone will satisfy the needs of most users. (A recent wrinkle is the IDE drives found in the recently announced PowerBook 150 and Quadra 630. Utility vendors will have to adapt their programs if they're to operate this type of drive.)



The Setup window for Transoft's SCSI Director Pro. The window shows all the SCSI peripherals connected to a Power Mac 8100 by type, vendor, name, firmware version, and storage capacity. You use the radio buttons along the left to pick a device, and the buttons at the bottom to configure the selected device. SCSI Director Pro displays devices attached to each of the Power Mac 8100's two SCSI buses, which can cause problems.

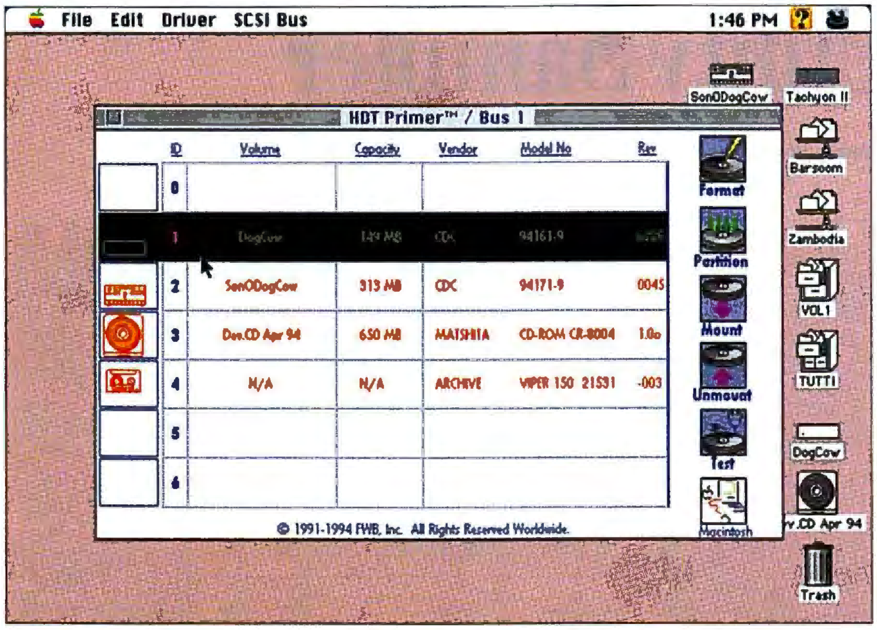
For this review, I evaluated two representative SCSI utility programs: Transoft's SCSI Director Pro 3.0.7 ($99.95) and FWB's Hard Disk ToolKit 1.5 ($199). I used a Power Mac 8100/80 to evaluate the software's compatibility with this new breed of Mac. My test drives were an old Quantum 80-MB hard drive, an even older Seagate 40-MB hard drive, and two CDC 150- and 350-MB hard drives scavenged from a defunct Unix workstation. This mix let me evaluate each utility's ability to deal with a variety of hardware.

The 80-MB Quantum drive came from an old Mac, so its installation should have been (and was) trouble-free. The two alien-format CDC drives presented the biggest challenge to the utilities, requiring a complete low-level format, setup, and installation of a Mac OS–compatible driver. The Seagate drive, of 1987 vintage and nearing the end of its useful life, was a worst-case test of each utility's hardware checks.

Transoft's SCSI Director Pro

The SCSI Director Pro software comes on two high-density (1.44 MB) floppy disks. The installation disk contains the program software and Installer application; the second is a bootable start-up disk. You need the boot disk when the Mac has only a floppy drive and a freshly installed third-party hard drive. It comes with several System Enablers that let it boot in a Mac Quadra 800, Quadra 840AV, Centris 650, LC III, and some PowerBooks. The installation disk holds other System Enabler files, such as those to start PowerBook Duos. The boot disk, unfortunately, won't start a Power Mac. Transoft can't be faulted for this omission, however: Current Power Mac system software simply won't fit on a single high-density floppy disk.

The installation disk has a smorgasbord of files, including the SCSI Director Pro utility program itself. A SCSI Assistant Control Panel mounts partitions or removable media from within applications when you're running System 6.0.x; an SD Removable Extension scans for removable media. Since Transoft supplies the necessary satellite CD-ROM support files (e.g., Foreign File Access and ISO 9660), its Extension can also mount CD-ROM drives. Rounding out the fare are the System Enablers already mentioned and an application/DA (desk accessory) combo



The Volume Selector window for FWB's Hard Disk ToolKit. Notice that the window displays the Power Mac 8100's external SCSI bus (bus 1). The internal hard drive, located on the internal bus (bus 0), is quite properly absent. The icons at the right edge of the window represent buttons that control the selected (highlighted) device.

that lets a CD-ROM drive play audio CDs.

The SCSI Director Pro application provides all the functions required to operate most SCSI storage devices. When you launch SCSI Director Pro, a Setup window appears (see the screen on page 159). In the Setup window, you format, partition, and install a SCSI device driver on the device's storage media, preparing it for use by the Mac OS. Notice that all SCSI peripherals on the bus appear in the Setup window, including tape drives, which the program doesn't operate on. To choose a device, you click on the radio button next to it in the Setup window.

Beneath the list of SCSI devices, an Auto Setup button provides an easy, one-button setup. With a single mouse-click, SCSI Director Pro automatically performs a low-level format on the target device, builds a partition that occupies most of the media, installs the Transoft SCSI driver, and mounts the device so that it appears on the Mac Desktop. If you need to install A/UX (Apple's version of Unix) or create several partitions on the hard drive, you must do it manually using the Format, Partition, and Mount buttons (the partition operation automatically installs the device driver). A Slot button lets you manage SCSI accelerator cards that plug into PDS (Processor Direct Slot) or NuBus slots.

To configure most storage devices, all you'll usually need are the controls in the Setup window. A Special menu lets you perform more exotic operations, like tinkering with the media's partition map, starting or stopping a hard drive, or reassigning blocks (i.e., marking blocks as unusable).

The manual's documentation of these features is spotty. Useful additions would be an explanation of the purpose behind modifying the media's partition map (to create a custom partition) and a step-by-step example. The manual is terse on general SCSI information, yet it has an appendix that provides detailed information on SCSI sense key and code tables. This is good stuff for the experts working on device drivers, but the novice hardware hacker may have some trouble.

The driver that SCSI Director Pro places on the media fully supports the multiple SCSI bus, asynchronous I/O, and SCSI-DMA capabilities provided by Apple's SCSI Manager 4.3. This type of driver enables the SCSI bus to be used more efficiently, which in turn lets the computer spend more of its time going about its duties rather than waiting on slow peripherals. The driver also conserves memory by allowing only one copy of itself to load in memory when it's present on several devices. This can save up to 50 KB of RAM for each additional SCSI peripheral that uses the Transoft device driver. The driver also has a Data-Guard feature that attempts to recover SCSI transfers lost if the SCSI bus experiences a glitch or if someone accidentally switches off a peripheral.

FWB's Hard Disk ToolKit

Hard Disk ToolKit comes on two 800-KB floppy disks. The first contains two applications, HDT Primer and HDT World Control, that provide all the functions necessary to set up and mount a SCSI peripheral. The second disk has a bevy of practical utilities in the form of Control Panels and Extensions. There's no bootable floppy disk.

HDT Primer handles the basic chores of formatting, partitioning, installing a driver, and mounting a SCSI peripheral's media. Similar to SCSI Director Pro, a Volume Selector screen displays all the SCSI peripherals attached to the computer and lets you select the device to work with (see the screen at left). Those devices that HDT Primer can't manage (e.g., tape drives) can't be selected.

Clicking on the Format icon on the Volume Selector screen starts a full-blown setup for storage devices, automatically sequencing through the partitioning, driver installation, and mounting operations. The Partition and Mount buttons function identically to those on SCSI Director Pro. Selecting the Test button starts an exhaustive suite of tests for evaluating the throughput and integrity of the media. Depending on the test options you pick, these tests can take several hours to run.

The driver that Hard Disk ToolKit installs on the media is compatible with SCSI Manager 4.3, which supports features such as asynchronous I/O, SCSI-DMA, and multiple buses. The FWB driver doesn't conserve memory: Duplicate copies of the driver can appear in memory, depending on the number of devices with drivers installed. The Mac SCSI boot process has the SCSI Manager load the driver for each SCSI device into memory. FWB is redesigning the driver to behave like Transoft's.

The HDT World Control application handles the more exotic SCSI device functions. Here you can start or stop a SCSI drive, prevent or allow media removal, reassign blocks, and so on. The manual is excellent; it provides an extensive description of hard disk media and how SCSI operates. It also gives a decent description of World Control's SCSI functions and what they mean. Someone new to SCSI yet willing to take a few risks to configure a cranky drive would stand a good chance of success using HDT World Control and the Hard Disk ToolKit manual.

An HDT Prober Control Panel lets you scan the SCSI bus, reset it, and mount removable media. When you hold down the Command key, HDT Prober scans the Power Mac 8100's second SCSI bus. The Control Panel is handy for System 6.0.x users who want to mount removable media or other partitions while in Photoshop or another application. System 7 users will also find HDT Prober good for the same purpose, since it launches faster than the HDT applications. You can use the HDT Extensions to automatically search for and mount removable media upon insertion into a drive. Because the package lacks the prerequisite CD support files, this Extension can't mount CD-ROM drives.

Compatibility Check

Power Mac compatibility is a minor issue for these tools, because all device drivers on the Power Mac are still in emulated 680x0 code. (Although not available in time for this review, FWB's new version 1.6 has native utility applications, but the drivers remain 680x0 code.) The asynchronous I/O driver capability that both packages offer is of potential benefit once vendors modify applications software to make the appropriate Toolbox calls. As with native PowerPC software, the conversion will take time, but FWB and Transoft's drivers are ready to support it.

On the Power Mac 8100/80, I noted one glitch in SCSI Director Pro's display. This computer has two independent SCSI buses: a high-speed internal bus and a standard-speed external bus. Although SCSI Director Pro has a menu command to scan a second bus, it apparently scans both buses and combines all SCSI devices together in the Setup window. If you have two drives with a SCSI ID of 0 on each bus, only the SCSI device on the internal bus appears in the Setup window—a potentially serious problem.

Hard Disk ToolKit handles this situation properly. As the screen on page 160 shows, it displays only peripherals attached to the system's external SCSI bus (bus 1). The high-speed internal hard drive (a Seagate ST11200N) is absent. As for Power Mac compatibility, I had no problems with either package's driver on the 8100/80.

Neither SCSI Director Pro nor Hard Disk ToolKit had any difficulties setting up any of the drives. Their automatic setup functions easily configured the CDC drives. SCSI Director Pro's tests ran in just a few minutes, providing an extensive report in a text file. This report covered data transfer rates for reading and writing (both synchronous and asynchronous) and seek times. On the old Seagate drive, error reporting was intermittent, but this was OK since the drive just bordered on unusable. However, you had to read the report file to see any mention of error conditions; no error messages appeared on-screen.

While Hard Disk ToolKit also creates a report file for the extensive tests it runs, this report contains little information other than that the test ran successfully. You can use the BenchTest application on the second floppy disk to get some drive performance information. Unlike with SCSI Director Pro, if a problem is detected, Hard Disk ToolKit displays a prominent error message on-screen. Repeated test runs also detected the wavering reliability of the old Seagate drive.

I tried Transoft's Data-Guard feature by switching off a hard drive in the middle of copying several large files. A dialog box was supposed to appear, reporting a problem, but I never saw this. However, the Finder did complain of an I/O error and presented a dialog box to continue or stop the copy operation on the current file. When I turned the drive back on and clicked on the Continue button, the remainder of the files transferred without problems. While the Data-Guard capability failed to save the file caught in the bus dropout, the rest copied intact, and it averted a system lockup.

Both SCSI tool packages are ideal for adding and managing SCSI storage devices on your Mac. Their one-button setup of most devices shields the casual user from exposure to SCSI arcana. If you've sprung for both a third-party SCSI hard drive and a CD-ROM drive, you might opt for SCSI Director Pro, since it provides CD-ROM support. If you've bought just a CD-ROM drive, you might want to consider FWB's CD-ROM ToolKit for $79.

Folks using plug-in SCSI cards for RAID arrays or other applications should use SCSI Director Pro, since it understands this type of hardware. But if you've salvaged a drive from another computer system or bought one at a flea market and want to connect it successfully to your Mac, FWB's Hard Disk ToolKit is a better choice because of the wealth of information in its manuals and its thorough hardware tests. And if you use a Power Mac 8100/80, you'll want Hard Disk ToolKit to properly manage devices on both of its SCSI buses. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an Associate Apple Developer and the author of Power Macintosh Programming Starter Kit *(Hayden Books, 1994). You can contact him on AppleLink as T.THOMPSON, or on the Internet or BIX at tom_thompson@bix.com.*

Alternative SCSI Utilities

If your needs are modest, the cost of a download might be all you have to pay for a useful SCSI utility. If your work has you constantly mounting and dismounting removable media such as SyQuest cartridges or MO disks, check out Robert Polic's SCSIProbe 3.5. It's a freeware Control Panel that scans the SCSI bus and displays the peripherals in a window. You can reset the SCSI bus, and a Mount button lets you mount removable media. SCSIProbe can install its own Extension that automatically mounts the media if it's present in a drive at boot time, and it lets you mount drives with a hot-key combination after the Mac is up and running. An option setting lets SCSIProbe close and remove any driver loaded from the media when it was mounted, thus conserving memory and avoiding driver conflicts when another cartridge is mounted in the drive. What SCSIProbe can't do is format and partition the device's media.

If you own A/UX, you already have a SCSI utility. In recognition of the fact that most A/UX software gets installed on huge third-party drives, Apple provides a "universal formatter" program. This is just a special version of HD SC Setup that skips the firmware check and manipulates the SCSI device anyway. The A/UX 3.0 HD SC utility successfully formatted all the hard drives tested in this review. However, this utility works only with hard drives, not with removable-media units.

About the Products

SCSI Director Pro 3.0.7 ..... $99.95
Upgrade $49.95
Transoft Corp.
1150 Coast Village Rd., Suite H
Santa Barbara, CA 93108
(800) 949-6463
(805) 565-5200
fax: (805) 565-5208
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Hard Disk ToolKit 1.5 ..... $199
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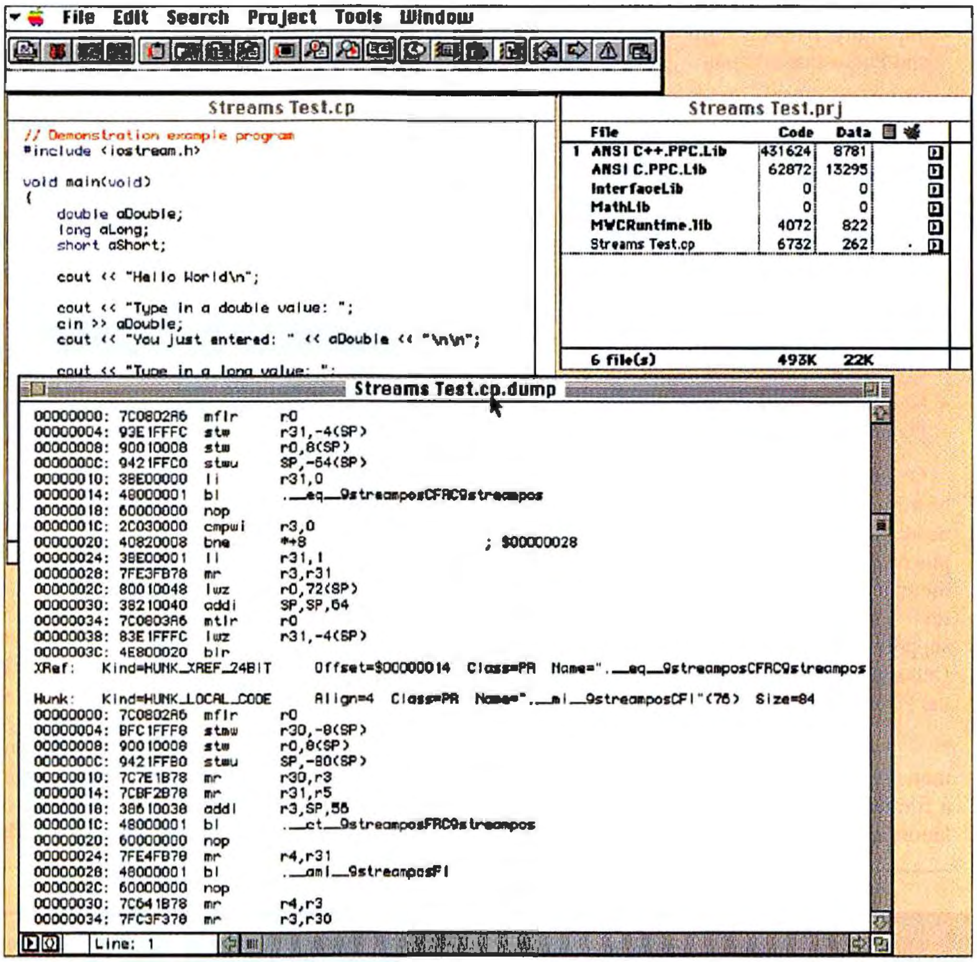

CodeWarrior's IDE (integrated development environment) showing the Program Manager window (upper right), an edit window (upper left), and some disassembled PowerPC code (bottom).

The official release of Metrowerks' CodeWarrior (as version CW3) provides more than just a top-notch multiplatform development system. It also injects some excitement and competition into the moribund field of Mac software development tools.

Before the introduction of CodeWarrior, mainstream software developers had two options: Apple's MPW command-line tools or Symantec's Think Project Manager, an IDE (integrated development environment). When Symantec released its own MPW-based command-line C compiler, Apple abandoned its C/C++ compilers and officially sanctioned the Symantec product, reducing the minimally competitive market to a race with only one runner. CodeWarrior changes all that. Now there is head-to-head competition, akin to Microsoft versus Borland, for the best C, C++, and Pascal development tools on the Mac and Power Mac.

Reviewing a product as wide-sweeping and feature-rich as CodeWarrior in just a few pages is always frustrating. Even though I've been using developer releases of CodeWarrior for over a year, there is still a lot of functionality I've only begun to explore. This review gives a high-level overview of the capabilities of CodeWarrior CW3 with the 3.5 upgrade. I tested the Gold version, which compiles for both 680x0 and PowerPC hardware. A Bronze version compiles just for 680x0 Macs.

Comfortable Environment

Central to CodeWarrior is its project-based IDE. The IDE is indicative of what you'll find with all CodeWarrior tools: It is small and fast and does what you expect. It fits comfortably and performs acceptably on my 8-MB PowerBook 145—not a state-of-the-art machine by any stretch, but one I frequently use while developing code. Although I've been able to compile demo applications in as little as 2 MB, my PowerBook does become a bit crowded when I try to run the CodeWarrior IDE and the source-level debugger simultaneously.

A Project Manager window provides the focal point through which you load and compile all files and libraries (see the screen). You can add files to the project singly or in arbitrarily large groups. All projects start out with a single code segment. Dragging a loaded file to the bottom of the project list creates a new segment, into which you can then load other files.

CodeWarrior provides the added flexibility of allowing each source file to contain multiple code segments. This is particularly useful when writing C++ and MacApp applications where, for efficiency, you may want to have constructor, destructor, and method code in a single physical file but be able to load the method code in a separate code segment.

Without this ability, you have to always load all the method code—which may be substantial—into memory just to instantiate or release an object. With CodeWarrior, you can control the application segmentation on a function-by-function level. The disadvantage is that the linker must have all the object and symbol files loaded into memory while performing the link. Linking even small MacApp programs can require 12 MB of memory.

The Project Manager window also provides a pop-up menu for each file. The

New Warrior

Just as this review was going to press, Metrowerks delivered its latest release, CW4. My perusal of the new version showed a number of incremental improvements:

- new C/C++ and Pascal compiler releases
- the ability to debug PowerPC shared libraries
- the ability to debug various third-party extensions such as XCMDs, as well as Quark and Photoshop add-ons
- a new PowerPC math library
- compilation of in-line functions into precompiled headers
- the official 1.0 release of the PowerPlant framework
- a hierarchical layout in the IDE Project Manager window that lets you collapse and expand segments; also, the ability to name segments from within the IDE
- the ability to include resource files directly in the project list
- the full set of projects from *Power Macintosh Programming Starter Kit* by BYTE's own Tom Thompson
- New documentation, including *C/C++ in Five Days* by Philip Machanick

One of the most interesting changes in CW4 is how in-line functions are included in precompiled headers. According to Metrowerks, CW4 will compile MacApp applications in less than 50 percent of the space previously required. Also, this last-minute review of CW4 reminded me that Metrowerks fully supports one of my favorite programming tools, The Debugger by Jasik Designs, on both the 68030 and the PowerPC.

About the Product

CodeWarrior CW4 Gold....................$399
Bronze version for 680x0 code only....$99
Prices include three free upgrades.
Metrowerks, Inc.
(U.S.:)
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(800) 377-5416
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menu serves two functions. You can mark a file as immediately requiring recompilation, and you can select any one of the include files referenced in the file and bring it up for editing and review.

A user-configurable toolbar provides a one-to-one mapping to all available menu commands. You add commands to the toolbar by simply holding down the Command-Control keys while selecting the menu item to add to the bar. You can also arrange toolbar icons in logical order. Although I'm usually not fond of toolbars, CodeWarrior's icons are, with few exceptions, fairly self-explanatory, and the immediate feedback provided by a single-line prompt provides instant recognition.

680x0 or PowerPC

The Gold version of CodeWarrior provides two versions of the IDE—one for generating 680x0 code and one for generating PowerPC code. Metrowerks provides both development environments, as well as the compilers running within them, as fat binaries able to run in native mode on any Mac platform. Thus, you can develop PowerPC applications on a 680x0 Mac, and 680x0 Mac applications on a Power Mac.

A Preferences setting lets you adjust your structure alignments to meet 680x0 or PowerPC requirements. The settings are unrelated to the platform your code will actually run on; for example, you can declare 680x0 Mac structure alignment in a PowerPC application. Although you should be careful to write platform-independent code that doesn't depend on structure alignment, these settings are useful when porting existing applications that may make use of native 680x0 structure alignments.

The CodeWarrior environment provides

a full, well-documented set of Apple Events for scripting. Typically, you use this Apple Event interface to connect a third-party text editor to the development environment. Other uses abound, however, such as writing a script to automatically import large numbers of new files into a project, or automatically compiling a series of independent projects and then linking them into a final application.

One feature missing from the IDE is the ability to use a single project to generate both 680x0 and PowerPC applications. Although any project can be opened by either IDE, there is no programmatic way to set which system libraries and precompiled headers are required for each platform. Although an AppleScript could be used to create a copy of the project and then load the appropriate libraries, it would be much more convenient to have a single project with multiple views—thus ensuring that the same base project was used to generate both 680x0 and PowerPC applications.

One essential feature of the IDE is the ability to import object files generated by MPW C/C++ compilers. In particular, CodeWarrior can import object and library files that use far code and far data segmentation. Missing from other Mac IDEs, this ability is vital when using large third-party libraries built for the MPW environment.

A complete CodeWarrior Gold installation consumes more than 100 MB of disk space. You can pare this down to less than 40 MB, depending on your requirements. For example, the 100-MB installation includes the C, C++, and Pascal compilers; on-line documentation; extensive examples; and a fully configured MPW 3.3.1. Metrowerks also provides an MPW version of the PowerPC C++ compiler.

The Compilers

CodeWarrior Gold provides two compilers on two platforms: an ANSI-standard C/C++ compiler and an ISO-standard Pascal compiler. Versions of these compilers are available for generating both 680x0 and PowerPC applications. Each compiler runs natively on the 680x0 Mac and the Power Mac. These are the only Mac PowerPC cross-compilers available for the Macintosh platform that I know of. The linker can also produce fat binaries that contain native 680x0 and PowerPC code.

As with many C++ compilers, CodeWarrior currently lacks templates and exception handling (although Metrowerks supplies a macro implementation of exception handling). Like other compiler manufacturers, Metrowerks is targeting these capabilities, particularly exception handling, for release in the near future.

In building 680x0 applications, you can choose from three memory models: Small, Large, and Smart. The Small model uses 16-bit memory-address offsets within a code segment. This limits the maximum segment size to 32 KB. The Large model provides 32-bit memory-address offsets in a code segment, allowing individual code segments to be larger than 32 KB at the cost of slightly reduced speed. The Smart model analyzes the code results and uses 16- or 32-bit offsets, whichever is more appropriate, to balance speed with the flexibility of large address spaces. CodeWarrior can also generate applications with data segments greater than 32 KB.

Although the C/C++ compiler typically receives the most attention, CodeWarrior also contains an ISO-standard Pascal compiler. This compiler does not have the Object-Pascal extensions needed for generating MacApp applications, so it isn't a potential MacApp porting tool. Although you can freely intermix C and C++ source files in a project, you must contain Pascal source files in their own project file. You can build Pascal files into libraries and then import them into C/C++ projects. To do so, you must move back and forth between the C/C++ and Pascal IDEs during development, which is awkward.

Class Libraries and Interfaces

CodeWarrior gives you interfaces both plain and fancy. The SIOUX interface library provides a quick-and-dirty interface for porting command-line applications to the Mac. SIOUX routes ANSI-standard `printf` and `getc` commands to the user through a scrollable text window. The output in this window can be cut, copied, pasted, and printed. Although you won't want to ship products built around SIOUX, it's excellent for test routines or for making first-pass ports of existing command-line applications to ensure functionality.

At the other end of the spectrum is PowerPlant and Constructor. PowerPlant is an extensive class library with some features unique for the Mac. Constructor is a view editor that lets you build user-interface components based on the PowerPlant class library. To use PowerPlant, you first build a set of user-interface views using Constructor. Constructor is a user-interface builder; it is not yet able to generate code automatically, although the documentation refers to this ability in several places.

There are two fundamentally different ways to build class libraries. You can

create a single base or root class (typically called `class Object`) from which all other classes are derived, or you can create a set of class structures, each of which has its own root. One advantage to an object structure with multiple roots is that naming conflicts are much less likely when you interface to third-party class libraries.

Another advantage is the ability to design class hierarchies that are logically independent of each other. Metrowerks describes this type of class structure as *mix-in* and claims that the majority of its class hierarchies are independent of each other. As there is less interaction among classes, the resulting system is easier to understand. Applications are also much smaller, since using a method in one class doesn't automatically load five other classes.

Metrowerks provides an impressive level of Mac system support within the PowerPlant framework. To start, there is a class to support the Macintosh Threads Manager. This class allows you to start cooperative (and limited preemptive) multitasking threads within a single application. Semaphores and shared queues allow threads to coordinate and communicate.

PowerPlant also supports Apple Events. Just building an application automatically provides the required Apple Events, like Open and Print. Hooks in the class library let you attach your interfaces in a reasonable and consistent way. The 3.5 upgrade includes classes (still in development) for supporting the Drag and Drop manager.

One of the continual problems facing developers using object-oriented languages such as C++ is how to quickly and efficiently track and store objects once they have been created. PowerPlant solves this problem by including a product called NeoPersist by NeoLogic. NeoPersist is not an object-oriented database. Rather, it is a library that provides *object persistence*. It allows you to store the state of a limited number of objects and then restore it at a later time—typically when an application is restarted. NeoPersist is a subset of a more full-function product called NeoAccess, which *is* an object-oriented database.

Another NeoPersist feature is the ability to maintain objects once they are created in memory. Since objects are dynamic, they can be destroyed when you least expect it. This is a particular problem in a multithreaded environment, where one thread can be creating objects and another thread using and destroying them. NeoPersist lets you verify that an object to which you are about to refer is valid. It can also provide automatic garbage collection by tracking all the references to a specific object and releasing that object once all the references have released it.

Documentation

All CodeWarrior documentation, ranging from an introductory *Principles of Programming* to technical reference guides, comes electronically. The information is extensive, but not excessive. Except for the introductory *Principles* book, most of the documentation is terse and technical but well written. It was easy to find such in-depth information as register usage within the 680x0 and PowerPC compilers, calling conventions, and a list of pragmas. Although terse, the documentation still finds space to provide excellent code samples for each of the ANSI library functions. In addition to documentation for CodeWarrior subsystems, Metrowerks also provides documentation for version 3.1.1 of MPW and the latest Threads Manager.

CodeWarrior ships with Apple Extensions for 680x0 and PowerPC platforms. Among them are AOCE (Apple Open Collaborative Environment), QuickTime, Speech, Drag and Drop, and the Threads Manager, which allows cooperative multitasking within a single application.

Coming into Its Own

CodeWarrior is a powerful, exciting, and quality development environment for the 680x0 Mac and PowerPC. It has been well received by the developer community, and many software development houses use it.

Metrowerks has improved CodeWarrior dramatically in the 3.0 release and 3.5 upgrade. Internet discussions indicate that, sparked by the rush to move projects to the PowerPC, most developers have been using Metrowerks with third-party frameworks and libraries. Now that the PowerBuilder class library has matured, it should get as much exercise as the base compilers. ■

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One World, One Fax

Global Village's One World fax server gives a Mac network an easy shared fax solution

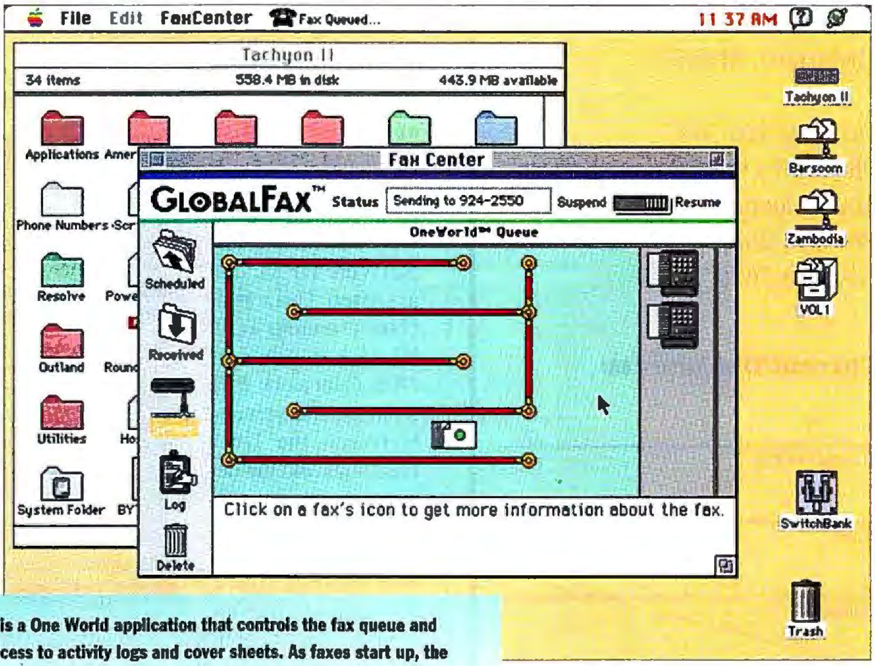
HOWARD EGLOWSTEIN

Somehow, I missed it. When I wasn't looking, the word *fax* became a verb. Several times a day I find myself *faxing* articles to authors, information to readers, or design documents to my partners in an ongoing development project. Increasingly, this is from the Mac on my desk, so I no longer have to print out the pages first and try to get our cranky fax machine to cooperate.

BYTE's editorial LAN has a Global Village One World fax server: a shared device that sits quietly on the network and provides shared fax (send only) services for any number of people in your organization, using only one or two phone lines. One World handles the details; imaging the pages, spooling the output, and queuing the jobs for transmission.

If the One World fax server sounds suspiciously like a standard fax modem, you're half right. It's a petite 6- by 10-inch box with a 16-MHz 68302 processor, 1 MB of RAM (expandable to 9 MB), sockets for one or two of Global Village's PowerPort modem cards, and an AppleTalk network connection (either LocalTalk or Ethernet wiring).

Installing one of these critters is simply a matter of finding a handy spot with a network connection, phone line(s), and an outlet. I had no trouble getting the test unit installed in our network wiring closet within minutes of opening the package.



Fax Center is a One World application that controls the fax queue and provides access to activity logs and cover sheets. As faxes start up, the queue manager displays the status with a fun animation—highlighting the entire package's friendly, nonthreatening approach to shared fax services.

The Trouble with Fax Cards

The alternative for a busy office, providing dedicated fax modems for everyone, can be a system administrator's nightmare. Assuming most people want to send faxes without tying up their voice line, there's the hassle (and cost) of providing an extra phone line to each desk. Now add the cost of a fax modem and the time it takes to get everything wired correctly. Installations with 10 or more people can likely justify buying a fax server on installation costs alone.

Faxing documents long distances during the day can cost a bundle. Most companies would be amazed at how much they spend on faxes if they had an accurate accounting of their fax activity. One World keeps a detailed log of who sent what to whom and how long it took. And consider the cost savings your company could realize if people scheduled their noncritical documents to go out at night when the phone rates are lower. The server's queue deals with the pending jobs and automatically shuffles them out through the modem cards in order.

Client Software

One World's client software comes in two parts. The first looks like a printer driver to any standard Mac application. To fax a document, you simply "print" it to the fax server, give it a phone number, and provide some scheduling details, and your document is away.

When your fax comes up to the top of the queue, a status icon appears in the system menu bar to tell you how your fax is doing. If you like, you can have the phone-line sounds come out of your Mac's speaker while the connection is established. Your pending faxes are stored in a special folder on your Mac. A buffer in the fax server stores as much of the fax as it can during the actual transmission but is fed from the data stored on your hard drive. Thus, to send a fax, your Mac must be on.

The second part of the software is a status monitor that normally installs into your Apple/DA (desk accessory) menu. Fax Center (see the screen) lets you examine jobs in the queue, delete or reschedule any of your faxes, check the server's history log file, or define cover sheets. Fax Center's Envelope function lets you group a number of documents together and fax them as a single operation.

Making a Connection

I installed the One World fax server on the mixed Ethernet/LocalTalk network in BYTE's Peterborough editorial offices. The evaluation unit was the 2EN model, with both LocalTalk and 10Base-T Ethernet wiring and a pair of Global Village's PowerPort Bronze II modems installed. The PowerPort Bronze supports faxing at data rates of up to 9600 bps. If you want your faxes to go out faster (and you're sending to a 14.4-Kbps fax machine), you can replace one or both of the modems

Reviews One World, One Fax

with Global Village's 14.4-Kbps PowerPort Gold modem card. The less expensive 1LT server model ships with one Bronze modem, one empty modem slot, and no Ethernet connection; to expand later, you can add a second modem. The 1LT doesn't have an Ethernet upgrade option, so if you have an Ethernet network or plan to upgrade an existing LocalTalk network, consider the more expensive 2EN.

BYTE has 50 to 60 machines sharing the network wire at any one time, and about one-third of them are Macs. At any time, the traffic is a composite of AppleTalk, Novell NetWare (IPX), and assorted Unix machines running TCP/IP to a number of NFS (Network File System) file servers. Between the Unix machines and the design department's heavy AppleTalk use, the network can get very busy at times. To operate, the One World server depends on a steady stream of data from the faxing client, although a built-in cache provides buffering for periods of heavy activity.

About the Product

One World
with software for 30 users:
1LT (Local Talk, one modem) $999
2EN (Ethernet, two modems) $1499
Additional user licenses are approximately $20 to $25 each, depending on quantity.

System requirements: Any Mac with 4 MB of RAM, System 7.x, and a Phase II AppleTalk network connection

Global Village Communication
685 East Middlefield Rd., Building B
Mountain View, CA 94043
(800) 736-4821
(415) 390-8200
fax: (415) 390-8282
Automated technical info by fax: (415) 962-9550
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One World doesn't support the TCP/IP and IPX network clients, but I wondered if the high traffic on the network would create a problem for the fax server. After working with the server during several periods of extra-heavy traffic, it appeared that the standard 1 MB of cache RAM was sufficient for the network configuration. If it wasn't, the 1 MB could be expanded to 3 MB (by adding two 1-MB SIMMs) or 9 MB (by adding two 4-MB SIMMs). We have a fair number of bridges and routers in place to help cut down on the network chatter; I suspect our network traffic is typical of many small-to-midsize offices.

Almost Too Easy for Words

Operating the One World GlobalFax client software is as easy as it gets. Select Fax from your application's menu (it replaces the Print option when you have the fax server selected as your printer) and choose a cover page and one or more phone numbers. Then click on Send....

GlobalFax comes with a selection of cover sheets that are automatically filled out with your name and other relevant fax information. You'll probably want to build your own, though, with a company logo or a cute graphic. To do that, simply create the graphic in any drawing program (I used Adobe's Photoshop) and save the image as a PICT file. GlobalFax imports the PICT file and lets you add the dynamic fields.

Pay close attention to your PICT file's resolution. I inadvertently saved my first cover page in Photoshop's default screen resolution (72 dots per inch). The horizontal resolution of a standard fax machine (200 dpi) looked terribly jaggy until I resaved the cover-sheet graphic at 200 dpi. Besides the usual resolutions, Standard (100 by 200 dpi) and Fine (200 by 200 dpi), One World also supports gray-scale faxing (on Mac SE/30s and better). I tried sending several gray-scale images to my gray-scale-capable Brother 780MC fax machine, and the output was surprisingly good.

I had only one recurring problem trying to get GlobalFax running on a number of Macs. The software tries to be smart about handling dialing codes for your phone system. The idea is that you tell the software how to get an outside line (often by dialing 9 first), how to dial long distance, and what your local area code is. If you enter all your phone numbers with the area codes into the fax software address book, GlobalFax is supposed to be smart enough to strip off the area code from local calls and dial long-distance codes when necessary. In practice, I never did get this feature to work correctly.

At $1499, the One World fax server is an effective way of providing a virtual fax machine to every Mac user in your organization. With as few as 10 users, you end up with a less expensive and possibly more capable solution for sending faxes from your office Macs. The best part is that using a fax server frees up your dedicated fax machine to receive incoming faxes. Now if they could just invent a fax machine that throws out all those junk faxes I keep getting.... ■

Howard Eglowstein is a developer for Penmanship, Inc. (Incline Village, NV), and a BYTE consulting editor. He can be reached on the Internet or BIX at heglowstein@bix.com.

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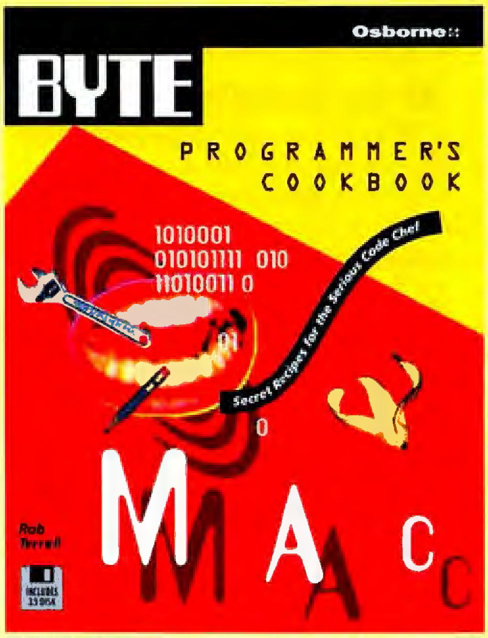

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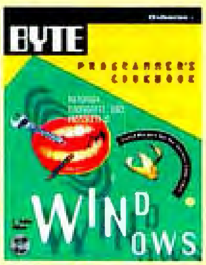

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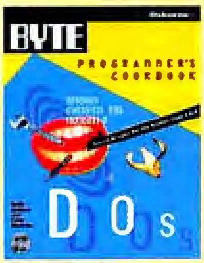

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31 NO-COMPROMISE PORTABLES

Our exclusive benchmarks rank the highest-performing notebook and subnotebook computers for running Windows, DOS, and Macintosh applications

ANTHONY J. LENNON

Today's high-end notebooks, fueled by 50- to 100-MHz 486s or even Pentium processors, allow you to take processing power with you when you leave the office. We tested 24 high-performance notebooks and five 486-based subnotebooks and found them to be effective Windows and DOS workstations. We also looked at two of the latest high-end PowerBooks from Apple. To round out our portables coverage, we also evaluated eight printers that can run on battery power.

While some of these systems come standard with such trendy features as built-in audio, you'll still pay a relatively high price for state-of-the-art portables. The average price for a color active-matrix notebook in this report is $4512. For an average of roughly $1270 less, you can buy a dual-scan color model offering less-brilliant colors. None of the notebook vendors (and only one subnotebook vendor) chose to submit for our review a color passive-matrix system, which has generally been supplanted by dual-scan as the low-cost alternative to active-matrix.

What's more, monochrome displays are almost nonexistent in high-end notebooks today: Only two vendors submitted monochrome notebooks, which sell for about $1000 less than dual-scan color models.

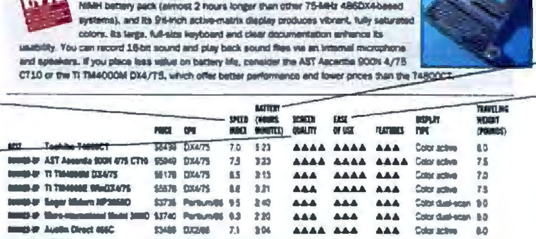
Fourteen of the notebooks (and all five subnotebooks) in this report use SL enhanced processors, which attests to the continuing drive by vendors to increase battery life. In addition, a majority of the notebooks use NiMH (nickel-metal-hydride) battery packs. The Toshiba T4800CT's use of this combination helped it to achieve the highest battery-life score among the notebook systems we tested: 5 hours, 23 minutes. Toshiba's Portege T3400CT took top battery-life honors

How to use this guide

We selected the best notebooks and subnotebooks by evaluating speed, screen quality, battery life, price, features, and ease of use.

Scores are calculated from the low-level benchmarks and the combined Windows and DOS application tests. Higher numbers indicate better performance.

Rates clarity, reproduction of gray scales or color, and range of viewing angles.



The time required to discharge a fully charged battery under real-world conditions (shown in hours:minutes).

A subjective assessment of the keyboard, pointing device, status lights, and other considerations.

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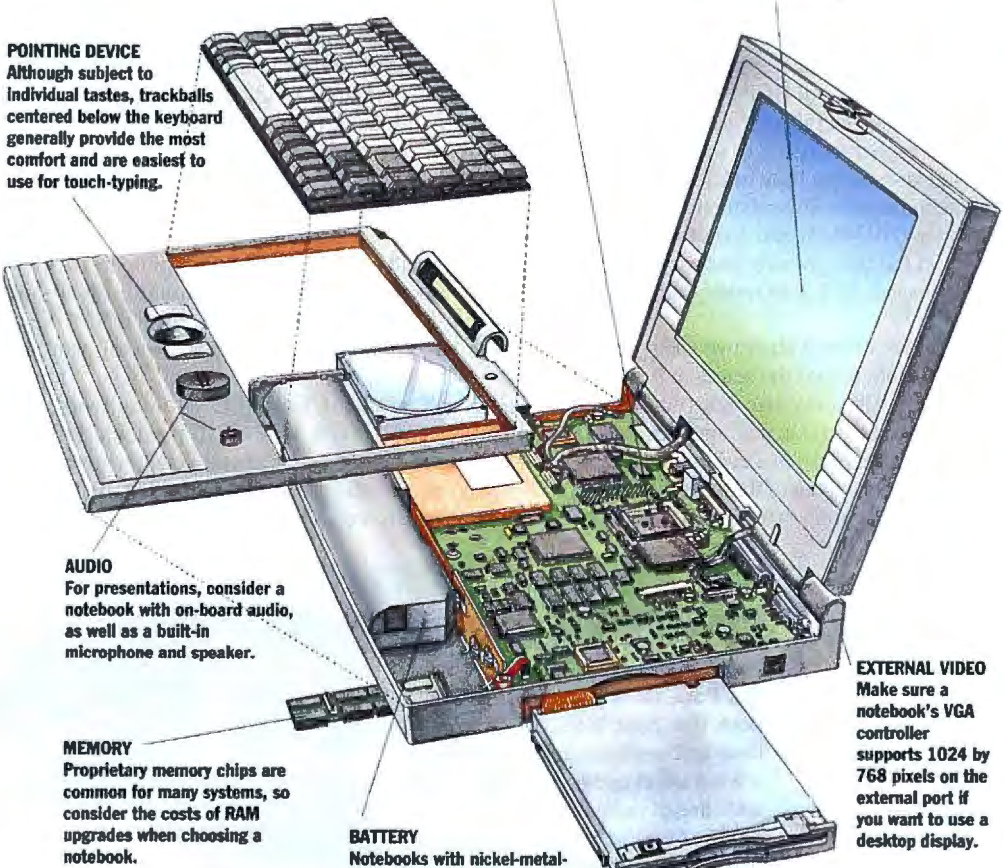
Important Notebook Components



for subnotebooks (6 hours, 9 minutes) using a lithium-ion battery, the only system to do so in this roundup.

Our performance tests used actual Windows and DOS applications, as well as low-level tests that stress individual system components, such as video and storage. Our exclusive battery tester rates power life with a word processing session that simulates real-world usage.

To evaluate printers for the road (a category that we looked at in our May and November 1993 printer reports), we ran our full suite of text and graphics tests to measure speed and print quality. The two Mannesmann Tally units we looked at use thermal-wax-transfer technology, and they are the clear performance leaders. The other models use thermal or ink-jet technology and retail from $299 to $399.

It's important to note that IBM updated its ThinkPad line of notebooks with models that fit our test criteria, but the company chose not to submit any for this evaluation. Hewlett-Packard offers a 486 version of its OmniBook subnotebook but couldn't supply us with a unit in time for testing. At press time, Ambra Computer announced that the company was being dissolved but that its notebooks reviewed here would continue to be available into the early fall.

OCTOBER 1994 BYTE BEST HIGH PERFORMANCE PORTABLES

BEST

HIGH-PERFORMANCE NOTEBOOK

Toshiba T4800CT

This system's NiMH battery pack powers the unit for close to 5½ hours, while its 9½-inch active-matrix display produces vibrant, fully saturated colors. The 75-MHz 486DX4-based system features a large, full-size keyboard and a local-bus video adapter. You can record 16-bit sound and play back sound files with the notebook's internal microphone and speakers.

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486 SUBNOTEBOOK

Zenith Z-Lite 425L

This subnotebook offers excellent monochrome screen quality and runs for close to 4½ hours on its NiMH battery pack. With a price of $1699, the Zenith Z-Lite 425L is also the winner in our low-cost category. Although not a performance leader, this modular 25-MHz 486SL-based unit supports up to 20 MB of RAM, and its Chips & Technologies 65535 video adapter supports external resolutions of up to 1024 by 768 pixels. Two Type II PCMCIA slots add to the system's expansion options.

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PORTABLE PRINTER

Mannesmann Tally MobileWriter

This printer is the obvious choice for speed and quality. The MobileWriter easily provides the top performance in all six of our printer benchmarks, and it received an above-average quality rating. The thermal-wax-transfer printer supports resolutions of up to 300 dpi and includes an 80-sheet input tray.

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THE BEST HIGH-PERFORMANCE

NOTEBOOKS

Not surprisingly, the two Pentium notebooks we tested ranked highest for flat-out speed. The Sager Midern NP3656D and the Micro-International HCP Pentium Series Model 3600D recorded overall performance scores that were about 25 percent higher than that of the Toshiba T4800CT, a DX4/75-based system that took best-overall honors. The two Pentium notebooks were also relatively inexpensive: the $3735 Sager Midern NP3656D had one of the lowest prices of the runners-up in the best-overall category. (Note that both Pentium notebooks use dual-scan rather than active-matrix screens.)

But superior Pentium performance comes with drawbacks: a large format and greater weight. Both tipped the scales at 9 pounds (with battery and AC adapter). The units' size helps accommodate a large heat sink, with an attached fan unit, mounted on top of the Pentium processor. A second, smaller fan, located on the left side of each unit, draws heat out of the system. Another trade-off of these systems: Battery life, approximately 2½ hours, was longer than that of only one other notebook in this category.

The 100-MHz 486DX4-based HyperData HB32Open, a low-cost runner-up, and the 75-MHz 486DX4 Texas Instruments TM4000E and TM4000M notebooks did not lag far behind the Pentium units in our speed tests. The TI systems fared especially well in tests that stressed processor and memory subsystems. However, the HyperData HB32Open features a 128-KB cache and an efficient 16-bit Cirrus GD6235 video subsystem that helped it perform on a par with the Pentium units in the disk-intensive tests.

The Austin Direct 466D and 466C systems were the fastest 66-MHz 486DX2-based systems we tested. Their superior video performance was aided by a 32-bit Western Digital 90C24A2-ZZ video subsystem.

On average, battery life for the notebooks in this report averaged close to 3 hours. The longest life we recorded was 5 hours, 23 minutes for the Toshiba T4800CT, the best-overall winner. By contrast, the HyperData HB32Open's battery lasted only 1 hour, 11 minutes. Seven of the nine systems that ran for over 3 hours used NiMH batteries, and five of these systems contained SL-enhanced 75-MHz 486DX4 processors.

The Mitsuba Ninja II DX4-75 ran the longest (3 hours, 34 minutes) among systems equipped with nickel-cadmium battery packs. In general, however, systems with nickel-cadmium battery packs ran for an average of only 2½ hours.

Our tests found the three 100-MHz 486DX4 notebooks to be power hungry: HyperData's HB32Open and the two 100-MHz Micro-International systems ran for an average of only 1½ hours.

All the systems support VGA. Cirrus Logic was the most used video-processor-chip manufacturer, followed by Western Digital and Chips & Technologies. Eleven of the notebooks feature 32-bit video buses. Resolutions of up to 1024 by 768 pixels are supported via an external monitor on all but the CAF Aqualite 2, Mitsuba Ninja II DX4-75, and NEC Versa V50 (which have maximum 800- by 600-pixel external resolutions).

After using each notebook for our day-to-day work, we gave the AST Ascentia 900N 4/75 CT10 particularly high ratings for the feel and response of its full-size keyboard; the keyboards that come with the Samsung NoteMaster 3945T and the TI TM4000E models are also noteworthy for their comfort.

POWERBOOK UPDATE


The PowerBook Duo 280c (left) and 540c.

The PowerBook 540c and the PowerBook Duo 280c ($5539 and $4299 in their test configurations, respectively) are the latest additions to Apple's portable line of computers. Both are based on 33-/66-MHz 68LC040 processors from Motorola and provided similar overall performance in our application benchmarks. They ran about five times faster than our baseline system, a Mac Classic II. (For a complete review, see "Apple Redefines the Notebook," August BYTE.)

Our test PowerBook 540c came configured with two NiMH batteries and ran for 5 hours, 55 minutes in our tests. The PowerBook Duo 280c ran for 3 hours, 50 minutes on its single NiMH battery pack.

The PowerBook 540c also has a unique trackpad pointing device located below the keyboard, along with the trackpad button. You simply drag your index finger across the trackpad to move the cursor across the display.

The PowerBook 280c's docking stations include an internal 1.44-MB floppy drive, slots for two NuBus cards, and support for an internal SCSI hard drive and built-in video. The PowerBook Duo 280c's MiniDock allows you to connect a variety of options, including an external video display, up to three Apple Desktop Bus input devices, up to six SCSI devices, LocalTalk cables, a printer, an external modem, and an external microphone, headphones, or speakers.

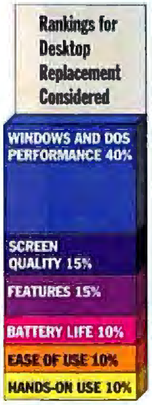

The PowerBook Duo 280c's MiniDock.

Only six of the notebooks contain enhanced parallel ports (see the Roll Call on page 192), which provide the high throughput that's critical for certain devices, such as network adapters. Most of the systems have bidirectional parallel ports; the TI TM4000E models contain unidirectional, or standard, parallel ports.

Many manufacturers cut costs by not implementing 16550 UART chips; these were contained in only six of the reviewed systems. These chips ensure reliable data transmissions with high-speed modems.

The TI TM4000M DX4/75 Active Color includes a fast SCSI-2 port. The other TI notebooks, the TM4000E models, were the only ones without any PCMCIA slot (the Amrel systems do not provide a Type I PCMCIA slot). The Ambra N75, CompuAdd 450 Colorpro, Micro-International HCP Pentium Series Model 3600D, Mitsuba Ninja II DX4-75, Sager Midern NP3656D, TI TM4000M DX4/75, and Toshiba T4800CT play and record sound via an internal microphone and speaker.

To rank the notebooks for the desktop replacement category, we limited the field to systems that had external resolutions of up to 1024 by 768 pixels, accepted hard drives of at least 500 MB, and supported an optional expansion chassis. This left us with 12 contenders.



KEY	
Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

BYTE BEST HIGH-PERFORMANCE NOTEBOOKS

Need a top-quality display and long battery life?

BEST OVERALL Toshiba T4800CT

OCTOBER 1994 BYTE BEST HIGH PERFORMANCE NOTEBOOK

This is the system of choice if you are willing to pay a premium price for long battery life and superb display quality. The unit ran for nearly 5½ hours on its NiMH battery pack (almost 2 hours longer than other 75-MHz 486DX4-based systems), and its 9½-inch active-matrix display produces vibrant, fully saturated colors. Its large, full-size keyboard and clear documentation enhance its usability. You can record 16-bit sound and play back sound files via an internal microphone and speakers. If you place less value on battery life, consider the AST Ascentia 900N 4/75 CT10 or the TI TM4000M DX4/75, which offer better performance and lower prices than the T4800CT.

		PRICE	CPU	SPEED INDEX	BATTERY (HOURS: MINUTES)	SCREEN QUALITY	EASE OF USE	FEATURES	DISPLAY TYPE	TRAVELING WEIGHT (POUNDS)
BEST	Toshiba T4800CT	$6499	DX4/75	7.0	5:23	▲▲▲▲	▲▲▲▲	▲▲▲	Color active	8.0
RUNNER-UP	AST Ascentia 900N 4/75 CT10	$5949	DX4/75	7.5	3:23	▲▲▲▲	▲▲▲▲	▲▲▲▲	Color active	7.5
RUNNER-UP	TI TM4000M DX4/75	$6178	DX4/75	8.5	3:13	▲▲▲	▲▲▲▲	▲▲▲	Color active	7.0
RUNNER-UP	TI TM4000E WinDX4/75	$5578	DX4/75	8.6	3:21	▲▲▲	▲▲▲▲	▲▲▲	Color active	7.5
RUNNER-UP	Sager Midern NP3656D	$3735	Pentium/66	9.5	2:40	▲▲▲	▲▲▲	▲▲▲	Color dual-scan	9.0
RUNNER-UP	Micro-International Model 3600D	$3740	Pentium/66	9.3	2:20	▲▲▲	▲▲▲	▲▲▲	Color dual-scan	9.0
RUNNER-UP	Austin Direct 466C	$3489	DX2/66	7.1	3:04	▲▲▲▲	▲▲▲	▲▲▲	Color active	8.0
RUNNER-UP	NEC Versa V50	$4029	DX2/50	5.6	3:19	▲▲▲▲	▲▲▲	▲▲▲▲	Color active	8.5

Cost-conscious?

LOW COST Mitsuba Ninja II DX4-75

This under-$3000 notebook's trackball is placed slightly off-center below the space bar, so your palms rest comfortably for touch-typing. The unit ran for over 3½ hours on its nickel-cadmium battery, which is second-best in its processor class. The notebook uses a relatively large 10-inch Sharp dual-scan display that produces above-average colors. However, its overall performance is below average when compared to that of similarly configured units. The system documentation is subpar.

		PRICE	CPU	SPEED INDEX	BATTERY (HOURS: MINUTES)	SCREEN QUALITY	EASE OF USE	FEATURES	DISPLAY TYPE	TRAVELING WEIGHT (POUNDS)
BEST	Mitsuba Ninja II DX4-75	$2795	DX4/75	6.9	3:34	▲▲▲	▲▲	▲▲▲	Color dual-scan	8.0
RUNNER-UP	Austin Direct 466D	$2498	DX2/66	7.1	4:02	▲▲	▲▲▲	▲▲▲	Color dual-scan	7.0
RUNNER-UP	Micro-International Model 6500M	$2960	DX4/100	7.9	1:36	▲▲▲▲	▲▲	▲▲	Mono passive	7.0
RUNNER-UP	HyperData HB32Open	$2895	DX4/100	8.5	1:11	▲▲	▲▲▲	▲▲▲	Color dual-scan	8.5
RUNNER-UP	Samsung NoteMaster 3945T	$3049	DX2/50	5.6	2:21	▲▲▲▲	▲▲▲▲	▲▲▲	Color active	7.0
RUNNER-UP	Gateway ColorBook DX4-75	$3499	DX4/75	7.3	3:15	▲	▲▲▲▲	▲▲▲	Color dual-scan	7.0

Want one system for both the road and the office?

DESKTOP REPLACEMENT Toshiba T4800CT

The T4800CT's expansion capabilities include support for up to 24 MB of RAM and a 500-MB hard drive. The Western Digital 90C24A local-bus video adapter provides external resolutions of up to 1024 by 768 pixels with 256 colors. You can simultaneously add one Type III and one Type II PCMCIA card.

		PRICE	CPU	SPEED INDEX	BATTERY (HOURS: MINUTES)	SCREEN QUALITY	EASE OF USE	FEATURES	DISPLAY TYPE	TRAVELING WEIGHT (POUNDS)
BEST	Toshiba T4800CT	$6499	DX4/75	7.0	5:23	▲▲▲▲	▲▲▲▲	▲▲▲	Color active	8.0
RUNNER-UP	AST Ascentia 900N 4/75 CT10	$5949	DX4/75	7.5	3:23	▲▲▲▲	▲▲▲▲	▲▲▲▲	Color active	7.5
RUNNER-UP	Sager Midern NP3656D	$3735	Pentium/66	9.5	2:40	▲▲▲	▲▲▲	▲▲▲	Color dual-scan	9.0
RUNNER-UP	Micro-International Model 3600D	$3740	Pentium/66	9.3	2:20	▲▲▲	▲▲▲	▲▲▲	Color dual-scan	9.0
RUNNER-UP	Austin Direct 466C	$3489	DX2/66	7.1	3:04	▲▲▲▲	▲▲▲	▲▲▲	Color active	8.0

The Highest Point In Notebook Computing. The New ZEOS Meridian.™

The Meridian includes the latest and hottest features: high-speed local bus video for super-fast video performance, two PCMCIA slots, and an 84-key keyboard with inverted "T" arrow keys and a new integrated TruePoint™ pointing device.

Highest Quality, Superior Performance & Power Up To 100MHz

Finally, desktop power to go. Travel around the world or to the highest peak. Work at home, in the office or on a plane. With the ZEOS Meridian line of color notebooks, the choices are endless and the power is unearthly.

What makes the Meridian the perfect workmate? Durable, sturdy construction that will travel anywhere, incredible power and performance that will take you to new heights, and more options than a road map. To meet your needs exactly, we offer you power, speed and memory choices–genuine Intel 486SX-33, 486DX2-50 or DX4-100 microprocessor; 4 or 8MB RAM user upgradable to 20MB; and IDE hard drives from 175MB to 350MB.

Meridian 400C Subnotebook

If you like to travel light, the Meridian 400C, at just under four pounds, is your ideal traveling companion and ultimate subnotebook.

The 400C features a 7.8" diagonal, STN color, backlit screen (backlit monochrome display is also available); two Type II PCMCIA slots; and an ergonomic palm rest. Packages 2 and 3 also include an external ultra-light (9 oz.) 3.5" 1.44MB floppy drive.

Meridian 800C Notebook

At 6 pounds and change, the Meridian 800C is light enough to travel anywhere yet it's large enough to use for presentations and regular desktop computing. You get the best of both worlds!

The 800C also includes a dual-scan color, backlit screen for

easy viewing; two Type II or one Type III PCMCIA slots; an internal 3.5" 1.44MB floppy drive; and an ergonomic palm rest.

Buy With Confidence

No matter which ZEOS notebook you purchase, you can be assured you're getting the best service and support in the business! ZEOS has won six *PC Magazine* Readers' Choice for Service & Reliability awards. No company has won more. In addition, ZEOS was the first to provide 24-hour toll-free technical support for quick and accurate answers to your questions.

Reach the highest point in notebook computing with the new ZEOS Meridian Line. There's no limit. With its durable design, awesome performance and technologically-advanced features, you'll be able to keep in touch with the office, write memos, organize your calendar, and work on priority documents–wherever you are. For power that will take you to the ends of the Earth or to the highest peak, call a ZEOS Systems Consultant today at 800-554-5226.

EPA POLLUTION PREVENTER

Standard With Every ZEOS Meridian™:

- Genuine Intel 486SX-33, 486DX2-50 or DX4-100 microprocessor.
- 8K (DX4: 16K) internal system cache.
- RAM expandable to 20MB.
- IDE hard drive upgradable to 350MB.
- High-speed local bus video with 1MB video RAM.
- Display: 640 x 480 color VGA backlit LCD, up to 256 colors. 400C: 7.8" diagonal STN color. 800C: 10.3" diagonal DSTN color.
- Supports an external SVGA color monitor at resolutions up to 1024 x 768.
- PCMCIA slots: 400C: 2 Type II, 800C: 2 Type II or 1 Type III.
- 84-key keyboard with embedded numeric keypad and 12 dedicated function keys, inverted "T."
- Eraser-shaped integrated TruePoint™ pointing device.
- Replaceable, rechargeable NiMH battery.
- Serial port, enhanced parallel port, external VGA video port, external keyboard or PS/2 mouse port (800C includes both). 400C also with external floppy drive port.
- Full power management features include Low Power mode and programmable Standby features.
- AC-DC adapter with full range from AC110-240V to DC.
- 400C: 7.8" x 10.2" x 1.7"; 3.9 lbs. 800C: 8.9" x 11.7" x 1.9"; 6.3 lbs.
- EPA Energy Star compliant.
- FCC Certified Class B; UL Listed.
- ZEOS Customer Satisfaction package.

Processors	Package 1		Package 2		Package 3	
	400C	800C	400C	800C	400C	800C
486SX-33	$1995 Lease $73/mo.	$2295 Lease $84/mo.	$2295 Lease $84/mo.	$2495 Lease $91/mo.	$2595 Lease $95/mo.	$2795 Lease $102/mo.
486DX2-50	$2195 Lease $80/mo.	$2495 Lease $91/mo.	$2495 Lease $91/mo.	$2695 Lease $99/mo.	$2795 Lease $102/mo.	$2995 Lease $110/mo.
DX4-100	$2495 Lease $91/mo.	$2795 Lease $102/mo.	$2795 Lease $102/mo.	$2995 Lease $110/mo.	$3095 Lease $103/mo.	$3295 Lease $110/mo.
$300 off with monochrome display! (400C only)	➤ 4MB RAM ➤ 175MB IDE hard drive ➤ 800C only: Internal 3.5" 1.44MB floppy drive ➤ MS-DOS 6.2		➤ 4MB RAM ➤ 260MB IDE hard drive ➤ 3.5" 1.44MB floppy drive, 400C: External, 800C: Internal ➤ Custom carrying case ➤ MS-DOS 6.2 ➤ Microsoft Windows for Workgroups 3.11 ➤ Lotus Organizer		➤ 8MB RAM ➤ 350MB IDE hard drive ➤ 3.5" 1.44MB floppy drive, 400C: External, 800C: Internal ➤ Custom carrying case ➤ Extra battery ➤ MS-DOS 6.2 ➤ Microsoft Windows for Workgroups 3.11 ➤ Lotus Organizer	

Fax Orders: 800-362-1205 or 612-362-1205. Phone Orders: Outside U.S. and Canada: 612-362-1212, Government: 800-245-2449, ZEOS Information Systems, Inc. GSA #GS00K94AGS5176. Purchase Orders, MasterCard, VISA, Am Ex, Discover, COD and affordable leasing programs.

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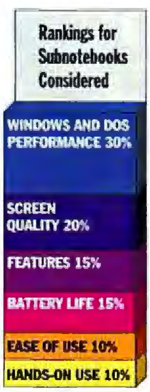
486-BASED SUBNOTEBOOKS

Although the Zenith Z-Lite 425L won top honors for best overall and low-cost, it faced some strong competitors in both categories. The AMS SoundWave 486 ($3250) combines top-notch performance, owing to its 75-MHz 486DX4 CPU (the only DX4 among the subnotebooks we tested) and 128-KB secondary memory cache.

The SoundWave 486 and the Compaq Contura Aero 4/33c Model 170 were the only color subnotebooks we tested, but based on these two examples, we found monochrome to be the better-quality screen type. The SoundWave's 9½-inch color dual-scan display from Hitachi is only average when compared to the screens on other subnotebooks. The Contura Aero's passive-matrix color display was among the poorest we saw in this sample.

The SoundWave's keyboard is the largest of the subnotebook keyboards; an integrated trackball sits in the middle of the wrist-rest area, below the space bar. Subpar documentation that lacked both comprehensiveness and clarity hurt the unit's overall ease-of-use rating. Battery life is also a weakness: The unit ran for under 2½ hours on its NiMH battery pack. AMS provides an impressive three-year warranty with the SoundWave.

The Gateway HandBook 486DX2-50 weighs only 5 pounds together with its battery pack and AC adapter, and it is the smallest subnotebook (1.6 by 9.75 by 5.9 inches) reviewed here. Its monochrome Sanyo display produces above-average-quality gray scales, which helped the unit achieve an excellent overall screen-quality rating. Gateway's quality documentation is excellent for novices. It features large, detailed diagrams and step-by-step instructions.



A drawback to the HandBook is its eraser-head pointing device, which is easily mastered but awkwardly placed to the right of the keyboard. Two mouse buttons are located on the front of the system below the keyboard. You need a special adapter to hook up a parallel device to the unit's nonstandard parallel port. The same port is used for its optional ($99) external floppy drive. There is no external video port, but an optional PCMCIA device can be used to hook up an external (640- by 480-pixel) VGA color monitor.

Toshiba's Portege T3400CT is the first portable we've tested with a lithium-ion battery. In our tests, battery life was over 6 hours (1½ hours longer than the Zenith Z-Lite 425L). Gray bars produced on the Portege's 8.4-inch monochrome display were below average, lacking definition in the light end of the spectrum. An eraser-head pointing device, located next to the *G* key, contributes to the unit's excellent ease-of-use rating. It also comes with a 3-year warranty.

The Compaq Contura Aero 4/33c Model 170 is another svelte unit. It weighs only 5 pounds with its optional ($159) external floppy drive, NiMH battery pack (which powered the unit for over 3½ hours), and relatively small AC adapter. The external floppy drive is a PCMCIA device that takes up the only PCMCIA slot when installed.

For fast speed and small size...

BEST OVERALL **Zenith Z-Lite 425L**

OCTOBER 1994 BYTE BEST 486-BASED SUBNOTEBOOK

An 8½-inch Epson monochrome display offers above-average gray-scale quality on this slim and lightweight (6 pounds, including floppy drive and adapter) system. The AC adapter attaches to the back of the external 3½-inch floppy drive. The combined unit then attaches to the left side of the system, giving the appearance of one seamless unit. A cable plugs directly into the AC adapter if the external floppy drive is not being used. But performance is not the forte of this 25-MHz 486SL-based system. In fact, it's the slowest of the five subnotebooks we reviewed. However, it ran for about 4½ hours on its NiMH battery back (second only to the Toshiba Portege T3400CT). Quality documentation adds to the usability of the unit.

		PRICE	CPU	SPEED INDEX	BATTERY (HOURS: MINUTES)	SCREEN QUALITY	EASE OF USE	FEATURES	DISPLAY TYPE	TRAVELING WEIGHT (POUNDS)
BEST	Zenith Z-Lite 425L	$1699	SL/25	3.6	4:28	▲▲▲▲	▲▲▲▲	▲▲▲	Mono STN	6.0
RUNNER-UP	AMS SoundWave 486	$3250	DX4/75	6.1	2:23	▲▲	▲▲▲	▲▲▲▲	Color dual-scan	6.5
RUNNER-UP	Gateway HandBook 486DX2-50	$2499	DX2/50	4.9	2:52	▲▲▲▲	▲▲▲	▲▲	Mono ISTN	5.0
RUNNER-UP	Toshiba Portege T3400CT	$2499	SX/33	4.0	6:09	▲	▲▲▲▲	▲▲▲	Mono passive	5.5
RUNNER-UP	Compaq Contura Aero 4/33c Model 170	$2517	SX/33	3.8	3:35	▲	▲▲▲	▲▲	Color passive	5.0

When price matters...

LOW COST **Zenith Z-Lite 425L**

With a test configuration price of $1699, the Zenith Z-Lite 425L is an excellent value for users who place more value on screen quality and battery life than on performance. The unit includes two Type II PCMCIA slots and an LED indicator with a multilevel battery gauge. A ROM-based Monitor program includes diagnostic utilities. The Z-Lite is backed by an industry-standard one-year warranty; extended warranties are available.

		PRICE	CPU	SPEED INDEX	BATTERY (HOURS: MINUTES)	SCREEN QUALITY	EASE OF USE	FEATURES	DISPLAY TYPE	TRAVELING WEIGHT (POUNDS)
BEST	Zenith Z-Lite 425L	$1699	SL/25	3.6	4:28	▲▲▲▲	▲▲▲▲	▲▲▲	Mono STN	6.0
RUNNER-UP	Gateway HandBook 486DX2-50	$2499	DX2/50	4.9	2:52	▲▲▲▲	▲▲▲	▲▲	Mono ISTN	5.0
RUNNER-UP	Compaq Contura Aero 4/33c Model 170	$2517	SX/33	3.8	3:35	▲	▲▲▲	▲▲	Color passive	5.0

KEY

Excellent ▲▲▲▲	Good ▲▲▲
Fair ▲▲	Poor ▲

BYTE BEST

PORTABLE PRINTERS

Need fast, high-quality printing?

BEST OVERALL **Mannesmann Tally MobileWriter**

OCTOBER 1994 BYTE BEST PORTABLE PRINTER

The MobileWriter is the heaviest (9½ pounds) printer we reviewed, but it's also the fastest and among the highest-quality. It prints using one-way ink-ribbon foils that install easily from the rear. An 80-page sheet feeder is integrated into the unit. The MobileWriter offers four standard emulations (which you select with DIP switches) and comes with a parallel interface. The standard nickel-cadmium batteries take up to 8 hours to recharge. The documentation would benefit from larger diagrams, but it is comprehensive. The more expensive MobileWriterPS supports PostScript (Level 1) and HP LaserJet Series II emulations; it also comes with a parallel port and an AppleTalk interface for Macintosh connections.

		PRICE	PRINTER TECHNOLOGY	BYTE SPEED INDEX (PPM)	PRINT QUALITY	BATTERY PACK	TRAVELING WEIGHT (POUNDS) [2]	MAXIMUM RESOLUTION (DPI)	PAPER INPUT (SHEETS)
BEST	Mannesmann Tally MobileWriter	$875	■	3.7	▲▲▲▲	Standard	9.5	300 × 300	80
RUNNER-UP	Olivetti JP 50	$399	★	1.7	▲▲▲▲	Optional	4.5	300 × 300	15
RUNNER-UP	Hewlett-Packard DeskJet 310	$455 [1]	★	1.9	▲▲▲	Optional	8.0	300 × 300	1 [3]
RUNNER-UP	Canon BJ-10sx	$349	★	1.4	▲▲▲	Optional	5.5	360 × 360	1
RUNNER-UP	Mannesmann Tally MobileWriterPS	$999	■	3.3	▲▲▲▲	Standard	9.5	300 × 300	80
RUNNER-UP	Hewlett-Packard DeskWriter 310	$455 [1]	★	1.3	▲▲▲▲	Optional	8.5	300 × 300	1 [3]
RUNNER-UP	Citizen Notebook Printer II	$399	■	0.9	▲▲▲▲	Standard	4.0	360 × 360	5
RUNNER-UP	Atlantic SlimWriter	$299	■	0.6	▲▲	Standard	4.0	360 × 360	1

[1] Includes optional sheet feeder ($76), which was used in testing.
[2] Includes battery, if standard.
[3] Not including sheet feeder, which is included in the price quoted here.

KEY

Excellent ▲▲▲▲ Good ▲▲▲
Fair ▲▲ Poor ▲

Printer technology:
Thermal ■ Ink-jet ★

We reviewed eight portable printers for traveling businesspeople who need to create invoices, bills, or other short documents while on the road. The printers range in price from $299 (for the Atlantic SlimWriter) to $999 (for the Mannesmann Tally MobileWriterPS).

Some offer true portability, with traveling weights of just 4 to 5 pounds. Others weigh 8 to 10 pounds—more than a typical notebook system—and require optional cut-sheet feeders for practical use. All print on transparencies and adhesive-backed labels, and only the Hewlett-Packard and Mannesmann Tally units do not print on envelopes.

The Mannesmann Tally printers use thermal-wax-transfer technology; the Citizen Notebook Printer II and Atlantic SlimWriter are thermal printers, and the other units are ink-jet models. All operate on both AC and battery power (battery power is optional on some models) and can draw power via an automobile cigarette-lighter adapter.

The Olivetti JP 50 received the highest print-quality rating, followed closely by the HP DeskWriter 310, Citizen Notebook Printer II, and the two Mannesmann Tally units. The HP DeskJet 310 and Canon BJ-10sx produce good-quality output. The Atlantic SlimWriter received only a fair print-quality rating, due mainly to its difficulty in printing distinct gray levels.

The easy-to-use Olivetti JP 50 can hold up to 15 sheets of paper. The 300-dpi printer includes a standard parallel interface and emulates the HP DeskJet 500. You can run the printer with nickel-cadmium, NiMH, or AA batteries. Ink cartridges are easy to install.

The HP DeskWriter 310 is primarily configured through software. It includes an AppleTalk interface and features a limited control panel that provides necessary status information but contains only three buttons. (Note: We tested the DeskWriter 310 with a Macintosh Quadra 640AV, while the other printers were tested with a Compaq Deskpro 66M, so the speed tests are not directly comparable.)

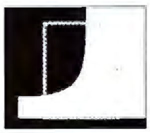
Printer Tests

Our printer performance tests evaluate the speed at which each printer produces five elements commonly found in standard documents: dense text, sparse text, bit-mapped text, graphics, and fonts. We tested printers using their default emulations and in the highest resolution available. The benchmarks run as an application under Microsoft Windows 3.1 on the PC or under System 7 on the Macintosh. Print servers, spoolers, and buffers were disabled during testing so the tests could measure the total time from the moment the first byte was sent until the last page exited the printer.

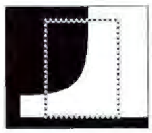
Print Quality and Usability

Our quality tests measure each printer's ability to draw a variety of lines and circles and print attractive, legible text in a wide range of sizes. They also test more esoteric features, such as a printer's paper-handling ability and how well it displays reversed (i.e., white-on-black) text and graphics.

We also considered paper handling, documentation, and design of the control panel. Features that receive special note in our scoring include a printer's ability to run on battery power, its traveling weight, the base input-tray capacity, and the availability of an automatic cut-sheet feeder. Finally, we used each printer during the test cycle and rated each model based on our overall impression of the unit.



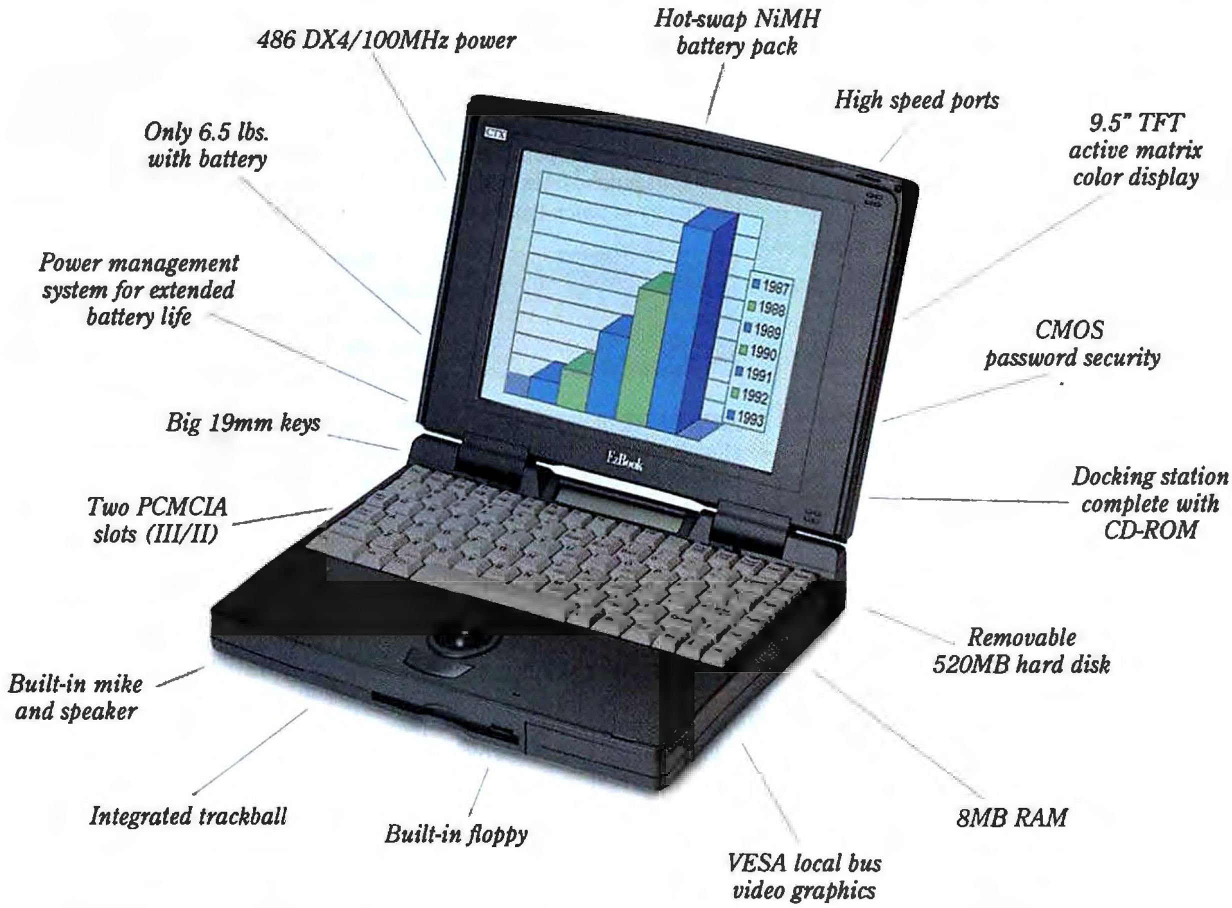
Ink-jet output



Thermal output

PC Magazine's Idea of the "Perfect Notebook."

CTX Introduces the Better-Than-Perfect Notebook.



Once again, CTX brings you more for less.

Introducing EzBook™, a powerful 486 notebook computer with all the great features PC Magazine calls for in its ideal, *hypothetical* notebook PC. And more.

More 486 DX4 power (100MHz) and 60 percent more disk capacity (520MB).

What's more, this better-than-perfect notebook is real and available now. And you can get one with its optional docking station complete with CD-ROM drive already built in for about the same low street price of $4500.

But if you're willing to settle for just a "perfect" EzBook notebook (PC Magazine's configuration), we can save you somewhere around $1000.

Or, if you want to save even more and be just slightly imperfect, get our economy EzBook with a monochrome or dual-scan screen, 4MB of RAM, a 260 MB disk, and no docking station for as low as $1549. You save nearly $3000.

More for less. That's just what we've been offering in color monitors for years. And now we outsell all the names you know best — like Sony, NEC, Mitsubishi, Samsung, and IBM.*

Who knows how successful CTX notebooks will be? But better-than-perfect isn't a bad place to start. Call 1-800-888-9052 ext. 301 for more information on where you can get the real, ideal notebook.

CTX

Circle 85 on Inquiry Card (RESELLERS: 86).

How We Tested

We assessed the performance of each notebook and subnotebook with BYTE's low-level benchmarks and with application and low-level Windows benchmarks developed by NSTL.

The BYTE low-level DOS benchmarks measure the performance of specific subsystems, such as the CPU, FPU, memory, video, and hard drive. Windows low-level tests determine how well a system can execute basic graphics calls. All Windows tests were executed in 640- by 480-pixel resolution in 16 colors, using vendor-specific video drivers (if supplied). In addition, NSTL's InterMark benchmark tests the low-level video throughput under Windows (system memory to screen, and system memory to system memory).

The application benchmarks consist of popular business applications for real-world performance measurements. For the DOS tests, we use WordPerfect 6.0, Lotus 1-2-3 release 3.x, and FoxPro 2.5. Our Windows application test suite includes Microsoft Excel 5.0, Microsoft Word 6.0, WordPerfect 6.0, and Microsoft FoxPro 2.6.

Our performance ratings are indexes. A system's performance rating for a single benchmark is the best time divided by the system's time. The weighted average of the indexes for the individual tests is used to generate the overall performance rating.

EASE OF USE

We worked extensively with each notebook and assessed the quality of each keyboard by concentrating specifically on key placement.

We evaluated pointing devices in terms of their placement and ease of use for both right- and left-handed users. We also considered the quality of the status indicators.

We also evaluated the ease of installing new batteries and upgrading the system RAM.

FEATURES

We asked each vendor to complete a detailed questionnaire that encompassed a full range of features. The individual features were weighted according to their importance and were used to calculate an overall features rating for each system.

SCREEN QUALITY

We evaluated three aspects of display quality: crispness, intensity/color range, and viewing-angle range. We ran numerous tests to examine clarity in both color and monochrome environments. We used DisplayMate Professional 1.0 from Sonera Technologies.

We measured the viewing-angle range of each display using a rotating platform that allowed us to move the test unit left and right until we detected visible distortion in the display.

To test color quality, we displayed a color bar on each of the color systems and divided displays into five categories.

BATTERY LIFE

We measured battery performance using BYTE's Thumper 2 battery-life tester. Thumper 2 re-creates real-world use by running a program that replicates a typical word processing session.

CONFIGURATION

Our testing was open to clock-doubled 486-class notebooks and 486-class subnotebooks running at any clock speed. We specified that the notebooks had to have a minimum of 8 MB of RAM, contain hard drives with a minimum capacity of 120 MB, and weigh less than 10 pounds with their battery, AC adapter, and power cord. Each notebook also had to have an internal 3½-inch floppy drive and a VGA display.

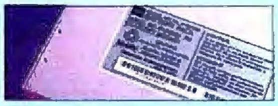
For inclusion in our review, subnotebooks had to contain 486-class processors and weigh less than 7 pounds with their battery packs, AC adapters, and external 3½-inch floppy drives. The units were configured with 8 MB of system RAM and IDE hard drives.

RAISING THE BAR ON EASE OF USE

Notebook designs continue to evolve with more functional, easier-to-use designs. Many advancements arrive first in the high-end models, such as the ones we tested for this report. Here are some design trends we noted.

TRACKBALLS Vendors used to scatter trackballs everywhere around their notebooks. In their latest incarnations, high-end notebooks generally have trackballs centered below the keyboard, often within a wrist-rest shelf. This design, popularized by the original PowerBooks, accommodates lefties and righties and keeps the fingers of touch-typists within an approximate range of the home row.

AUDIO Built-in sound, plus integrated speakers and microphones, are helpful tools if you are using a fast, local-bus-video notebook computer for presentations. Seven of the 24 notebooks we tested were configured for sound.



NIMH BATTERIES The 16 notebooks using the nickel-metal-hydride battery chemistry lasted an hour longer on average than those with more traditional nickel-cadmium batteries.

Contributors

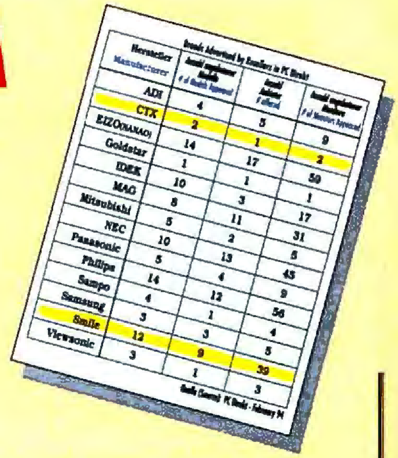
Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

Siva Kumar, *Senior Tester/NSTL, specializes in hardware and network-operating-systems testing.*

Anthony J. Lennon, *Project Manager/NSTL, evaluates portables, systems, peripherals, and network hardware.*

The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com; at NSTL, Inc., Plymouth Corporate Center, Plymouth Meeting, PA 19462; or at (610) 941-9600. Contact BYTE on the Internet or BIX at ajoch@bix.com or at (603) 924-9281.

WE ARE LEADING CTX IN EUROPE,
HERE WE COME, USA



Hersteller / Manufacturer			
ADI	4	5	9
CTX	2	1	2
EIZO(NANAO)	14	17	59
Goldstar	1	1	1
IDEK	10	3	17
MAG	8	11	31
Mitsubishi	5	2	5
NEC	10	13	45
Panasonic	5	4	9
Philips	14	12	56
Sampo	4	1	4
Samsung	3	3	5
Smile	12	9	39
Viewsonic	3	1	3

Here is an unbeatable proof that CTX is no where near Smile's popularity in Europe. According to the most popular PC magazine in Germany - PC Direkt Feb. 1994, Smile is one of the top brand-name monitors selected by resellers to represent their product lines.

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Circle 114 on Inquiry Card.

HONORABLE MENTIONS

The $3868 Canon Notejet II 486c is an intelligent solution for those who regularly need both a computer and a portable printer. The 9-pound unit features a built-in bubble-jet printer whose ink cartridge installs in a compartment located above the keyboard. You lift the keyboard to expose the paperfeed slot. A paper tray attaches to the rear of the unit where printed pages exit.

You can easily upgrade **the Panasonic CF-V21P notebook's LCD display (color, monochrome, or pen-type) by opening two latches, one located on each side of the display. Four types of attachable units are available for the system's Multimedia Pocket: a 1.44-MB Floppy Pack, a CD-ROM Pack that supports 3½-inch CD-ROM (180-MB) discs, a Video Pack that enables you to view video and TV on the full-size LCD screen, and a second NiMH battery pack.**

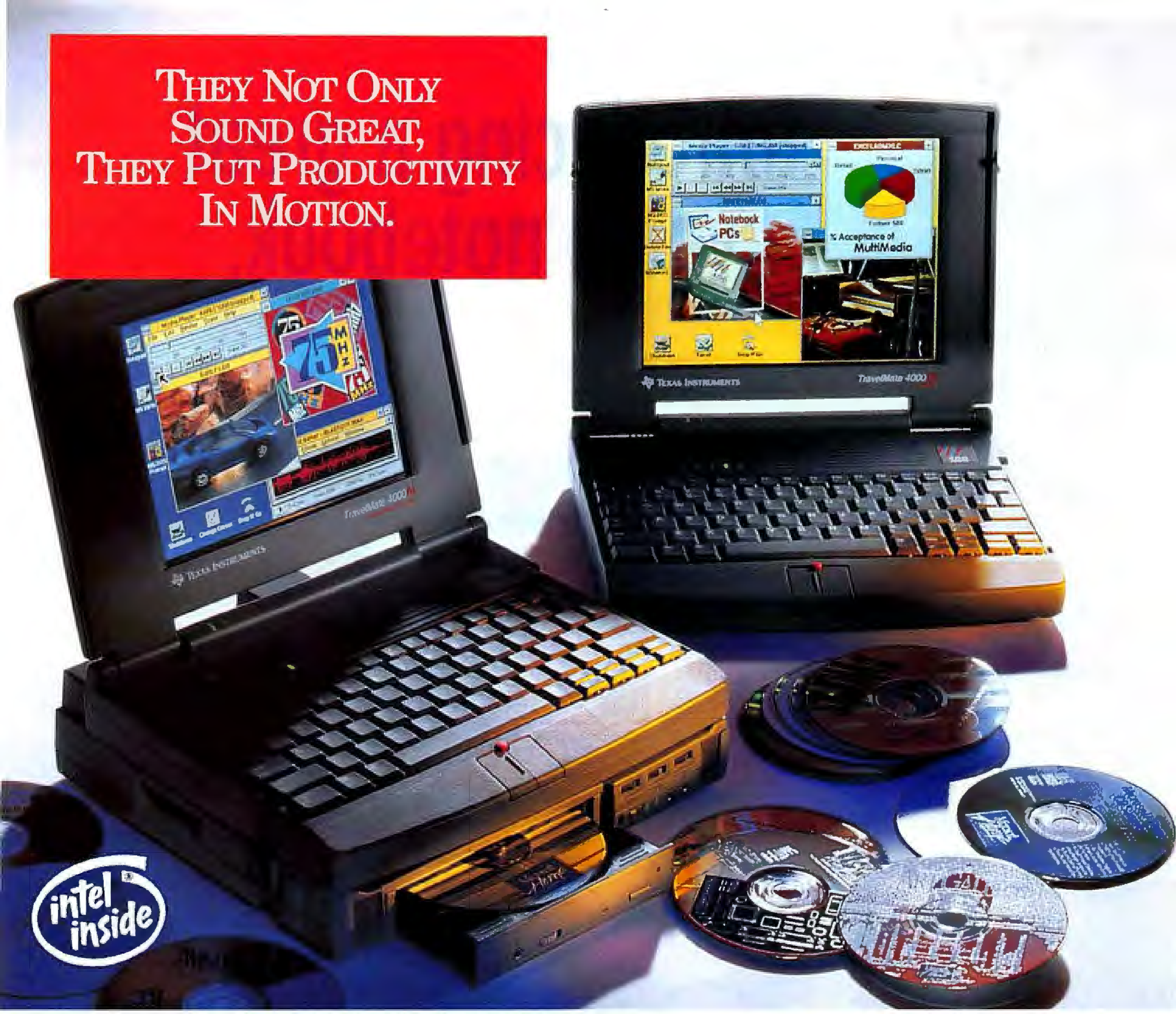
Adjustable legs on the Sager NP3656D **(below) allow typing at a variety of keyboard angles. Also, the HyperData HB320pen has a dedicated numeric keypad in the wrist-rest area, rather than an embedded or overlaid numeric keypad.**

An optional drive-bay adapter enables you to use the hard drive from the AST Ascentia 900N 4/75 CT10 in a standard desktop system. The hard drive in the adapter can act as the sole hard drive in a desktop system or used in conjunction with an existing hard drive.

Dubious Achievements

The Compaq Contura Aero 4/33c Model 170 subnotebook's optional external 1.44-MB floppy drive attaches to the system's Type II PCMCIA slot, precluding the use of an alternate PCMCIA device. The system's integrated pointing device is located on the bottom right corner of the wrist rest. Mouse buttons are awkwardly placed on the side of the system.

An AC adapter is optional ($45) with the Atlantic SlimWriter printer. The AC-powered battery charger included with the printer will not power the unit. It takes about 8 hours to recharge a fully depleted battery.



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TM4000M/25

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Circle 153 on Inquiry Card.

ROLL CALL OF PORTABLES TESTED

HIGH-PERFORMANCE NOTEBOOKS

VENDOR	MODEL	CPU	PRICE AS TESTED	SPEED INDEX	BATTERY LIFE (HR:MIN)	EASE OF USE	FEATURES	SCREEN QUALITY	SL ENHANCED CPU?	PROCESSOR VOLTAGE
Aero Computers	8466T250	Intel DX2/66	$1775	5.6	2:32	▲▲	▲▲▲	▲▲▲	✓	5.0
Ambra Computer Corp.	N75	Intel DX4/75	$3499	7.5	1:56	▲▲▲	▲▲▲	▲▲▲▲	✓	3.3
Amrel Technology	SLT 486DX2-66	Intel DX2/66	$2850	6.8	2:24	▲▲	▲▲▲	▲▲▲		5.0
Amrel Technology	SLT 486DX2-66	Intel DX2/66	$3750	6.8	1:57	▲▲	▲▲▲	▲▲▲▲		5.0
AST Research	Ascentia 900N 4/75 CT10	Intel DX4/75	$5949	7.5	3:23	▲▲▲▲	▲▲▲▲	▲▲▲▲	✓	3.3
Austin Direct	466C	Intel DX2/66	$3489	7.1	3:04	▲▲▲	▲▲▲	▲▲▲▲		5.0
Austin Direct	466D	Intel DX2/66	$2498	7.1	4:02	▲▲▲	▲▲▲	▲▲		5.0
CAF Technology, Inc.	Aqualite 2	Intel DX2/66	$3270	5.5	2:02	▲▲	▲▲	▲▲		5.0
Canon Computer Systems, Inc.	Notejet II 486c	IBM SLC2/50	$3868	4.4	1:58	▲▲▲	▲▲	▲▲▲	✓	4.0
CompuAdd	450 Colorpro	Intel DX2/50	$3695	5.3	2:33	▲▲▲	▲▲▲	▲▲▲▲		5.0
Gateway 2000	ColorBook DX4-75	Intel DX4/75	$3499	7.3	3:15	▲▲▲	▲▲▲	▲	✓	3.3
HyperData Technology Corp.	HB32Open	Intel DX4/100	$2895	8.5	1:11	▲▲▲	▲▲▲	▲▲	✓	3.3
Micro-International, Inc.	HCP Pentium Series Model 3600D	Intel Pentium/66	$3740	9.3	2:20	▲▲▲	▲▲▲	▲▲▲		5.0
Micro-International, Inc.	HCP Performance Model 6500M	Intel DX4/100	$2960	7.9	1:36	▲▲	▲▲	▲▲▲▲	✓	5.0
Micro-International, Inc.	HCP Performance Model 6500T	Intel DX4/100	$4460	7.4	1:49	▲▲	▲▲	▲▲▲▲	✓	5.0
Mitsuba Corp.	Ninja II DX4-75	Intel DX4/75	$2795	6.9	3:34	▲▲	▲▲▲	▲▲▲		3.3
NEC Technologies, Inc.	Versa V50	Intel DX2/50	$4029	5.6	3:19	▲▲▲	▲▲▲▲	▲▲▲▲	✓	3.3
Panasonic Personal Computer Co.	CF-V21P	Intel DX2/50	$4798	5.0	2:36	▲▲▲	▲▲▲	▲▲▲▲	✓	3.3
Sager Midern Computer, Inc.	NP3656D	Intel Pentium/66	$3735	9.5	2:40	▲▲▲	▲▲▲	▲▲▲		5.0
Samsung Electronics America	NoteMaster 3945T	Intel DX2/50	$3049	5.6	2:21	▲▲▲▲	▲▲▲	▲▲▲▲	✓	3.3
Texas Instruments, Inc.	TM4000E WinDX2/50 Active Color	Intel DX2/60	$3678	6.4	2:55	▲▲▲▲	▲▲▲	▲▲▲		5.0
Texas Instruments, Inc.	TM4000E WinDX4/75 Active Color	Intel DX4/75	$5578	8.6	3:21	▲▲▲▲	▲▲▲	▲▲▲	✓	3.3
Texas Instruments, Inc.	TM4000M DX4/75 Active Color	Intel DX4/75	$6178	8.5	3:13	▲▲▲▲	▲▲▲	▲▲▲	✓	3.3
Toshiba America Information Systems	**T4800CT**	**Intel DX4/75**	**$6499**	**7.0**	**5:23**	**▲▲▲▲**	**▲▲▲**	**▲▲▲▲**	**✓**	**3.3**

SUBS

VENDOR	MODEL	CPU	PRICE AS TESTED	SPEED INDEX	BATTERY LIFE (HR:MIN)	EASE OF USE	FEATURES	SCREEN QUALITY	SL ENHANCED CPU?	PROCESSOR VOLTAGE
AMS, Inc.	SoundWave 486	Intel DX4/75	$3250	6.1	2:23	▲▲▲	▲▲▲▲	▲▲	✓	3.3
Compaq Computer Corp.	Contura Aero 4/33c Model 170	Intel SX/33	$2517	3.8	3:35	▲▲▲	▲▲	▲	✓	5.0
Gateway 2000	HandBook 486DX2-50	Intel DX2/50	$2499	4.9	2:52	▲▲▲	▲▲	▲▲▲▲	✓	3.3
Toshiba America Information Systems	Portege T3400CT	Intel SX/33	$2499	4.0	6:09	▲▲▲▲	▲▲▲	▲	✓	3.3
Zenith Data Systems	**Z-Lite 425L**	**Intel SL/25**	**$1699**	**3.6**	**4:28**	**▲▲▲▲**	**▲▲▲**	**▲▲▲▲**	**✓**	**3.3**

PORTABLE PRINTERS

VENDOR	MODEL	PRICE	PRINTER TECHNOLOGY	BYTE SPEED INDEX (PPM)	EASE OF USE	PRINT QUALITY	MAXIMUM RESOLUTION (DPI)	STANDARD DRIVERS INCLUDED	SUPPORTS BATTERY POWER?
Atlantic Technologies, Inc.	SlimWriter	$299	■	0.6	▲▲	▲▲	360 × 360	DW	✓
Canon Computer Systems, Inc.	BJ-10sx	$349	★	1.4	▲▲▲▲	▲▲▲	360 × 360	W	OP
Citizen America Corp.	Notebook Printer II	$399	■	0.9	▲▲▲▲	▲▲▲▲	360 × 360	DW	✓
Hewlett-Packard Co.	DeskJet 310	$379	★	1.9	▲▲▲▲	▲▲▲	300 × 300	DW	OP
Hewlett-Packard Co.	DeskWriter 310	$379	★	1.3	▲▲▲▲	▲▲▲▲	300 × 300	A	OP
Mannesmann Tally Corp.	**MobileWriter**	**$875**	**■**	**3.7**	**▲▲▲**	**▲▲▲▲**	**300 × 300**	**MT1**	**✓**
Mannesmann Tally Corp.	MobileWriterPS	$999	■	3.3	▲▲▲	▲▲▲▲	300 × 300	MT1	✓
Olivetti North America	JP 50	$399	★	1.7	▲▲▲▲	▲▲▲▲	300 × 300	DW	OP

= BYTE Best. Printer technology: Thermal ■ Ink-jet ★ Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲ ✓ = yes.

FEATURES CONTINUE ON NEXT PAGE

RAM (MB) TESTED/MAX.	SECONDARY CACHE RAM (KB)	DISPLAY TYPE	SCREEN MANUFACTURER	LIGHTING	MAXIMUM INTERNAL RESOLUTION (PIXELS)	MAXIMUM EXTERNAL RESOLUTION (PIXELS)	COLORS/GRAYS (INTERNAL RESOLUTION)	DIAGONAL SCREEN SIZE (INCHES)	VIDEO PROCESSOR
8/20	0	Monochrome passive	Epson	Backlit	640 x 480	1024 x 768	64	9.5	Cirrus GD6235AD
12/20	0	Color active-matrix	Sharp, NEC	Backlit	640 x 480	1024 x 768	256	9.5	C&T 66540
8/52	0	Color dual-scan	Sharp	Backlit	640 x 480	1024 x 768	256	9.5	Cirrus GD6225/6235
8/52	0	Color active-matrix	Sharp	Backlit	640 x 480	1024 x 768	256	8.5	Cirrus GD6225/6235
8/32	0	Color active-matrix	Hitachi	Backlit	640 x 480	1024 x 768	256	10.0	WD 90C24
8/32	0	Color active-matrix	Hitachi	Backlit	640 x 480	1024 x 768	256	9.5	WD 90C24A2-ZZ
8/32	0	Color dual-scan	Hitachi	Backlit	640 x 480	1024 x 768	256	9.5	WD 90C24A2-ZZ
8/20	128	Color dual-scan	NEC	Backlit	640 x 480	800 x 600	64	9.0	Cirrus GD6225
12/12	0	Color dual-scan	Tottori Sanyo	Backlit	640 x 480	1024 x 768	256	10.3	WD 90C24
8/20	0	Color active-matrix	Toshiba	Backlit	640 x 480	1024 x 768	256	9.5	C&T 65535
8/20	0	Color dual-scan	Sanyo	Backlit	640 x 480	1024 x 768	256	10.3	Cirrus GD6235
8/20	128	Color dual-scan	Hitachi	Backlit	640 x 480	1024 x 768	256	9.4	Cirrus GD6235
8/40	0	Color dual-scan	Sanyo	Backlit	640 x 480	1024 x 768	256	10.3	Cirrus GD6440
8/20	0	Monochrome passive-matrix	Epson	Backlit	640 x 480	1024 x 768	64	9.5	Cirrus GD6235AD
8/20	0	Color active-matrix	Sharp	Backlit	640 x 480	1024 x 768	256	8.5	Cirrus GD6235AD
8/20	0	Color dual-scan	Sharp	Backlit	640 x 480	800 x 600	256	10.0	C&T 66540
8/20	0	Color active-matrix	NEC	Backlit	640 x 480	800 x 600	256	9.5	WD 90C24A2
8/20	0	Color active-matrix	Matsushita	Backlit	640 x 480	1024 x 768	256	10.4	WD 90C24A2
16/40	0	Color dual-scan	Sanyo	Backlit	640 x 480	1024 x 768	256	10.3	Cirrus GD6440
8/20	0	Color active-matrix	Samsung	Backlit	640 x 480	1024 x 768	64	9.4	WD 90C24A
8/20	0	Color active-matrix	Sharp	Edgelit	640 x 480	1024 x 768	256	8.4	Cirrus GD6420
8/20	0	Color active-matrix	Samsung	Edgelit	640 x 480	1024 x 768	256	9.5	Cirrus GD6440
8/20	0	Color active-matrix	Sharp	Edgelit	640 x 480	1024 x 768	256	8.4	Cirrus GD6440
8/24	0	Color active-matrix	INP [1]	Edgelit	640 x 480	1024 x 768	256	9.5	WD 90C24A
8/20	128	Color dual-scan	Hitachi	Backlit	640 x 480	1024 x 768	256	9.5	WD 90C24
8/12	0	Color passive-matrix	Compaq	Backlit	640 x 480	640 x 480	16	7.5	Compaq
8/20	0	Monochrome ISTN	Sanyo	Backlit	640 x 480	640 x 480	16	7.9	C&T 65510
8/20	0	Monochrome passive-matrix	INP [1]	Edgelit	640 x 480	1024 x 768	16	8.4	WD 90C24A
8/20	0	Monochrome STN	Epson	Backlit	640 x 480	1024 x 768	64	8.5	C&T 65535

OPERATES ON AC POWER?	SUPPORTS 220/240 AC VOLTAGE?	AUTOMOBILE ADAPTER AVAILABLE?	SIZE (INCHES) WIDTH	LENGTH	HEIGHT	TRAVELING WEIGHT (POUNDS) (WITH BATTERY IF INCLUDED IN SYSTEM PRICE)	PAGES PRINTED PER INK-MEDIUM UNIT	COST PER MONO INK-MEDIUM UNIT	COLOR INK MEDIUM AVAILABLE?
OP	OP	✔	12.0	8.5	1.0	4.0	20	$5	✔
✔	✔	✔	12.2	8.7	1.9	5.5	500	$25	
✔	✔	✔	11.7	4.1	2.0	4.0	50	$5	✔
✔	✔	✔	12.0	5.8	2.5	8.0	500	$22	✔
✔	✔	✔	12.0	5.8	2.5	8.5	500	$22	✔
✔	✔	✔	8.7	11.4	2.3	9.5	150	$15	
✔	✔	✔	8.7	11.4	2.3	9.5	150	$15	
✔	✔	✔	5.2	11.8	2.4	4.5	440	$19	

[1] INP = information not provided. N/A = not applicable. OP = optional.

ROLL CALL OF PORTABLES TESTED

HIGH-PERFORMANCE NOTEBOOKS

VENDOR	MODEL	VIDEO MEMORY INSTALLED (KB)	VIDEO MEMORY BUS WIDTH (BITS)	SYSTEM SIZE (INCHES) (H/W/D)	TRAVELING WEIGHT (POUNDS)	BATTERY CHEMISTRY	HARD DISK CAPACITY (MB) (TESTED/MAX.)	HARD DISK MANUFACTURER
Aero Computers	8466T250	512	16	1.7/11.0/8.6	7.0	Nicad	240/520	Conner
Ambra Computer Corp.	N75	1024	16	2.0/11.0/8.6	8.0	NiMH	340/450	Seagate
Amrel Technology	SLT 486DX2-66	512	16	1.80/11.6/8.7	7.5	NiMH	127/500	Quantum
Amrel Technology	SLT 486DX2-66	512	16	1.8/11.6/8.7	7.5	NiMH	127/500	Quantum
AST Research	Ascentia 900N 4/75 CT10	1024	32	1.6/11.5/8.5	7.5	NiMH	340/510	Toshiba
Austin Direct	466C	1024	32	2.0/11.1/8.58	8.0	NiMH	340/525	Toshiba
Austin Direct	466D	1024	32	2.0/11.1/8.58	7.0	NiMH	262/525	Toshiba
CAF Technology, Inc.	Aqualite 2	512	16	2.0/11.0/8.6	8.0	Nicad	120/540	Toshiba
Canon Computer Systems, Inc.	Notejet II 486c	1024	32	2.5/12.2/10.0	9.0	Nicad	130/260	Tomen
CompuAdd	450 Colorpro	512	32	2.0/8.66/11.4	8.0	NiMH	340/340	Toshiba
Gateway 2000	ColorBook DX4-75	512	16	1.7/11.7/8.5	7.0	NiMH	250/340	Toshiba
HyperData Technology Corp.	HB32Open	512	16	11.3/8.8/2.0	8.5	NiMH	262/525	Toshiba
Micro-International, Inc.	HCP Pentium Series Model 3600D	1024	32	2.3/11.1/10.3	9.0	NiMH	250/520	Conner
Micro-International, Inc.	HCP Performance Model 6500M	512	16	1.8/11.0/8.6	7.0	Nicad	328/520	IBM
Micro-International, Inc.	HCP Performance Model 6500T	512	16	1.8/11.0/8.6	7.5	Nicad	328/520	IBM
Mitsuba Corp.	Ninja II DX4-75	1024	32	1.75/11.0/8.2	8.0	Nicad	121/520	Quantum
NEC Technologies, Inc.	Versa V50	1024	32	2.0/11.7/9.6	8.5	NiMH	340/540	IBM
Panasonic Personal Computer Co.	CF-V21P	1024	32	1.9/11.7/8.7	8.0	NiMH	210/450	Seagate
Sager Midern Computer, Inc.	NP3656D	1024	32	2.3/11.14/1.31	9.0	NiMH	344/520	IBM
Samsung Electronics America	NoteMaster 3945T	1024	32	2.1/11.3/8.9	7.0	NiMH	262/262	Toshiba
Texas Instruments, Inc.	TM4000E WinDX2/50 Active Color	1024	16	2.1/11.0/8.5	7.5	Nicad	200/200	Seagate
Texas Instruments, Inc.	TM4000E WinDX4/75 Active Color	1024	16	2.1/11.0/8.5	7.5	Nicad	455/455	Seagate
Texas Instruments, Inc.	TM4000M DX4/75 Active Color	1024	16	1.9/11.0/8.5	7.0	NiMH	340/340	Seagate
Toshiba America Information Systems (BYTE Best)	**T4800CT**	**1024**	**16**	**2.2/11.7/8.3**	**8.0**	**NiMH**	**500/500**	**Toshiba**

SUBS

VENDOR	MODEL	VIDEO MEMORY INSTALLED (KB)	VIDEO MEMORY BUS WIDTH (BITS)	SYSTEM SIZE (INCHES) (H/W/D)	TRAVELING WEIGHT (POUNDS)	BATTERY CHEMISTRY	HARD DISK CAPACITY (MB) (TESTED/MAX.)	HARD DISK MANUFACTURER
AMS, Inc.	SoundWave 486	1024	32	1.6/11/8.5	6.5	NiMH	340/520	IBM
Compaq Computer Corp.	Contura Aero 4/33c Model 170	512	16	1.7/1.25/7.5	5.0	NiMH	172/250	Compaq
Gateway 2000	HandBook 486DX2-50	16	8	1.6/9.75/5.9	5.0	NiMH	250/250	Toshiba
Toshiba America Information Systems	Portege T3400CT	1024	16	1.7/9.9/7.9	5.5	Lithium-ion	120/120	Toshiba
Zenith Data Systems (BYTE Best)	**Z-Lite 425L**	**256**	**16**	**1.5/9.9/7.6**	**6.0**	**NiMH**	**170/170**	**Seagate**

PORTABLE PRINTERS

VENDOR	MODEL	OPERATING NOISE LEVEL (DB)	STANDARD INTERFACES: PARALLEL	RS-232C	RS-422A	LOCALTALK	RESIDENT TYPEFACES	STANDARD EMULATIONS: HP LASERJET II (PCL4)	EPSON LQ	IBM PROPRINTER
Atlantic Technologies, Inc.	SlimWriter	47	✔	OP	OP		4		✔	✔
Canon Computer Systems, Inc.	BJ-10sx	45	✔				1		✔	✔
Citizen America Corp.	Notebook Printer II	45	✔		✔		5		✔	✔
Hewlett-Packard Co.	DeskJet 310	58	✔				4			
Hewlett-Packard Co.	DeskWriter 310	58			✔	✔	11			
Mannesmann Tally Corp. (BYTE Best)	**MobileWriter**	**46**	**✔**				**14**	**✔**	**✔**	**✔**
Mannesmann Tally Corp.	MobileWriterPS	48	✔			✔	39	✔		
Olivetti North America	JP 50	37	✔				6			

(BYTE Best) = BYTE Best. ✔ = yes. N/A = not applicable. OP = optional.

UART	CENTRONICS PARALLEL PORT [2]	TYPE OF POINTING DEVICE [5]	PCMCIA SLOTS	INTEGRATED SOUND?	INTEGRATED MICROPHONE?	FCC RATING	NUMBER OF KEYBOARD KEYS	SWITCHABLE TO 220/240 AC VOLTAGE?	DOCKING STATION PRICE	WARRANTY LENGTH (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
16450	B	INT	2 II or 1 III			B	86	✔	$425	1	(212) 971-0285	(800) 232-1050	1354
16450	EPP	INT	2 II or 1 III	✔	✔	A	101	✔	$399	1	(919) 713-1550	(800) 252-6272	1355
8250	B	PO	2 II			B	84	✔	$560	1	(818) 303-6688	(800) 882-6735	1356
8250	B	PO	2 II			B	84	✔	$560	1	(818) 303-6688	(800) 882-6735	1357
16550	EPP	INT	2 II or 1 III			B	82/83 [3]	✔	$487	3	(714) 727-4141	(800) 876-4278	1359
16450	B	INT	2 II or 1 III			B	85	✔	$299	1	(512) 339-3500	(800) 752-1577	1360
16450	B	INT	2 II or 1 III			B	85	✔	$299	1	(512) 339-3500	(800) 752-1577	1361
8250	B	INT	2 II or 1 III			B	86	✔	$499	1	(818) 369-3690	None	1362
16450	B	INT	2 II or 1 III			B	84	✔	N/A	1	(714) 438-3000	(800) 445-2780	1363
16550	B	INT	2 II or 1 III	✔	✔	B	84	✔	$89 [4]	1	(512) 250-1489	(800) 627-1913	1364
16550	B	PO	2 II or 1 III			B	85	✔	N/A	1	(605) 232-2000	(800) 846-2000	1365
16450	B	INT	2 II or 1 III			B	84/85 [3]	✔	N/A	1	(909) 468-2950	None	1366
16550	EPP	INT	1 II and 1 III	✔	✔	B	86	✔	$520	1	(713) 495-9096	(800) 967-5667	1367
16450	B	INT	2 II or 1 III			B	86	✔	$520	1	(713) 495-9096	(800) 967-5667	1368
16450	B	INT	2 II or 1 III			B	86	✔	$520	1	(713) 495-9096	(800) 967-5667	1369
16450	B	INT	2 II or 1 III	✔	✔	B	85	✔	$495	1	(909) 392-2000	(800) 648-7822	1370
16450	EPP	INT	2 II or 1 III			B	83	✔	$629	3	(408) 433-1250	(800) 388-8888	1371
16450	B	INT	2 II or 1 III			B	84	✔	$999	1	(201) 271-3182	(800) 742-8086	1372
16550	EPP	INT	1 II and 1 III	✔	✔	B	86	✔	$475	1	(818) 912-8786	(800) 669-1624	1373
16450	B	INT	1 II and 1 III			B	84	✔	$52 [4]	2	(201) 229-4000	(800) 726-7864	1374
16450	U	QuickPort	None			B	83	✔	$849	1	(817) 771-5856	(800) 848-3927	1375
16450	U	QuickPort	None			B	83	✔	$849	1	(817) 771-5856	(800) 848-3927	1376
16550	EPP	INT	2 II or 1 III	✔	✔	B	84	✔	$849	1	(817) 771-5856	(800) 848-3927	1377
16450	B	QuickPort	1 II and 1 III	✔	✔	B	82	✔	$649	3	(714) 583-3000	(800) 334-3445	1378
16550	EPP	INT	2 II or 1 III	✔	✔	B	83	✔	$595	3	(818) 814-8851	(800) 886-2671	1379
16550	EPP	INT	1 II			B	76	✔	$99 [4]	3	(713) 370-0670	(800) 345-1518	1381
16450	B	INT	1 II			B	78	✔	N/A	1	(605) 232-2000	(800) 846-2000	1382
16450	B	INT	1 II			B	82	✔	$239 [4]	3	(714) 583-3000	(800) 334-3445	1383
16550	EPP	LitePoint	2 II			B	82	✔	N/A	1	(708) 808-5000	(800) 582-0524	1384

IBM GRAPHICS	OTHER EMULATIONS	PAPER INPUT (SHEETS)	AUTOMATIC FEEDER PRICE	AUTOMATIC FEEDER CAPACITY (SHEETS)	HANDLES ENVELOPES?	HANDLES TRANSPARENCY FILM?	HANDLES ADHESIVE-BACKED LABELS?	MAXIMUM PAPER WEIGHT (POUNDS)	FCC RATING	WARRANTY LENGTH (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
	ATLAN1	1	$99	20	✔	✔	✔	22	B	2	(910) 350-0700	(800) 779-7705	1346
	CAN1	1	$90	100	✔	✔	✔	28	B	2	(714) 438-3000	(800) 423-2366	1347
	CIT1	5	$69	30	✔	✔	✔	28	B	2	(310) 453-0614	None	1348
	HP1	1	$99	60		✔	✔	24	B	1	None	(800) 752-0900	1349
	NA	1	$99	60		✔	✔	24	B	1	None	(800) 752-0900	1350
✔	MT2	80	Standard	80		✔	✔	24	B	1	(206) 251-5524	(800) 843-1347	1351
	MT3	80	Standard	80		✔	✔	24	B	1	(206) 251-5524	(800) 843-1347	1352
	OLIV2	15	Standard	15	✔	✔	✔	20	A	1	(509) 927-5600	(800) 255-4319	1353

[2] B = bidirectional; EPP = enhanced parallel port; U = unidirectional port.
[3] An extra function key for international language use is provided.
[4] Port replicator.
[5] Int = integrated; PO = popout.

Alpha Rides High

The Alpha 21164 puts DEC firmly at the top of the performance pyramid

BOB RYAN

When talking about the new Alpha 21164 from DEC, it's impossible to avoid using superlatives. The 21164 is the fastest microprocessor in the world. It contains the most transistors and, coincidentally, also has the largest-capacity on-chip caches. It's the first general-purpose MPU (microprocessor unit) with an on-board second-level cache. Finally, it has the fastest clock of all commercial microprocessors.

At 330 SPECint92 and 500 SPECfp92, the 21164 far outclasses current-generation microprocessors such as the HP-PA 7200, the IBM Power2, and DEC's own Alpha 21064A, all of which deliver in the neighborhood of 175 SPECint92. The 21164 delivers three times the integer performance of the 100-MHz Pentium and 66 percent more floating-point power than the Mips R8000/8010, a processor specifically designed for floating-point-intensive operations. DEC likes to point out that the 21164 can perform 600 transactions per second, compared to 241 for a dual 66-MHz Pentium-based Compaq ProLiant 2000.

In short, the 21164 is a "take no prisoners" microprocessor. It's the first to execute over 1 billion instructions per second (actually 1.2 BIPS, to be exact as you can with such an elusive measure as instructions per second).

By the Numbers

The 21164 has 9.3 million transistors, most of which are for cache memory. Like other Alphas, it has an 8-KB direct-mapped instruction cache and an 8-KB direct-mapped data cache. What makes the 21164 different is its 96-KB, three-way set-associative, unified L2 (level 2) cache. Putting the L2 cache on-chip greatly reduces the average latency of a memory access that misses the primary caches.

The 21164 is a refinement of DEC's RISC philosophy. More than any other company, DEC keeps its instructions and processing pipelines simple. This keeps the latency of any stage in the pipeline low and lets DEC boost the clock speed to boost performance. The 21164 runs at two speeds: 266 and 300 MHz. The external bus can run at any integer divisor of the processor clock from 1 to 15. The processor also provides support for an L3 cache.

How It Works

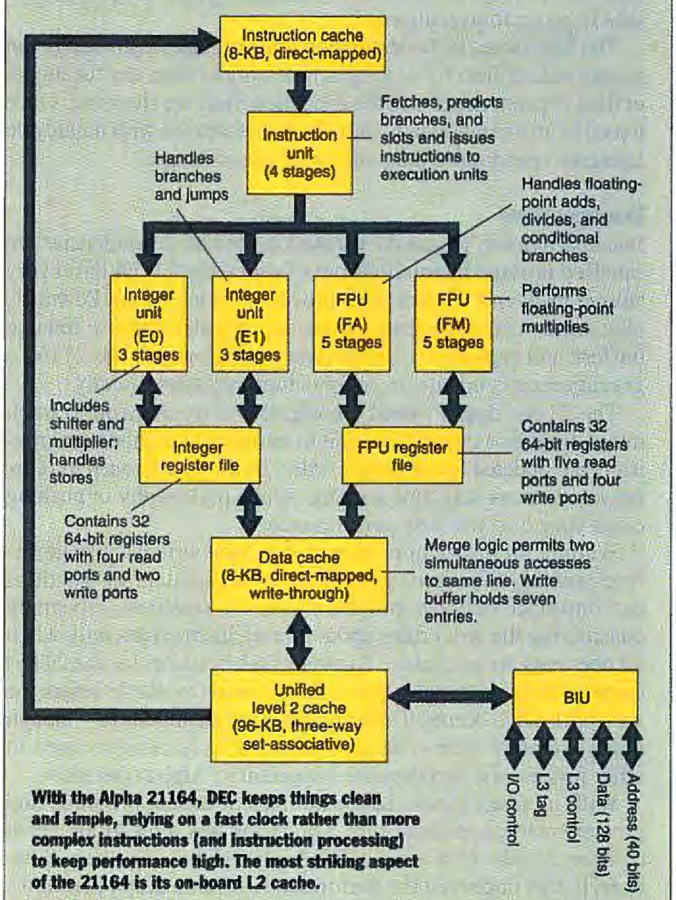
The 21164 contains four execution units and can issue up to four instructions—two integer and two floating-point—per clock cycle. The two integer units are not identical, although each has an ALU and both perform loads. One unit—E0 in DEC nomenclature—has the necessary circuitry to perform stores, shifts, and integer multiplies. The other unit, E1, handles branch processing in addition to common integer instructions.

The FPUs also differ from one another. The floating-point add pipeline, FA, handles addition, division, and floating-point conditional branches; FM, the multiplication pipeline, does the multiplying. The 21164 contains both an integer-register and a floating-point-register file. To handle multiple, simultaneous accesses from the execution units, the integer-register file has four read ports and two write ports, while the floating-point-register file has five and four ports, respectively.

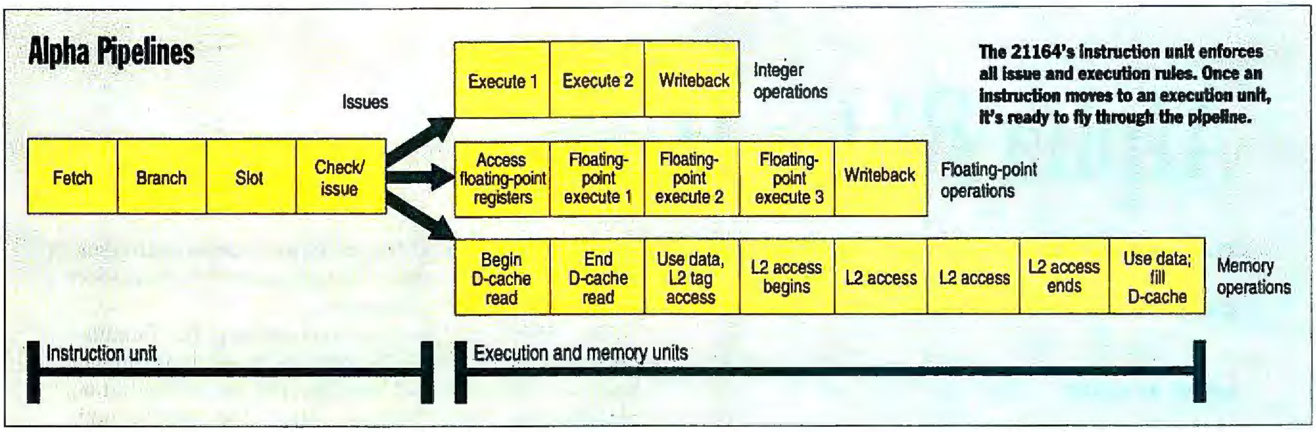
Like earlier Alphas, the 21164 features fairly deep pipelines. The first four stages are common to all instructions and occur in the instruction unit. The integer units add three stages to instruction processing, for a total of seven stages; the floating-point units require five stages to perform their functions.

continued

21164 Microarchitecture



With the Alpha 21164, DEC keeps things clean and simple, relying on a fast clock rather than more complex instructions (and instruction processing) to keep performance high. The most striking aspect of the 21164 is its on-board L2 cache.



The 21164's instruction unit enforces all issue and execution rules. Once an instruction moves to an execution unit, it's ready to fly through the pipeline.

The instruction unit consists of the following stages: instruction prefetch, buffer, and decode—including branch prediction, slotting, and instruction issue. In the prefetch stage, the instruction unit retrieves four instructions at a time from the instruction cache. It next checks for branches and predicts them based on 2 history bits. The third stage of instruction processing slots four instructions for issuing. If these four instructions can't issue to four different execution units, the second stage stalls until all four of the current instructions are issued. The instruction unit's final stage checks operand registers for dependencies and reads the integer-register file. Again, all preceeding stages will stall if any instruction in this stage can't be issued. All source operands must be available by the end of this stage for the instruction to be able to move to execution.

The four stages in the instruction unit are static; instructions can remain stalled there for as long as necessary to clear any functional or data dependencies. But the execution units are dynamic. Once issued to an execution unit, only those instructions with multicycle latencies spend more than one cycle in each stage.

Execution Time

Because it doesn't issue an instruction until all dependencies are satisfied or issue instructions out of order, the 21164 has a very simple back end. Unlike with processors such as the PowerPC 604, which can issue instructions out of order and use rename buffers and registers to avoid data dependencies, the 21164's execution units update the architectural registers directly.

The 21164 doesn't need a complicated mechanism to track instructions or a completion unit to ensure that architectural registers are updated in the proper order. Its direct approach to retiring instructions is in tune with the Alpha philosophy of pushing clock speeds to increase performance.

Waiting for instructions to proceed to the writeback stage before making their results available to subsequent instructions can introduce bubbles into the execution pipelines, especially considering the strict rules about issuing instructions only when all operands are available. To avoid such bottlenecks, the 21164 comes with bypass routes that make operands available before the writeback stage occurs. These bypasses are analogous to—though more extensive than—the feed-forwarding techniques used in other processors, and they are important to Alpha operation.

With its faster clock, larger number of execution units, and greater instruction-issue rate, the 21164 has a lot going for it compared to the 21064 and 21064A. DEC didn't stop there, however; it also improved the performance of some key operations. For example, the 21164 reduces the latency of floating-point operations from six cycles to four, and L1 data-cache accesses have been cut from three cycles to two.

Such cycle counts may still seem high compared to those of other processors—many take just one cycle to access the data cache, for example—but remember that the 21164's clock ticks much faster. Two cycles on the 21164 take less time than one cycle on the 100-MHz PowerPC 604, which means that cache lookup is actually faster on the 21164. Of course, because the PowerPC 604 has larger, more complex caches, it has a higher hit rate. Such are the trade-offs that microprocessor designers face.

To Market

The 21164 comes in a 499-pin ceramic PGA (pin-grid array) with an integrated slug for mounting a heat sink. It's built with the same 0.5-micron process (for a 0.35-micron effective line length) used for the 21064A. Samples will ship in October, with the 266-MHz version available in at least limited volumes in January. The 300-MHz version will be available in volume in March.

DEC believes it can meet this aggressive schedule because the 21164 is being produced on a tried-and-true process. DEC will also have a core logic/PCI (Peripheral Component Interconnect) chip set available at the same time as the 266-MHz version of the 21164, and an evaluation board will be available in December.

The 266-MHz version of the 21164 will sell for $1865 each in lots of 5000, while the 300-MHz version will go for $2669 each, about what you'd currently pay for three 100-MHz Pentiums. This pricing reflects DEC's strategy to offer single-chip performance that no other vendor can.

While the 21164's performance advantage will shrink soon with expected announcements about new UltraSparc, Mips, and PowerPC processors, it's highly unlikely that any of these will best 300SPECint92. The Alpha's performance lead seems secure for a long time. Also, a move to DEC's 0.35-micron process, which should be on-line sometime next year, should provide the 21164 with a nice midlife die shrink, which will certainly make it less expensive to produce and may lead to increased performance.

While the 21164 will undoubtedly appear in DEC systems that run Unix and VMS, the company is concentrating its merchant chip efforts on Windows NT. The Alpha architecture leads Mips in the number of supported NT applications, and it enjoys an 18-month to two-year advantage over NT on the PowerPC. If a high-end desktop-and-server market for NT does develop, then DEC's future will be brighter than its immediate past. ■

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QNX Forges Ahead

Outfitted with a new graphics microkernel, this compact, modular, and efficient real-time operating system supports an expanding range of applications

PETER D. VARHOL

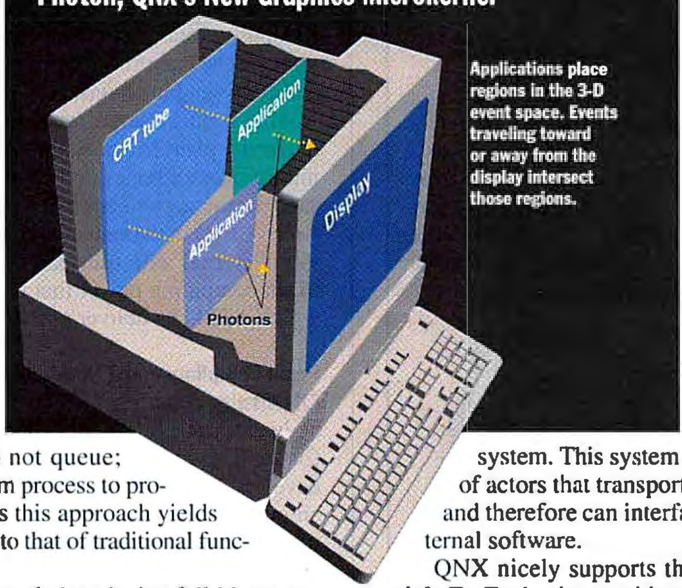
While the trade press obsessively focuses on Windows NT, OS/2, Chicago, and Unix, one elegant operating system that rarely makes headlines is QNX Software's QNX. Yet its list of features is impressive. QNX delivers 32-bit performance, achieves superb modularity thanks to its pure microkernel architecture, passes messages in a network-transparent way, and complies with Posix. It offers the benefit of looking and feeling a lot like Unix, without the cost (in overhead) of being Unix.

The heart of QNX is its tiny 8-Kb microkernel. Because this microkernel can fit entirely into the on-chip caches of the Intel 486 and the Pentium, kernel calls execute very quickly. The microkernel's four main functions—interprocess communication, network communication, process scheduling, and interrupt dispatch—are exposed through a compact API. There are only 14 system calls.

QNX is a message-passing operating system. It uses blocking versions of Send, Receive, and Reply function calls. Messages do not queue; rather, they're copied from process to process. QNX Software says this approach yields performance comparable to that of traditional function calls.

Of course, the microkernel alone isn't a full-blown operating system. It lacks a file system, device management, and a command-line interpreter. These and other modules can be added to QNX to complete the package. The resulting operating system is correspondingly larger, but it's still quite small and capable compared to the 32-bit operating systems popular today.

Photon, QNX's New Graphics Microkernel



The microkernel itself is useful in two ways. First, it can be used as-is in an embedded system as a resource manager. Embedded systems usually do not require a file system or any of the other traditional user-level parts of an operating system. The microkernel and process manager alone can handle many embedded applications, such as electronic sensors or process control systems.

Second, the microkernel can perform all the kernel-level operations needed to support a more complete operating system. Its small size means that it requires less memory, leaving more memory for user-level programs. Although the QNX microkernel runs only on the x86 family of processors, it might be thought of as a hardware abstraction layer, shielding the systems programmer from the details of the underlying hardware. Additional modules can be developed to customize the operating system in a number of different ways.

Real-Time Distributed Systems

QNX has made its reputation in the real-time arena, typically supporting data acquisition and process control applications. For FasFax (Nashua, NH), a leading developer of point-of-sale terminals for the fast-food industry, the ability to add custom modules to QNX was a compelling feature. FasFax uses QNX as the underlying executive for a distributed, real-time, point-of-sale information gathering and analysis system.

The FasFax development team, made up of operating-system hackers rather than the traditional MIS types that are more common in point-of-sale development, has built its own distributed message-passing architecture on top of the QNX system. This system implements the concept of actors that transport requests and responses and therefore can interface with a variety of external software.

QNX nicely supports this approach. Eric Strovink, FasFax's vice president of engineering, says no other modern operating system offers the same combination of portability, robustness, and cost effectiveness. The FasFax operating-system gurus use QNX message-passing only as the underlying transport mechanism for their own actors. Thanks to QNX's high performance and modularity, they can customize the surrounding environment to suit the needs of a modern, distributed, point-of-sale system while QNX handles the kernel-level management of processes and devices.

Message Passing for a Multiprocessor Solution

Other people highly value QNX's transparent networking, which relies on its intrinsic message passing. The network manager is not a part of the microkernel but is tied directly into it. There is a private interface between the kernel and the network manager, so that any messages passed from a local process to a remote process are queued directly to the network manager. This manager, called *net*, manages the sending and receiving of messages without regard to whether they are local or remote. In effect, the manager merges microkernels on separate nodes into a single, virtual microkernel.

The message-passing architecture, combined with networking services, effectively produces a seamless distributed system. From the standpoint of user processes, there is no difference between a local call and a call across the network. Likewise, all services above the microkernel are transparently accessible to all processes, whether or not they are local. For data acquisition purposes, QNX can also make use of a private connection between microkernels on a network. This lets the kernels share information about a data acquisition process without generating a lot of network traffic.

Both the seamless networking and the private data acquisition bus made QNX attractive to Georgia State University, which is using QNX to develop a conferencing system to support a remote learning initiative. The problem was how to apply as much computing power as possible, at the lowest possible cost, to multiuser inputs arriving via an ATM communications facility. According to engineer Hal Trebes, Georgia State is using a multiprocessor Intel box with a built-in SCSI bus between the CPUs, in addition to the standard PC ISA bus. Georgia State is using the SCSI bus for interprocess communication between CPUs, and the ISA bus to route input from an ATM-based telecommunications system. The interprocess communication will make use of QNX's ability to send messages between kernels along its private bus.

After getting a single multiprocessor system up and running, the university plans to extend the same technology to network several multiprocessor boxes and communicate among them with message-passing techniques that were established to communicate between CPUs in the same multiprocessor box. The result will be a virtual kernel with transparent interprocess computing, and so much computing power that the gating factor will be the rate at which ATM can deliver packets to the network.

Posix Compliance and Portability

QNX fully complies with Posix 1003.1 (APIs for process management, device I/O, and file-system I/O) and 1003.2 (syntax for shell and utilities). Code written to the Posix APIs can be developed in a familiar environment and then cross-compiled to an embedded system running the QNX microkernel. Alternatively, you can develop code directly on QNX using the Watcom 32-bit C compiler and port it to other platforms. (The FasFax development team relied on both strategies.) QNX also adheres to the draft standard for Posix 1003.13, minimal real-time systems.

I've been porting a conferencing system from SCO Unix to QNX. The source code and shell scripts I'm working with were written as generically as possible, and the port has been a breeze. I've only had to modify some pointers and type casts from the original source code and to make sure that some of the system calls worked in the same way. From the standpoint of an applications developer, QNX feels very much like Unix, with the differences rarely noticeable.

Photon and X for Windowing

In June, QNX Software announced initiatives supporting windowing systems and GUIs for QNX. Photon, QNX's new graphics microkernel, is built on the same principles as the QNX microkernel itself. It's a resource manager for graphical regions and events (which QNX refers to as *photons*). The Photon microkernel is about 20 KB of code plus 40 KB of data. Other necessary parts for a PDA (personal digital assistant) system include some shared libraries, VGA (or other) graphics drivers, and a pen-input driver. The total amount of memory needed for code and data is about 250 KB.

Photon doesn't assume that the end product is going to be a windowing system, and it doesn't include the window manager within the microkernel. This approach lends itself to a lightweight implementation for PDAs that don't use overlapping windows. If you do add Photon window manager, it costs an additional 30 KB of code and 64 KB of data.

FasFax's Strovink is excited about Photon and plans to move from his product's existing windowing manager to Photon—not only for compactness, but also for portability. The Photon microkernel uses APIs through its binary interface library that are compatible with X Window System.

QNX also comes with an implementation of an X server, announced at the same time as Photon. This X utilizes the QNX message-passing scheme for communication between QNX kernels, and TCP/IP for communication with other X servers. It is a full X11.5 implementation, with the Motif window manager, scalable fonts, and font server. The Photon APIs are a subset of the windowing and Motif APIs used for this implementation.

What is the purpose of a full X implementation on QNX? Process control systems do require human intervention. A manufacturing process, for example, can be monitored and controlled by a touchscreen at a supervisor's station. Accordingly, QNX Software has developed touchscreen drivers for its implementation of X.

Keep It Simple

QNX continues to maintain a compact and robust environment; its message-passing architecture ensures modularity and can be readily extended. New modules can be developed in user space and debugged at source level, and then deployed as kernel-level services. Thanks to the small number of APIs in the kernel and the limited number of APIs in the other QNX-provided components, systems-level programming is relatively straightforward, and the resulting code can be very reliable.

Clearly, QNX is an operating system to be reckoned with in the future. While many experts claim that message passing slows the performance of an operating system, numbers published by QNX Software indicate that QNX performs on a given Intel-based machine as well as, or better than, Unix. While its widespread adoption is limited by a lack of off-the-shelf applications software, surely there are enough real-time projects and custom software development efforts to keep this elegant operating system thriving well into the future. ■

Peter D. Varhol is chair of the graduate computer science and mathematics department at Rivier College in Nashua, New Hampshire. He can be reached on the Internet or BIX as pvarhol@bix.com.

URGENT—YOUR INPUT NEEDED

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Computer Security

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___peer-to-peer LAN

___server-based LAN

___multisegment LAN

___LAN connected to mini or mainframe host

___LAN connected to a metropolitan-area network

___LAN connected to a WAN

Do you have an Internet connection?

___Yes ___No

If so, what type?

___direct ___through a commercial service ___dial-up

Do you provide some type of physical access security on your network?

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Do you encrypt data for transmission over public networks?

___Yes ___No

Have you ever suffered financial loss due to unauthorized use of data?

___Yes ___No

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Charting the Uncharted

A road map to porting shared memory, process management, and semaphore calls from Unix to Windows NT

STEVE NIEZGODA

If you develop Unix applications, market dynamics may eventually force you to come face to face with Windows NT. The good news is that the two operating systems have a lot in common: Both are based on abstractions like multiple processes, virtual memory, and networking. But while much Unix functionality exists in NT, the trick from a programming perspective is finding it.

Some Unix calls map effortlessly to Win32 counterparts. For example, Win32's WaitForSingleObject( ) and GetExitCodeProcess( ) replace Unix's waitpid( ) nicely. But many other substitutes are not obvious. I'll describe some of these subtleties here.

To help me identify important substitute calls, I wrote a custom back-end application. By *back-end*, I mean an application that doesn't contain a user interface but relies heavily on system calls to provide and control resources. Back-end applications are notorious users of low-level system calls, like process primitives, shared memory, and semaphores. My application is a process synchronization program where two processes—a producer and a consumer—share a common buffer. The producer places data into the buffer, and the consumer takes it out.

Shared Memory

In Win32, Microsoft combines shared memory and memory-mapped files into a single set of API calls. Thus, the Unix calls shmget( ), shmat( ), shmdt( ), and shmctl( ) have no direct counterparts (see the table). Win32's CreateFileMapping( ) maps a physical file into a block of memory. When CreateFileMapping( ) receives a NULL file handle, it behaves like shmget( ) and reserves a block of memory of specified size. However, unlike with shmget( ), the first call to CreateFileMapping( ) allocates memory. MapViewofFile( ) is analogous to shmat( ) in that it allows applications access to the shared memory.

In Unix, shmat( ) allows a process to map a piece of shared memory to its address space more than once; the Win32 MapViewofFile( ) provides similar functionality. The ubiquitous Win32 CloseHandle( ) detaches from (and, in the case of the last open handle, deallocates) shared memory. It replaces Unix shmdt( ) and shmctl(IPC_RMD). On Intel-based machines, Win32 requires memory-mapped files to start on 64-KB boundaries. This may be limiting: A Unix program depending on several contiguous, non-64-KB chunks of shared memory may need a face-lift.

Process Management

Unix developers use fork( ) for two purposes, and there is no single Win32 substitute for these tasks. Most often, developers use fork( ) in the course of loading other applications. In these cases, fork( ) immediately precedes exec( ) (or another member of the exec( ) family).

The Win32 CreateProcess( ) is a viable substitute for a fork-exec combination, but there are some important differences. First, Win32 imposes a 1024-byte limit on the command line. If the argument list requires more space, you should pass data through environment variables, shared memory, or files. Second, CreateProcess( ) is no match for exec( ) in building command-line arguments. Unix passes argv as an array of strings. Win32, in contrast, passes a single command-line string. This may cause parsing problems for strings that contain spaces or double quotes. Finally, CMD.EXE does not expand regular expressions as the Unix shell does.

Sometimes exec( ) does not follow fork( ). Implementing this flavor of fork( ) in Win32 is tricky. Microsoft recommends using threads because they offer multiple paths of execution inside a single address space. Threads use less overhead than processes do, but they require more synchronization. Because threads share variables, controlling access is important.

A fork( ) sans exec( ) can also be implemented with CreateProcess( ). This approach is attractive when the child process needs only a subset of the parent's resources. After a child process is created, the parent must copy all relevant handles and data to the child. Inheritance is a clean mechanism for transferring handles. Object handles become inheritable by setting bInheritHandle, located in the security descriptor, to true during creation. (By default, bInheritHandle is false.) When CreateProcess( ) is invoked and the InheritHandles argument is specified, all the parent's inheritable handles are duplicated for the child. Alternatively, DuplicateHandle( ) can be used to copy handles between processes—but then the child must be made aware of these handles. In both cases, you should pass global variables and data structures on the command line, in shared memory, or in the environment space.

The Win32 process structure is not hierarchical, so there is no Unix concept of the parent process. Consequently, applications cannot assume that killing the parent process automatically kills child processes. There is a kludge, however. Child processes become grouped if their parent is created with CREATE_NEW_PROCESS_GROUP set. Then, GenerateConsoleCtrlEvt( ) can send Control-C or Control-Break signals to the group. However, only children who share the console with the parent process receive the signal. *continued*

KEY SUBSTITUTES FOR TRANSLATING UNIX TO WIN32

UNIX	WIN32	COMMENTS
Shared memory		
shmget( )	CreateFileMapping( )	NT implements shared memory through memory-mapped files.
	OpenFileMapping( )	
shmat( )	MapViewofFile( )	
	OpenFileMapping( )	
shmdt( )	UnMapViewofFile( )	Unattaches from shared memory.
	CloseHandle( )	CloseHandle( ) deallocates resources.
shmctl( )	No counterpart	Shared memory is deallocated with CloseHandle( ).
Process management		
fork( )	CreateProcess( )	Good substitute for fork( ) + exec( ).
	CreateThread( )	Can be used for fork( ) not followed by exec( ).
exec( )	CreateProcess( )	CreateProcess( ) is more like system( ) than exec( ).
waitpid( )	WaitForSingleObject( )	
	WaitForMultipleObjects( )	
	WaitForSingleObjectExt( )	
	WaitForMultipleObjectsExt( )	
	GetExitCodeProcess( )	
getpid( )	GetCurrentProcessID( )	
getppid( )	No counterpart	Process structure is not hierarchical.
kill( )	SendMessage (WM_CLOSE)	Use TerminateProcess( ) under extreme circumstances.
Binary semaphores		
semget( )	CreateMutex( )	
semop( )	ReleaseMutex( )	Increments semaphore count by one or more.
	WaitOnSingleObject( )	Decrements semaphore count by one.
semctl( )	No counterpart	Semaphore is deallocated with CloseHandle( ).
Counting semaphores		
semget( )	CreateSemaphore( )	
	OpenSemaphore( )	
semop( )	WaitForObject...( )	Any flavor of WaitFor...; however, consumes only one semaphore at a time.
	ReleaseSemaphores( )	
semctl( )	No counterpart	Semaphore is deallocated with CloseHandle( ).

Finally, the Win32 call TerminateProcess( ) is not a suitable replacement for Unix kill( ). Microsoft recommends terminating processes with the WM_CLOSE message. TerminateProcess( ) is only for extreme circumstances, because DLLs do not call all their exit routines.

Semaphores

Win32 supports two types of semaphores: mutual exclusion (mutex) and counting. In Unix, mutex semaphores are a special case of counting semaphores—the semaphore count is either 0 or 1. They port easily to Win32. CreateMutex( ) is the Win32 replacement to semget( ).

Unix semaphore operations are performed by setting the sem_op parameter to an integer value and invoking semop( ). In Win32, WaitForSingleObject...( ) and ReleaseMutex( ) perform down and up operations, respectively.

In Unix, you can treat multiple semaphore operations as a single atomic unit. The syntax is transparent: semop( ) accepts a pointer to an array containing one or more semaphores. When the array contains multiple semaphores, the operating system blocks until the program signals all semaphores. This functionality exists in Win32 but requires different syntax (see the table).

Counting semaphores are not as portable as mutexes. The Win32 calls CreateSemaphore( ), ReleaseSemaphore( ), WaitForObject( )..., and CloseHandle( ) are comparable to the mutex calls described above. (There is also OpenSemaphore( ), which lets multiple processes share a single semaphore.) Win32's big weakness is that no API call consumes more than one semaphore.

Consuming multiple semaphores in Unix is trivial: You simply set sem_op to the desired value (e.g., −2 or −3) and invoke semop( ). Win32 WaitForObject...( ), however, can reduce the semaphore count by only one. (There is no limitation in the other direction: ReleaseSemaphore( ) can increase the semaphore count an arbitrary amount.) This limitation can wreak havoc. Consider an application where three reader processes and one writer process share a block of memory. The writer requires exclusive access; the readers require shared access. In Unix, the writer sets sem_op to −3 and blocks until the readers finish. Each reader sets sem_op to −1. In Win32, the readers are straightforward: Use WaitForSingleObject( ). However, there are only two alternatives for the writer, and both are unattractive. The first is to nest WaitForSingleObject...( ) inside a for(i = 0; i < 3; i++) statement. The second is to redesign the code. Adding a second writer compounds the problem, because the for(...) statement must be protected by a mutex.

The persistence of semaphores and shared-memory resources also differs between Unix and Win32. Unix semaphore and shared-memory constructs remain in memory until explicitly deleted. In Win32, all of a process's open handles close automatically on exit.

APIs and Products

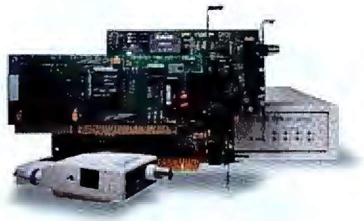
Porting applications from Unix to NT using the preceding is what I call the brute-force method. An alternative may be a commercial program that offers developers a common API. One such program, Consensys's Portage, provides a Unix System V release 4 interface for Win32. DataFocus's Nutcracker supports SVR4, Posix.1, and Berkeley 4.3 extensions, including sockets.

At press time, both Nutcracker and Portage address only the back-end aspects of applications, but the companies say they are working on libraries to help with user interfaces and other front-end elements. If minimizing time to market is not crucial for your Unix application, redesigning it from Win32 may be appropriate. However, if you need to port to NT quickly and can enhance front-end pieces later, consider one of these programs as a painless alternative to brute-force translations. ■

ACKNOWLEDGMENT

Alan Brown, a senior consultant at DataFocus, contributed information about substitute calls.

Steve Niezgoda is a member of the FBI Laboratory's Computer Analysis and Response Team and a graduate student at George Mason University. He can be reached on CompuServe at 76114,1542 or on the Internet or BIX c/o editors@bix.com.



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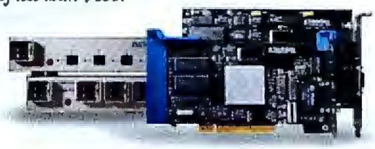

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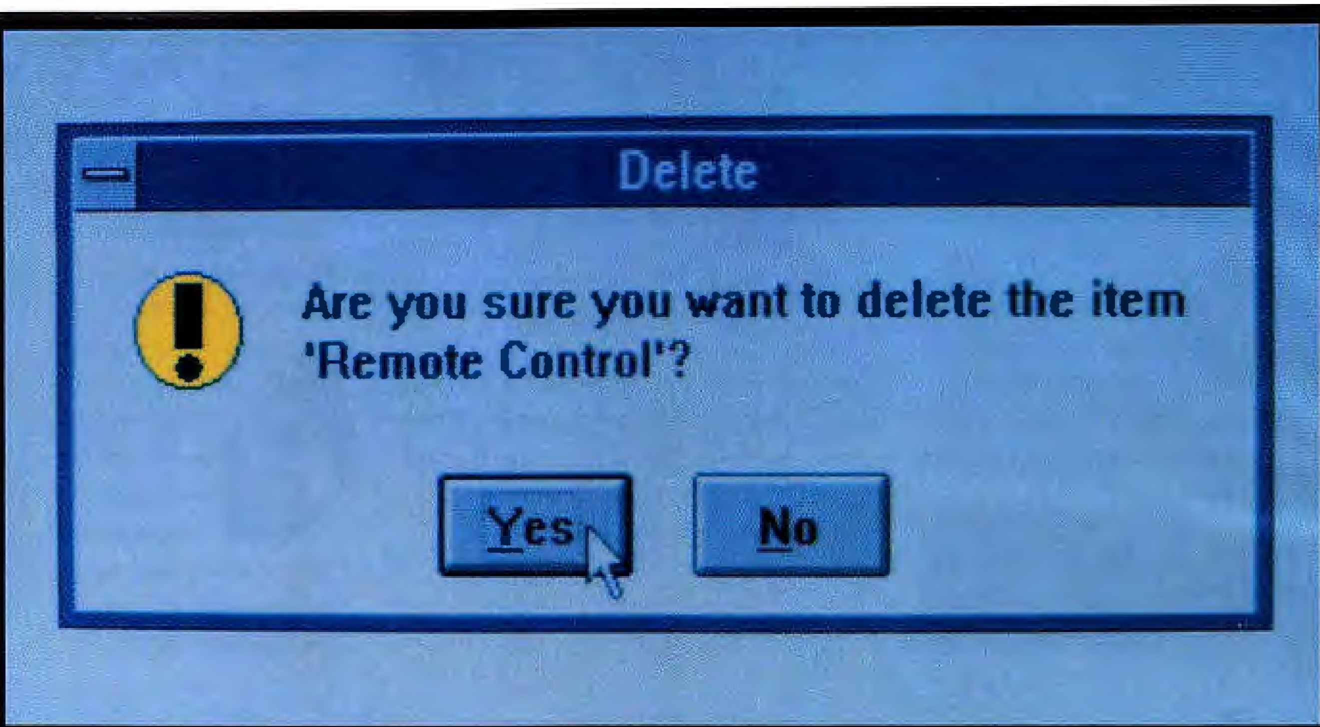

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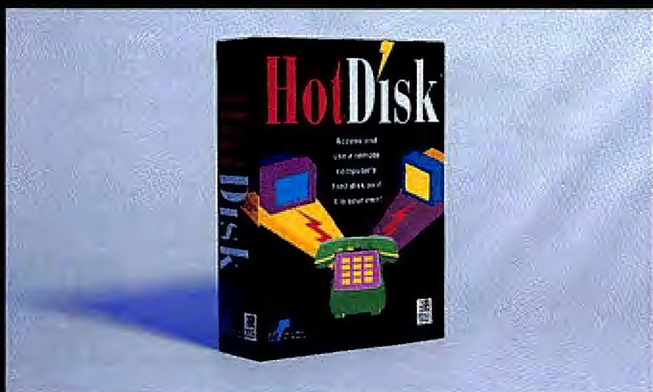

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Clearing Away the ISDN Roadblocks

Although proprietary protocols and arcane service-ordering procedures still stand in ISDN's way, there are promising signs of progress

JEFFREY FRITZ

One of the biggest obstacles to WAN interoperability has been the U.S. government. A decade ago, it broke up AT&T's Bell System to create the seven RBOCs (Regional Bell Operating Companies). At the time, the Bell System was a model of interoperability. Had the government not intervened, using ISDN equipment and services might be equally straightforward today.

The diversity that was the aim of the AT&T breakup hasn't been a totally bad thing; telephone devices are now available from many sources at competitive prices. But with that diversity comes a loss of interoperability. No longer is there a single, unified telephone network; now there are seven large networks and thousands of small- and medium-size telephone operations. These diverse networks offer radically different data services at widely varying prices with limited interconnection. Some carriers offer digital services now, but others haven't a clue as to when they will be able to provide such services.

Pity the poor administrator of an enterprise network who must deal with a plethora of state tariffs; widely varying carrier capabilities; and a myriad of different local telephone companies, regional operating carriers, and interexchange carriers. Providing ubiquitous communications in such an environment is a nightmare.

Too Many Flavors

This confusing array of choices comes just as telephone carriers are deploying digital services such as ISDN, a telecommunications technology able to provide video, high-speed data, and voice communications simultaneously over a single telephone line. Given that national and international standards bodies spent years developing ISDN, users might reasonably expect consistent and interoperable deployment. However, that's not the case.

The problems are many. There are too many flavors of ISDN. Users buying ISDN equipment and services face an intimidating array of options, and poorly trained

TYPICAL ISDN TRANSLATIONS TABLE

Settings shown are examples for AT&T 5ESS Custom and National-1 ISDN.

DEVICE TYPE		AT&T 7506 ISDN PHONE	FUJITSU SRS-410 TERMINAL ADAPTER	COMBINET CB-400 ETHERNET BRIDGE
DSL TN	Digital subscriber-line phone number	5551234	5555678	5559123
D service	Type of service on D channel	SX	S	S
B1 service	CSV, CSD, or DMD?	DMD	CSD	CSD
B2 service	CSV, CSD, or DMD?	DMD	CSD	CSD
NT1 type	Network-terminator type	AULC	AULC	AULC
USPID	User-service profile identifier	0155512340	0155556780	0155591230
MAXB CHL	Maximum number of B channels	2	2	2
CKT TN	Circuit telephone number	5551234	5555678	5559123
TERMTYP	Terminal type	TYPEC	TYPEE	TYPEC
DISPLAY	Is there an LCD display on device?	Yes	No	No
CSV	Circuit-switched voice on device?	1		
CSV CHL	Circuit-switched voice channel(s)	Any		
CSD	Circuit-switched data on device?	2	2	2
CSD CHL	Circuit-switched data channel(s)	Any	Any	Any
CSD LIMIT	Circuit-switch data-channel limit	1	2	2
SEND PKTSZ	Send packet size	128		
SEND PKTWD	Send packet window	3		
RCV PKTSZ	Receive packet size	128		
RCV PKTWD	Receive packet window	3		

These devices don't offer packet service on the D channel.

Actual telephone number of the device. Some switches support one number for both voice and data. Other switches require separate numbers for voice and data channels.

Indicate if the device supports CSV, CSD, or DMD services. This allows the user to specify which service should be on which channel. DMD tells the switch to be prepared to offer either voice or data on the channel, depending on what the user device requests when it sets up the call.

A unique identifier assigned to the ISDN device. This setting is important when several devices are connected to the same ISDN line in a passive-bus (or multipoint) configuration.

Indicates which B channel can accept circuit-switched data. Notice that most devices indicate Any, meaning that it doesn't matter to the user device.

SEND PKTSZ sets the transmit-packet size for D packet service.

SEND PKTWD sets the transmit-window size for D packet service.

Notice that there are also related settings for receive-packet size and window as well. These configurations are usually set to the default values and are not changed unless there is some obvious reason for doing so.

S stands for Q.931 signaling, and X stands for X.25 packet service.

Stands for circuit-switch service on (user) demand.

ULC stands for universal line card. AULC is a 2B1Q ULC.

Terminal type varies by device type and central-office switch. It tells the switch about the internal "smarts" of the device.

TYPEA services are dumb and depend on the central-office switch for most processing of user events. TYPEC and TYPEE are smarter devices that are capable of handling call forwarding, automatic callback, and other features.

telephone sales representatives can make matters worse. Bridges and terminal adapters often don't interoperate, telephone central-office switches are complex to configure, and digital services are difficult to order.

Moreover, if you decide to move your ISDN equipment to a new location, the ISDN line has to be configured in advance. It typically takes days for a carrier to process such an order. The ability to take an ISDN bridge on a trip, connect it to the local hotel phone system, and access your corporate network is a long, long way off. But network users need that kind of functionality now.

The Secret Words

To set up a line for your ISDN network device, you need to know telco-speak, including terms such as *terminal type*, *SPID* (Service Profile Identifer), and *bearer service*. Users are expected to understand highly technical issues that, for the most part, even telephone-company technicians don't fully grasp. This intimidates the user who just wants to hook up to the network and use it.

Before any ISDN devices can be used, the telephone line must be preconfigured by the carrier for each specific ISDN device. This process is called *translation*. Translations are much like network configuration files, but they are even more complex and cumbersome (see the table on page 207). Get just one translational entry wrong, and the ISDN line likely won't work. The end user is expected to tell the telephone companies how to translate the central-office telephone switch for each device. Moreover, ISDN vendors expect users to know what kind of switch their local operating company uses in the local exchange.

A Simpler Way to Order ISDN Service

The NIU-F (North American ISDN User's Forum) and the COS (Corporation for Open Systems) are both working to simplify the ISDN ordering process. Both organizations have proposed, and are now working on, standardized phrases that can be used to order common translation schemes.

When a user purchases an ISDN device, he or she is provided with a phrase that must be reported to the telephone-company order taker. The intent is that the user will request translations based on terms such as *Intel Blue* and *Nynex A*. These code words are supposed to make translations easier for end users. Unfortunately, unless local telephone carriers can effectively train their business-office personnel in the use of these terms, a user's request for *Byte Yellow* could be met by a deafening silence.

A better way to configure lines is to let computers do what they do best and avoid the telephone-company translation process altogether. In computer networking, it's common for devices to bootstrap themselves into operation. A new router, for example, may boot with a standard configuration that allows a minimal amount of communication with a configuration server. Once basic communications have started, the server downloads the specific configuration parameters into the network device.

In an ideal world, your new ISDN Ethernet bridge would come with an EPROM that stores the ISDN line translations for that device. When you connect the bridge to an ISDN line, it would come up in a low-level signaling mode that allows configuration communications between the central-office ISDN switch and the bridge. Once the communications link was established, the bridge would begin to send translation information to the switch, which would use the information to configure the ISDN line to the specific translation parameters that the device required. Other than plugging the bridge into the ISDN line, the user and the local carrier wouldn't be involved in the translation process.

continued

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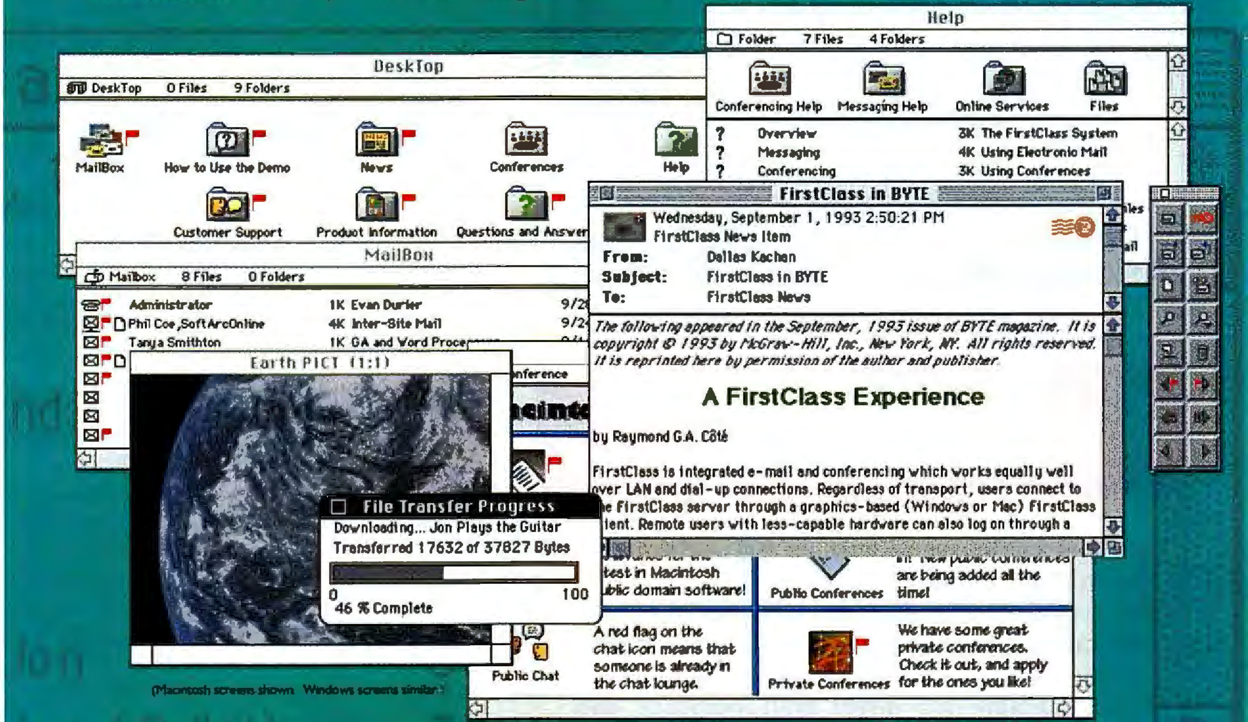

(Macintosh screens shown. Windows screens similar.)

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Full Message History?	Y	Pseudo	Pseudo	-
BBS Functions?	Y	-	-	-
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Restrict Any Feature?	Y	Y	-	-
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This scenario is entirely feasible today. Indeed, some switch vendors have built this capability into their ISDN switches. But don't expect your local carrier to tell you about this feature. Because they must pay an extra charge to activate it, thus far they have tended not to advertise its existence.

The ISDN Archipelago

Until recently, data calls worked only within the local switch. Data couldn't travel between different vendors' switches, or even between similar switches in different locations. These islands of data connectivity presented a terrible problem for corporations trying to use ISDN for enterprise WAN connectivity.

Fortunately, Bellcore, the research arm of the seven RBOCs, created a standard called N-ISDN (National ISDN). This standard addresses interswitch compatibility issues well. For instance, it is now possible to place circuit-switched data calls between different vendors' switches, and many ISDN devices can easily be moved from one switch to another with minimal reconfiguration. Telephone carriers still must deploy the signaling standards necessary to connect the various ISDN switches together.

While recent progress on this front has been encouraging, one big problem remains unsolved. Vendors have deployed ISDN network devices using proprietary communications protocols. That makes it impossible for, say, vendor A's ISDN bridge to connect to vendor B's ISDN bridge. A similar problem exists with routers. Network users are forced to stay within one vendor's product line; WAN interconnection involving heterogeneous networks can be very problematic. As a result, strict corporate purchasing requirements are necessary to ensure that a remote user's network device will work with an enterprise network device.

PPP to the Rescue

Fortunately, a white knight has appeared, in the form of the Point-to-Point Protocol, or PPP. The IETF (Internet Engineering Task Force) has issued a series of RFCs (requests for comment) governing PPP. One of these, RFC 1618, describes PPP over ISDN.

While the IETF continues to work on the PPP RFCs, the NIU-F's ENDIF (Enterprise Network Data Interconnectivity Family) has been working on an implementation agreement for PPP over ISDN. ENDIF has provided major networking vendors with the opportunity to work together to produce agreements for core WAN ISDN technology. The ENDIF's work closely mirrors the IETF's PPP RFCs.

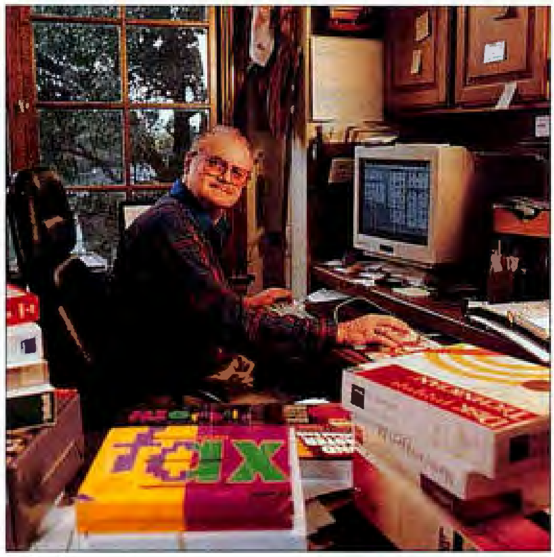
A major breakthrough occurred last June at the National Institute for Standards and Technology in Gaithersburg, Maryland. Seven major network vendors, all ENDIF participants, came together to demonstrate interoperability between ISDN devices using MAC (media access control) layer bridging and IP routing. For the first time, each vendor was able to connect and pass real user data to each other and to an internet. This is an encouraging development that—along with automatic line configuration and interswitch, intercarrier compatibility—will help usher in the era of plug-and-play interoperability for ISDN network devices.

Indications are that installing and making ISDN WAN connections will, in a few years, be as easy as picking up the telephone. Network users and managers require, and expect, no less. ■

Jeffrey Fritz is a telecommunications engineer responsible for the design and management of data communications for West Virginia University, including its ISDN applications lab. He is also the author of Sensible ISDN Data Networks *(WVU Press, 1992). You can contact him on the Internet at jfritz@wvnvm.wvnet.edu or on BIX c/o "editors."*

JERRY POURNELLE

Odds and Ends



AMY ETRA © 1994

Short-shrift time at Chaos Manor finds Jerry looking at an outliner, an uninstall program, a Windows shell, and much more

I don't know where the month went. Actually, I do: I use Franklin Quest's Ascend to keep track of what I have to do, and that automatically gives me a record of what I did. Most of the month was eaten by final polishing of *Beowulf's Children* by Larry Niven, Jerry Pournelle, and Steven Barnes. The publisher accepted the book last month, but we found some ways to improve it. Then we had a panic effort to save the space station. I'm no great fan of the space station, and in an ideal world, we'd be investing our space R&D money in something else; but it's the only far-out R&D program we have at present, and Dan Goldin is turning NASA around. He deserved support.

We also had a mild panic when the DC/X, the little spaceship that Max Hunter, General Graham, and I talked the National Space Council into building, had a fuel-leak explosion during a test. The good news is that while the aeroshell got ripped up, the ship recovered and landed on its tail of fire: the first intact recovery of a rocket ship from an in-flight abort. Love that ship.

What with all that, a couple of computer shows, and a speech to the Cisco Systems' users meeting, there wasn't time for any big projects here; but really neat products keep flowing in.

All of which means that it's short-shrift time at Chaos Manor. Short-shrift ground rules: I don't mention things I don't like, and you should assume that all these products deserve more space than I'll have time to give them.

Do you remember ThinkTank? It was an early outline program that caused a lot of excitement back in CP/M days. I played with it but never really used it. Later on came Symantec's GrandView for DOS systems, and I used that a lot; I even wrote columns with it. GrandView running under Quarterdeck's Desqview task switcher was a really good way to organize notes. I wrote essays, travel impressions, and even scenes for novels with it.

The problem with GrandView was that while it was fine as an outliner, and let me expand and hide and hoist and move text and titles around, it wasn't all that hot as a word processor. There was a version of it that was supposed to be compatible with Q&A Write, but it wasn't really. I never really decided to abandon GrandView. I just stopped using it, and a few months ago I quietly consigned it to archive tape.

Most word processors have outliner features, but I've never been fond of them. Partly it's a learning curve, but mostly I just don't feel the need, because I don't write outlines much. Even when I was using GrandView, I didn't use the special outline control features very often.

The theory behind outline programs is that you write as you think of things to say. Set down various points you want to make and expand each when you think of something that belongs there. You can hide text so that all you see is the main headings or expand it so that all the text is visible. Whenever you think of a point, you can stick it into the proper section of the document you're creating or tack it onto the end, if you don't know where it goes. It allows free-form writing, and you don't get bogged down in details.

Another way to write is to do what I advised my kids to do when they were learning to write nonfiction: sit down and write everything you can think of about the subject. Print it. List the topic sentence of each paragraph. If you find a paragraph that doesn't have a topic sentence, fix it. When you're done, see if that's the order in which you want to present your information. It probably won't be. Now rewrite your essay, putting things in the proper order. Polish it a couple of times, and you're done.

All this is preparatory to telling you about Inspiration, an outline program that I probably wouldn't have looked at if my partner Steven Barnes hadn't noticed it. "You'll like that," he said.

Steven has done some TV scripts and was story editor of a series. He teaches classes on writing. He's better organized than I am, and I think that's the clue. In any event, Inspiration has all the features of ThinkTank, GrandView, and other traditional outliners. In addition, it has a number of visual/graphics features that let you turn your work into diagrams and flowcharts. There are idea maps, tree charts, process flows, plans and diagrams, and suchlike, as well as traditional outlines.

Inspiration was originally a Mac program, and the Windows version has a number of Mac-like features. It's likely to appeal to the same kind of people who like Macs. If you like storyboarding, you'll like Inspiration. Now that I have it installed, I may use it myself.

Many Windows applications now come with uninstall programs. Most of those work, but a few leave junk like references to themselves in WIN.INI, PIFs (program information files), or useless fonts. Other programs—including most older ones—don't have an uninstall facility at all. That means that unless you know what you're doing, when you delete a program, you won't get it all.

UnInstaller from MicroHelp takes care of that job. When you invoke UnInstaller, it looks at your INI files and finds lines that reference nonexistent software. Another part of the program finds all the tracks of a program and offers to delete them. There are other features.

This isn't a program you're going to need every day, but when you do need it, you need it bad. It's not perfect, and you want to be careful how you use it; but it knows more about Windows than I do, and it gives you lots of warning before it actually wipes anything out. I'll certainly keep it. Recommended.

There are a zillion Windows shells out there. The best known is Symantec's Norton Desktop for Windows, which works quite well. Over the years, however, they've added feature after feature to it, so that now it takes six high-density disks and nearly an hour to install. Last night during the course of installation, it thought it found a virus in my system. Then, when the installation was about 65 percent complete, it slowed to considerably less than 1 percent per minute. The disk lights would go on and off, but nothing would happen for a long time; I suppose it was decompressing big files.

Once it's installed, Norton Desktop works quite well. It's much more intuitive than Program Manager, and it sure is loaded with features, including the virus checker, which now didn't think it saw one after all.

By contrast, Quarterdeck's SideBar installs in a couple of minutes. It's not loaded with features. There's no virus detector and no backup program; but it sure works, and I like it. I miss Norton Desktop's file viewer, which knows how to translate odd file formats, but the viewer in Norton

Commander can do that, too, and I generally keep Commander available in a DOS Window. That's the only Norton Desktop feature I really miss.

SideBar incorporates many of the features of OS/2. The right mouse button is used a lot. More to the point, SideBar can create "shadow" objects. That is, I can drag the icons of the programs I use most onto a little vertical toolbar on the right side of the desktop. If I drag them there, the icons vanish from within their original groups; but if I bring them in with Control-drag, the icons remain in their original groups, while the shadow that's installed in the toolbar can launch the program.

SideBar allows folders within folders. It allows folders on the toolbar. It lets you have icons for folders; every program group won't look just like any other group. It has access to all your disk drives, and in Windows for Workgroups, that includes all the network drives; Norton Desktop doesn't seem to understand that concept. SideBar lets you put program icons directly on the desktop, inside folders or out. There's a "recycler," which functions as a wastebasket, and a clock icon that works. You can also customize the toolbar.

There are other features, such as launching Word 6.0 for Windows by clicking on beowulf.doc. If you launch a second Word document, the program puts it in a different window of Word 6.0 rather than launching a new copy of the word processor.

SideBar's paper documentation isn't very good, but the on-line help documents are excellent. My advice is not to bother looking for anything in the manual; just hit the F1 key. You'll find what you want to know a lot faster. I spent 5 minutes searching the documents and never did find out how to install a new program, but the help files showed me in a few seconds.

All program shells advertise that they let you organize your work just the way you like, and I suppose most of them do. I have nothing against any of them, but I don't seem to use them much. SideBar is the first Windows shell that I have put on more than one computer. Alex has already ordered one to install on Larry Niven's machine, because SideBar is excellent for setting things up for a nonexpert user. I was never fond of Windows shells, and the only DOS shell I ever cared for was Norton Commander; but SideBar is different. Recommended.

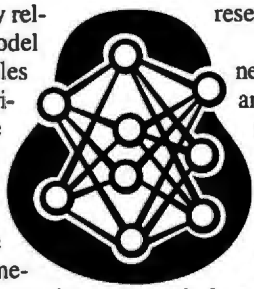
One of the most dramatic things we saw at Spring Comdex was Elastic Reality. To say this is a morphing program is about like saying that Rodin's *The Gates of Hell* is a statuary group. It turns a man into a tiger, grows horns on the devil, changes little girls into big men.... The problem is, you have to see it to believe it. It produces effects on a Mac with QuickTime that I wouldn't have believed you could get without a Silicon Graphics system. Indeed, Elastic Reality was developed with Silicon Graphics hardware, and that version was used to produce special effects for feature films and major TV series. Now you can get it for the Mac.

I won't list all the features because I haven't time. The video that comes with it shows you a bunch of stuff it will do, and I expect any software retailer will let you watch that. Just let me say that if you do graphic arts with a Mac, you need this program. Highly recommended.

One of the things computers do well is the tedious work of looking for trends in masses of data. This is often done by using matrix manipulations to generate multiple regression equations, and that

remains the best general approach when you have structured data and are familiar with matrix algebra. A simpler method is to turn loose an analytical tool known as a neural network on your data. Neural networks learn sort of the way you do. That is, they look at many different cases and form a bunch of tentative hypotheses. They then reward (i.e., give greater weight to) the theories that pay off while eliminating those that don't.

That, by the way, is the classic method of operations analysis. You look at an ongoing process, try to identify relevant variables, devise a model that relates the input variables that you can control to the criterion you want, validate the model, and try to optimize. This doesn't always work—sometimes pure intuition is better—but it works more often than you'd think. Sometimes you get spectacular results through the most unexpected actions. A neural network that would do operations research would be wonderful.



The problem is that most neural networks are difficult to understand and nearly as difficult to use. What most of us need is a neural network that's as easy to use as a spreadsheet. We could then let it examine the data and frame hypotheses for us to choose among.

That describes Braincel, which is far and away the best neural network for beginners that I know of. The documents aren't especially clear, but they're good enough that a bit of hard work and a lot of practice will get you going. The main example in the manual shows how to create an expert system to screen loan applications. Inputs are such things as monthly income, monthly expenses, home owner or renter, years in present job, and so forth. You input your data, build and train the expert system, and then test it on new data. There are other examples—one of Pournelle's laws is that if you're explaining something complicated, you can't have too many examples—and I was able to figure out how to use Braincel in a couple of hours.

Once you've worked the examples, you're ready for the back of the book, where program author Mark Jurik explains in some technical detail just what a neural network is and the difference between back propagation and back percolation. Alas, just as he gets interesting, he says, "It's too mathematical to go into details here"; but there's also a decent bibliography for those who find mathematicians' equations easier to read than their prose.

Fortunately, you don't have to understand neural networks and back propagation in order to use them. You do need some common sense, and if you're going to bet much on the predictions of your neural-network model, you'd best develop some feel for tests of statistical significance. Computer programs like Stat will help with that.

One use of a neural network is to analyze financial information. Stock market reports talk about technical factors and technical corrections; mostly, that refers to a bunch of empirical rules about what the market will do tomorrow based on what it did for the past month. Some technical-analysis systems have been around for a long time. An early one was Dow theory, named for one of the founders of Dow Jones.

Neural networks won't teach you Dow theory, but they can allow you to make your own financial hypotheses. There's a section about financial data in the appendixes to the Braincel manual. If you are really interested, however, you might want to look at the *NeuroVe$t Journal.* It isn't cheap, but it goes fairly deep into prediction theory. It also advertises a bunch of other neural-network programs and analytical tools. If I were going to set out to build an investment expert system, I'd want it.

Last year (see "Neural Net Adds Smarts to Spreadsheets, Slowly," January 1993 BYTE), Maureen Caudill compared Braincel out of the box to a program she had been using for a year or so, with the inevitable result that she didn't like it as much as the one she uses all the time. That's a valid conclusion, but if you're that familiar with neural networks, you don't need advice from me. On the other hand, if you know nothing about neural networks and want to learn, Braincel is the best way I know to start.

Braincel has both automatic and professional modes; in professional mode, you have to make a number of decisions, and some of them may be hard to understand. No matter. Try automatic mode first to get a feel for what's going on.

Once you've used your neural network in automatic mode to create an expert system you understand, you'll want to try again in professional mode, in which you collaborate with the machine to design the model. After that, you have to decide whether to trust the expert system or go with your own judgment.

There's no real answer to that. There are two main values to expert systems and explicit models. First, by showing exactly how decisions are made, you can determine whether you have left out any important variables, and you'll know just how sensitive your decisions are to the various data inputs. The other value is that the expert system is consistent and never allows irrelevant factors to influence its decision. This can have important legal consequences.

If you're at all interested in neural networks, Braincel is about as painless an introduction as I know. Recommended.

At last fall's Comdex, I was given a copy of a program called WizRule, which will examine a large database for rules. An example of a rule might be "If Warehouse = 1, then there is a probability of 0.996 that agent = 3." This doesn't sound interesting, but note that the probability isn't 1. Are the deviant cases data-entry errors or evidence of fraud? In addition to linear probabilities, WizRule will look for relationships that may be useful for finding incorrect entries, spotting fraud, or making predictions. It will, given time, examine very large databases.

I won't go into great detail on WizRule because all I know about it is that it's published by Rational, Ltd., which is an Israeli company. I was given a copy, I have used it, and I can think of a lot of uses for it—but I don't know where you can get a copy, because there is neither address nor phone number in the manual or on the disk. If anyone knows, please tell me, and I'll publish the company's address in an upcoming column.

Databases contain a lot more information than most people can get out of them. Neural networks with fuzzy logic and rule analyzers are important tools for extracting some of that information.

There are also analysis programs that use specific structured models to make forecasts. One of the modeling methods is known as exponential smoothing. Another is stationary time series. *continued*

If you would like to know a lot more about the subject, I recommend Robert Goodrich's *Applied Statistical Forecasting*, which is a book available from Business Forecast Systems. If you just want to use forecasting models, Forecast Pro is available from the same source. I have the Windows version. There's also one for DOS. Forecast Pro is fairly easy to learn for anyone who'd be likely to use it. If you want to know more about it, I covered the program in some detail in my June 1993 column. (Also, see "Forecasting the Future" in this June's BYTE.) It's still the best program of its kind I know of.

Windows users tend to forget that there are still plenty of DOS users out there. Every now and then I have to use a DOS system, and when I do, I remember SideKick. Borland's SideKick was one of the first TSR programs. You load it, go about your work, and if you need it, you pop it up. SideKick has a calendar, an appointment book, a phone book, various calculators (including scientific and financial), a note editor, and stuff like that. I used SideKick for years, and when I converted to Desqview, I still kept a Desqview window reserved for SideKick. I didn't abandon SideKick until I converted to Windows.

If you still use DOS and don't know about SideKick, you're missing something.

Evaluating monitors is a problem. I can tell you whether I like one or not, I can use one for a while and see how it holds up and if I get a headache, I can tell you the specifications, but it's not easy to find objective measures.

There is one way. DisplayMate from Sonera has a suite of tests for color balance, focus, pincushioning, and all the other factors involving monitors. It's easy to install and use, and it will discover and describe in detail problems that you didn't know you had. It will also help you tune your monitor to its best possible performance. This can be important if you stare at a monitor all day.

DisplayMate is self-teaching. You don't need the manual; just install it and fool around following directions. When you're done, your monitor will probably look better, and you'll certainly know more about gray scales and color balance than you did when you started.

I used DisplayMate to examine a new ViewSonic 17 monitor. But I didn't need to; anybody can see that the ViewSonic 17 is beautiful. The tilt stand works, the controls are right up front and computer-controlled—they call it OnView on-screen programming, and it works about the way you adjust your TV set's color with the remote control—and it has an Energy Star rating. The monitor looks great at a resolution of 1280 by 1024 pixels. It works with both PCs and Macs. The screen is nearly flat. The black is black. I don't know what else to say.

I now have an NEC MultiSync 5FGp, a Nanao FlexScan T560i, and the ViewSonic 17. I've run DisplayMate on all of them, and they all pass nicely: good focus, black screen, brilliant color, and sharp-edged lines. They're all fast, and when you change from Windows to DOS applications, they change screen resolutions easily and efficiently. Some monitors don't do that well. I have an older monitor that gives a loud click and throws gubbage on the screen when making that change.

I can't emphasize strongly enough the importance of a really excellent monitor for those who spend a lot of time staring at computer screens, and that becomes more important the older you get. My setup works best if the monitor is at eye level and approximately 30 inches from my nose. That means at least a 15-inch monitor, and a 17-inch monitor is better. CAD workers will want a larger monitor, but for writing, I find a 21-inch monitor a bit large because the lines of text will be wider than I can take in without swinging my head.

I don't know if Pen Windows systems will catch on. For a while, I used a really neat little machine called the Dauphin DTR-1, which had a number of interesting features, including Pen Windows. Alas, the early model I used had some power management problems that the production systems don't have. One of these days I'll try it again, because the little darling worked really well when it was working, and it was a lot of fun.

Meanwhile, if you're interested in learning more about what Pen Windows can and can't do, the best way is to get the Kurta VideoTablet VTS-5. Kurta made the pen tablet for the Dauphin system.

The Kurta system comes with a board to install in your PC, a neat and fairly rugged tablet, the pen, and all the Pen Windows software. I confess I haven't done a lot with this beyond getting it up and running, which took nothing special. I fully intend to do some real work with this when I get a bit more time. After all, Niven and I postulated pen-based computer systems in our novel *The Mote in God's Eye* and its sequel *The Gripping Hand* (available in paperback at a bookstore near you), so I have a bit of a stake in seeing it all come to pass. The VideoTablet VTS-5 makes for a painless way to experiment with and learn about pen control.

I'm told it's also in practical use. A physician keeps his patient records using a Kurta VideoTablet, and there are educational and commercial applications.

My son Frank has been the director of publicity for a major resort hotel, owner of a mail-service business, and a partner in a telemarketing firm. Unlike Alex, he's not a propeller head; he just wants to know what computers can do. Recently, he figured it was time to learn more, so he took a privately offered course on Macs. They studied Adobe Premiere, Adobe Photoshop, Soundworks, and Macromedia Director. The course took six weeks at two nights and some weekend time per week, and finally eight straight days of multimedia immersion.

Frank has been a Mac user since he first saw one. He's done ad campaigns, mass mailings, business plans, and so forth on Macs for years. I'll let him describe the course.

"Joining me were entertainment-industry professionals and a grandmother who wants to make children's CD-ROMs. With backgrounds ranging from a Philips CD-ROM producer to a commercial director who makes videos for McDonald's, we set off to learn the basics of video compression, editing, and interactive programming. We started with Premiere, a potentially wonderful video-editing system.

"Using a Radius Video Vision board installed in a Mac Quadra 900, we struggled to load and compress video from a

Canon Hi-8 camera to edit our own movie. We quickly learned how much information and quality drops out during compression. Error reports showed something like 10 percent to 12 percent of the video input was lost in compression translation. We did find a way to decrease that by 4 percent by turning off external sounds and disabling the network.

"Premiere is impressive, offering transition devices between scenes that rival high-end editing suites. It includes page turns, clock wipes, crystal dissolves, and more than 20 transition-editing devices. If you don't mind a few quirks or the cost, you can be doing MTV-style videos of your friends' weddings in no time.

"The problem arises when you need broadcast quality. With the speed of most hard drives today, you'll drop out frames when you print the video to a Beta deck, and to solve it you'll need an array drive and adapters. Unless you're really slow, you'd do better to rent a D-2 editing suite at $200 an hour. It will save money in the long run.

"Macromedia Director offers some impressive opportunities as a CD-ROM authoring tool. With its LINGO-based programming language, Director translates bit by bit from Mac to PC systems. It's one of the few programs that will do that.

"You can import all your elements into a casting area in Director and then set it up on your stage. Music, text, images, and moving video all translate easily into Director. You will find problems with the programming and the interactivity. Director uses LINGO to program intricate—and not-so-intricate—decision trees. I'm told it is a close second to C programming and is a major stumbling block for noncomputer types seeking refuge from DOS in the Mac environment. I got lost.

"I think I'll hire a professional."

What Frank learned is that while desktop hardware is *almost* good enough for broadcast-quality work, and the software is *almost* good enough for professional-quality editing, there's still a bit of a way to go. The small-computer world has come a long way from 7- by 9-pixel monochrome characters displayed on a 16-row by 64-column screen. As I reported last month, my new Pentium system is capable of displaying on a good monitor color pictures of quality comparable to drugstore-developed Kodak photographs; but we're not quite to broadcast-quality desktop video editing. This time next year that may not be true. Stay tuned.

Speaking of desktop video, we've had a VideoLabs Flexcam camera since before the earthquake. You've probably seen this: a little CCD (charge-coupled device) camera eye smaller than a golf ball atop a long, flexible gooseneck. It looks like a miniature cyclopean snake, which I suspect is what the designer intended.

Anyway, it brings video into your system through a standard video input. The camera focuses from ¼ inch to infinity and captures quite acceptable color even at low light levels. It has good auto white balance. It's easy to use and a lot of fun. If you want your computer to see you—as, for instance, in a video-interactive conference—this is a good tool to do it with.

The game of the month is MicroProse Software's XCOM: UFO Defense. It's probably going to be the game of the

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year. If I describe it—you're in charge of defending the Earth against an invasion of aliens in flying saucers with systems reminiscent of the late, lamented *UFO* TV series, a strategy and role-playing game—you'll think this is something nobody will want. I sure thought that from the description on the box, and I'd tossed it in the discard pile when my friend Rich Heimlich called to tell me I should try it. I thought at first that he was nuts.

Hours later I emerged to see it was dawn outside. Last night, Alex and I stayed up until dawn with it again. People, this game is *addictive*. You have been warned.

The CD-ROM of the month is a series that's not too dramatic unless you're in the professions. While others have been doing whizbangs, Lightbinders (2325 Third St., Suite 320, San Francisco, CA 94107, (415) 621-5746) has been quietly using CD-ROMs to publish professional journals that are available from the sponsoring organizations. I have ASBMB's Journal of Biological Chemistry and the Protein Society's Protein Science Collection from Cambridge University Press, which integrates interactive 3-D molecular models directly into the research articles. Lightbinders has a number of other interesting science publications and is doing many of the things I predicted would be done with CD-ROMs back when I first learned about them. If you're in the sciences, you should know about them.

The first book of the month is Cheryl Currid's *Computing Strategies for Reengineering Your Organization* (Prima Publishing, 1993). It's a readable introduction into modern high-tech management strategy. There are a kazillion books on how to get on-line. The one I fancied this month is by Sharon Fisher and Rob Tidrow, *Riding the Internet Highway* (NRP, 1994). There's a lot of solid information well presented here.

Finally, Lt. Phillip Pournelle was Officer of the Deck when the helicopter carrier *Tripoli* left San Diego harbor for deployment to the Persian Gulf. He's carrying one of the latest Zenith color laptop computers for what may be the most strenuous torture test I can devise. So far he loves it. Stay tuned for details.

Next month promises to be even more hectic than this: Roberta and I celebrate our thirty-fifth anniversary with a trip to Victoria, British Columbia. This time, we can afford to stay in the Empress Hotel instead of just hiking up there to have breakfast. On the way, we'll visit the Microsoft campus. ■

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.

For More Information

I recommend **Applied Statistical Forecasting** ($39.95) for those who want to know a lot more about the subject. If you just want to use forecasting models, **Forecast Pro** ($595; Forecast Pro XE, $995) is still the best program of its kind I know of. Contact **Business Forecast Systems**, 68 Leonard St., Belmont, MA 02178, (617) 484-5050; fax (617) 484-9219. **Circle 1146 on Inquiry Card.**

Braincel ($249; $99 special until October 30) is about as painless an introduction to neural networks as I know. Contact **Promised Land Technologies, Inc.**, 195 Church St., Eighth Floor, New Haven, CT 06510, (800) 243-1806 or (203) 562-7335; fax (203) 624-0655. **Circle 1147.**

DisplayMate for Windows ($79; DisplayMate Professional, $249; Standard DisplayMate, $149) will help you tune your monitor to its best possible performance. Contact **Sonera Technologies**, P.O. Box 565, Rumson, NJ 07760, (800) 932-6323 or (908) 747-6886; fax (908) 747-4523. **Circle 1148.**

Elastic Reality (Windows, $495; Mac/Power Mac, $349.95; Silicon Graphics, $2995) produces effects on a Mac with QuickTime that I wouldn't have believed you could get without a Silicon Graphics system. Contact **Elastic Reality, Inc.**, 925 Stewart St., Madison, WI 53713, (608) 273-6585; fax (608) 271-1988. **Circle 1149.**

If you want your computer to see you—as for instance in a video-interactive conference—**Flexcam** ($595; Flexcam Pro for S-Video, $795) is a good tool to do it with. Contact **VideoLabs, Inc.**, 10925 Bren Rd. E, Minneapolis, MN 55343, (612) 897-1995; fax (612) 897-3597. **Circle 1150.**

If you like storyboarding, you'll like **Inspiration** (introductory price of Windows version, $129; Mac version, $295). Contact **Inspiration Software**, 2920 Southwest Dolph Court, Suite 3, Portland, OR 97219, (800) 877-4292 or (503) 245-9011; fax (503) 246-4292. **Circle 1151.**

Libraries and institutions only can subscribe to Lightbinders' **Journal of Biological Chemistry** CD-ROM (call for price) by contacting **ASBMB**, 9650 Rockville Pike, Bethesda, MD 20814, (301) 530-7154; fax (301) 571-1824. **Circle 1152.**

If I were going to set out to build an investment expert system, I'd want **NeuroVe$t Journal** (U.S., $85 per year; Canada, $90 per year; international, $95 per year; subscription price includes a disk with 20 years of data on the stock market). Contact **NeuroVe$t Journal**, P.O. Box 764, Haymarket, VA 22069, phone and fax (703) 754-0696. **Circle 1153.**

Once it's installed, **Norton Desktop for Windows** ($179) works quite well. It's much more intuitive than Program Manager, and it sure is loaded with features, including a virus checker. Contact **Symantec Corp.**, 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (503) 334-6054; fax (503) 334-7473. **Circle 1154.**

Lightbinders' **Protein Society's Protein Science Collection** CD-ROM (call for price) is available from **Cambridge University Press**, Journals Dept., 40 West 20th St., New York, NY 10011, (212) 924-3900 ext. 334; fax (212) 691-3239. **Circle 1155.**

I was never fond of Windows shells, but **SideBar** ($59.95) sure works, and I like it. Contact **Quarterdeck Office Systems**, 150 Pico Blvd., Santa Monica, CA 90405, (800) 354-3222 or (310) 392-4218; fax (310) 314-4217. **Circle 1156.**

If you still use DOS and don't know about **SideKick** (DOS version, $69.95; Windows version, $29.95), you're missing something. Contact **Borland International**, 1800 Green Hills Rd., Scotts Valley, CA 95067, (408) 438-5300; fax (408) 439-9344. **Circle 1157.**

Uninstaller 2 ($69.95) looks at your INI files, finds lines that reference nonexistent software, and gives you lots of warning before it actually wipes anything out. Contact **MicroHelp, Inc.**, 4359 Shallowford Industrial Pkwy., Marietta, GA 30066, (800) 922-3383 or (404) 516-0899; fax (404) 516-1099. **Circle 1158.**

The **VideoTablet VTS-5** ($1495) makes for a painless way to experiment with and learn about pen control. Contact **Kurta Corp.**, 3007 East Chambers St., Phoenix, AZ 85040, (800) 445-8782 or (602) 276-5533; fax (602) 276-9007. **Circle 1159.**

Anybody can see that the **ViewSonic 17** ($1045) is beautiful. The tilt stand works, the controls are right up front and computer-controlled, and it has an Energy Star rating. Contact **ViewSonic**, 20480 Business Pkwy., Walnut, CA 91789, (800) 888-8583 or (909) 869-7976; fax (909) 869-7958. **Circle 1160.**

XCOM: UFO Defense (call for price) is *addictive*. You have been warned. Contact **MicroProse Software**, 180 Lakefront Dr., Suite 120, Hunt Valley, MD 21030, (800) 879-7529 or (410) 771-1151; fax (410) 771-1174. **Circle 1161.**

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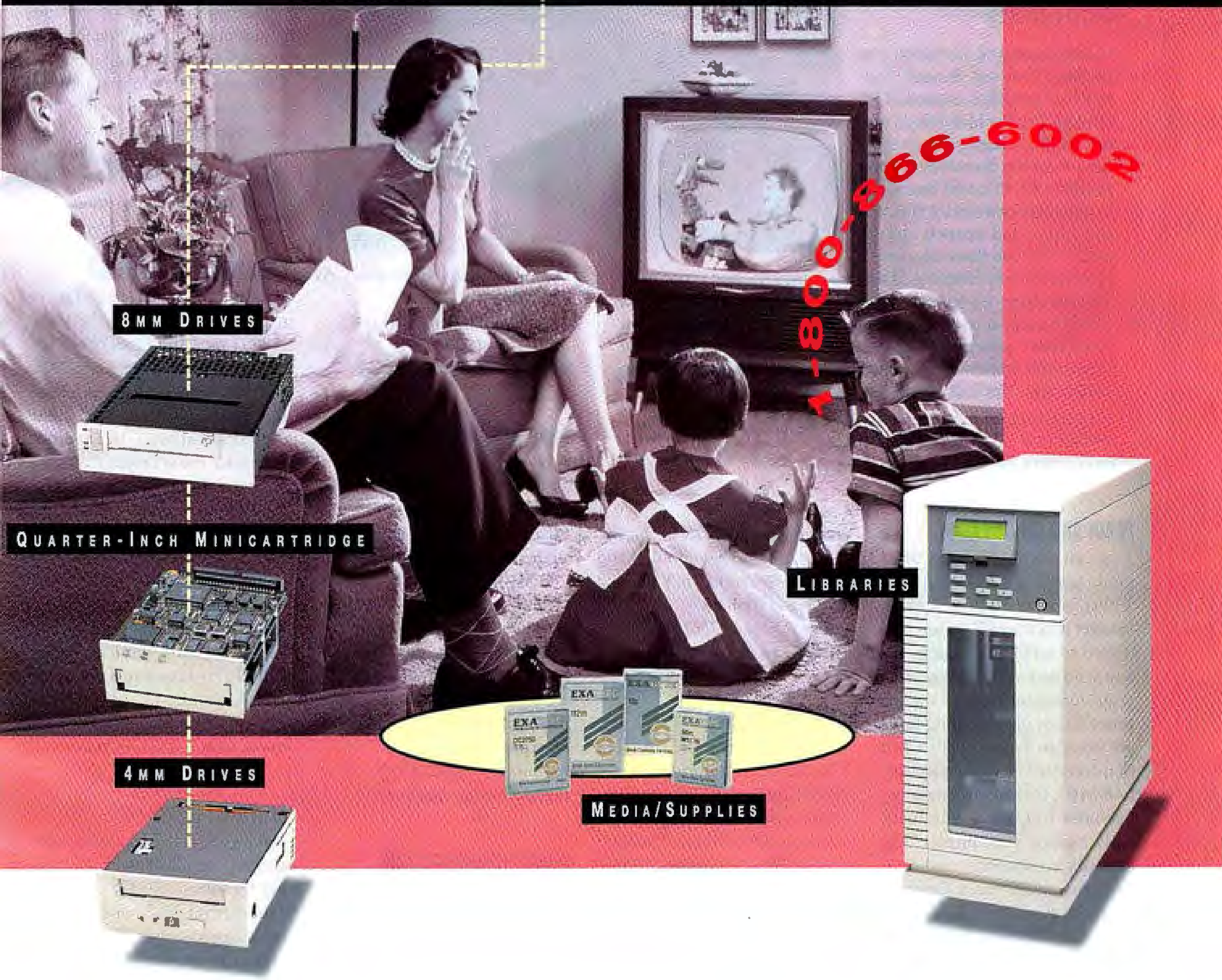

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What's New Hardware

PORTABLE SPEECH SYNTHESIZER

Lightweight and portable, the DECtalk Express Speech Synthesizer provides expanded PC capabilities for individuals who are blind or visually impaired or have learning disabilities. Compatible with PCs and Macs, the synthesizer converts ASCII text to synthesized speech output, which lets you hear computer-monitor-screen contents, database contents, and other text. The less-than-1-pound unit has a speaking-rate range of 75 to 650 wpm, a user volume control, speech options, comprehensive pronunciation rules and controls, and a large integrated dictionary. It connects to your computer via the serial port. The unit retails for $1195.

Contact: Digital Equipment Corp., Maynard, MA, (800) 344-4825 or (800) 722-9332.

Circle 1271 on Inquiry Card.

PLAIN AND FANCY FAXING

You can use the Faxplus 9624 plain-paper fax modem (from $399) as a stand-alone unit or connect it to your PC. When connected to a PC, the modem lets you send and receive faxes from your computer even if the PC is not turned on. Incoming faxes are stored in the Faxplus's 1 MB of memory (which is expandable to 8 MB); if the unit's memory becomes full, it can automatically turn on your printer. The network-compatible modem is from Advanced Image Communications (Orinda, CA).

Phone: (510) 254-5400.

Circle 1274 on Inquiry Card.

PCMCIA MODEM

A voice/fax/data modem card, the ST1414L ($299) supports voice-mail, mailbox, and fax-back capabilities. Microphone and speaker interfaces let you record and listen to messages directly, and a battery-saving ultralow-power sleep mode drops the power consumption to less than 4 mA. From Smart Modular Technologies (Fremont, CA), the PCMCIA modem provides full-duplex data communications and send-and-receive fax capability at 14.4 Kbps. The auto-dial and auto-answer modem is V.42- and V.42bis-compliant.

Phone: (510) 623-1231.

Circle 1275 on Inquiry Card.

MPEG PLAYBACK

An MPEG decoder card from VideoLogic (Cambridge, MA), MPEG Player ($349) provides MPEG video and audio playback via the VESA Media Channel. The card uses the company's PowerStream video processor with the SmoothScale image-enhancing algorithm, which transforms small MPEG video clips into full-motion movies at any window size. Video playback is as fast as 30 frames per second.

Phone: (617) 494-0530.

Circle 1276 on Inquiry Card.

AUDIO OBJECT LINKING

A 16-bit sound card that comes bundled with three sound packages, the Audio Rock-It/16 ($129) is compatible with Windows 3.1, Windows Sound System 2.0, and Ad Lib/Sound Blaster 2.01. In addition to supporting WAV and MIDI files, the Advanced Digital Systems' (Cerritos, CA) card supports OLE.

Phone: (800) 888-5244 or (310) 926-1928.

Circle 1277 on Inquiry Card.

GRAPHICS RIDE THE PCI BUS

A 64-bit PCI local-bus graphics accelerator card, the PowerGraph Pro PCI ($299) has a 64-bit internal data path and can support a bandwidth in excess of 200 MBps. The 2-MB, DRAM-based card from STB Systems (Richardson, TX) has an on-board BIOS and provides GUI-acceleration features, such as linear addressing, hardware cursor, pattern fills, BITBLT, and color expansion.

Phone: (214) 234-8750.

Circle 1278 on Inquiry Card.

DIRECT CELLULAR LINK

The Cellular Direct PCMCIA modem ($329) from Apex Data (Pleasanton, CA) plugs directly into the data-access port on a cellular phone, eliminating the otherwise required data-interface box. The Cellular Direct stores information about your phone in

ROM, which allows the modem to instantly recognize the type of cellular phone being used and to automatically provide the dial tone. Celeritas's Throughput X-Cellerator technology improves the modem's cellular data and fax throughput regardless of the error-correction protocol in use.

Phone: (510) 416-5656.

Circle 1279 on Inquiry Card.

LOCALTALK TO ETHERNET

Pocket-size LocalTalk-to-Ethernet bridges, the Mini EtherPrint ($439) and Mini EtherPrint Plus ($529) connect your LocalTalk devices, such as Macs, printers, modems, and PDAs (personal digital assistants), to Ethernet networks. From Dayna Communications (Salt Lake City, UT), the bridges support a BNC and an RJ-45 connection. If a power outage takes place, the units will come back on-line and restore their connections automatically. Mini EtherPrint supports one or two LocalTalk devices; Mini EtherPrint Plus supports up to eight devices.

Phone: (801) 269-7200.

Circle 1280 on Inquiry Card.

ETHERNET CD TOWER

A network-ready CD tower subsystem, the CD Tower-7 Ethernet ($6995) includes a built-in Ethernet interface and a quadruple-speed drive. The unit attaches to an unused Ethernet connection on your existing network, providing all workstations with access to individual CDs. From Procom Technology (Irvine, CA), the CD Tower-7 unit provides you with a maximum storage capacity of 4.5 GB, SCSI-2 interfaces, access times as fast as 200 ms, and sustained data transfer rates greater than 600 KBps. The unit is also available with double- or triple-speed drive mechanisms.

Phone: (714) 852-1000.

Circle 1281 on Inquiry Card.

PROJECT IN FULL COLOR ▶

The video- and audio-capable ProColor 1500 LCD projection panel ($3799) features a 16.7-million-color palette to display 24-bit digitized color photographs at 640 by 480 pixels. The unit has the ability to accept a direct feed from a video camera or play back videotapes. External audio signals are accepted from any source, including wireless microphones. From Boxlight (Poulsbo, WA), the panel is compatible with desktop, laptop, and notebook computers.
Phone: (800) 762-5757 or (206) 779-4479.
Circle 1286 on Inquiry Card.

FLEXIBLE VIEWING

The FlexScan T2•17 ($1299), a 17-inch monitor from Nanao (Torrance, CA), features ScreenManager, which is built into the microprocessor and displays all vital image controls on-screen; SuperErgoCoat antiglare and anti-radiation coating; and extended scanning frequencies as high as 30 to 85 kHz horizontally and 55 to 160 Hz vertically. A WideView feature allows the T2•17 to display edge-to-edge images, and a 75-ohm termination switch lets you interconnect several monitors and display the same screen. The monitor incorporates Sonnetech's Colorific color management software.
Phone: (800) 800-5202 or (310) 325-5202.
Circle 1282 on Inquiry Card.

HIGH-STORAGE BACKUP

A QIC (quarter-inch cartridge) tape-backup drive based on the QIC 3010 minicartridge standard, the Tape510 stores 255 MB of data (510 MB with compression) using standard tape cartridges and 340 MB (680 MB with compression) using extended-length cartridges. From Iomega (Roy, UT), the internal Tape510 ($399) plugs into the floppy drive controller; the Tape510 parallel port unit ($599) is compatible with the bidirectional enhanced parallel port. The drives also read QIC-40, QIC-80, and Irwin formatted tapes.
Phone: (801) 778-1000.
Circle 1283 on Inquiry Card.

ENTER THE ALPHA WORLD

Based on the DEC Alpha AXP 21066 chip, the NekoTech Mach 1-166 system (from $3995) has a clock rate of 166 MHz, which is upgradable to 200 MHz. The desktop computer has 1 MB of cache memory; system memory ranges from 16 to 256 MB. Mass storage is achieved via a 1.44-MB floppy drive and a hard drive with a capacity of 250 MB, 500 MB, or 1 GB. The Mach 1-166 system is from NekoTech (Irvine, CA).
Phone: (714) 580-0055.
Circle 1284 on Inquiry Card.

PERSONAL PRINTING OF GRAPHICS

The Epson Stylus 800+ ($359) prints at 165 cps in letter-quality mode and 250 cps in draft mode with a print resolution of 360 by 360 dpi. Capable of producing enhanced graphics, the Epson America (Torrance, CA) printer has seven standard fonts, four of which are scalable. A microweave function reduces banding.
Phone: (800) 289-3776 or (310) 782-0770.
Circle 1285 on Inquiry Card.

NETWORK ADAPTERS

The Madge Smart 16 Ringnode Token Ring adapter ($295) has 128 KB of RAM that provides buffer space for data frames and allows protocols to be downloaded onto it. The preconfigured Madge Networks (San Jose, CA) unit supports the ISA bus and is available in STP and UTP versions. The adapter ships with the company's Smart LAN Support Software 4.2.
Phone: (800) 876-2343 or (408) 955-0700.
Circle 1287 on Inquiry Card.

The NW2000 WAN adapter ($599) from Eagle Technology (San Jose, CA) provides connectivity between remote NetWare networks running NetWare MultiProtocol Router 2.11. The adapter supports frame-relay services and has 256 KB of memory. The unit's two ports can be configured for V.35 and RS-232 interfaces.
Phone: (408) 577-3900.
Circle 1288 on Inquiry Card.

REMOVE THE JITTER

Designed by Chipcom (Southborough, MA) for its high-end ONcore Switching System, the ONcore Token Ring Jitter Attenuator Card ($795) installs on any ONcore token-ring module with ring-in/ring-out connection capability. The daughtercard eliminates jitter from signals coming in from existing rings.
Phone: (508) 460-8900.
Circle 1289 on Inquiry Card.

PAGER PROVIDES INDEPENDENCE

Mac-based, the NeuroPage paging system ($10,000; software only, $1500) provides independence and mobility to cognitively disabled people. The system replaces an attendant with an intelligent pager that receives timed alphanumeric messages that cue the patient when to take action. From Hersh & Treadgold (San Jose, CA), the pager beeps or vibrates to alert the patient that a message up to 240 characters long has arrived; a feedback mechanism confirms that the patient has received and acted on the message.
Phone: (408) 997-7017.
Circle 1290 on Inquiry Card.

APPROACHING V.34

A V.fast-class 28.8-Kbps external data/fax modem, the 2842EX ($299) comes with a high-speed serial card that includes two ports, has IRQ settings 2 through 5 and 7, is compatible with the 16550 UART and RS-232 interfaces, and supports COM port levels 1 through 8. The modem adjusts its speed automatically to accommodate noisy phone lines and slower connected modems or fax machines and runs self-diagnostics each time it's turned on. The unit is compatible with Group III Class 1 and 2 and has 14.4-Kbps send-and-receive capabilities. When the V.34 protocol is ratified, upgrades will be available at no cost.

Contact: CalCom Products, Placentia, CA, (714) 961-1888.
Circle 1272 on Inquiry Card.

What's New Hardware

VIEW SLIDES ON YOUR MONITOR ▶

The FlexCam Scientific desktop video camera (from $995) has a standard 8mm C-mount lens that precisely images scientific objects, including x-rays, for display on computer monitors or frame grabbers. Compatible with most industry microscopes, the camera has an optional microscope adapter ($195) that lets you focus the lens down to 1 inch to effectively produce a microscopic magnification of 50 to 1 when viewed on a 25-inch monitor. From VideoLabs (Minneapolis, MN), the camera displays NTSC or PAL color images in low-light conditions.
Phone: (612) 897-1995.
Circle 1292 on Inquiry Card.

NEURAL NETWORKING

A neural-network coprocessing board for the PC, the Model 1000 NeuroEngine ($4995) lets you train and run neural networks on your PC at high speed. The multiple-instruction, multiple-data-stream coprocessor board operates under DOS and runs up to 140 million connections per second. You can configure up to 10 of the boards as a parallel processor to execute 1.4 billion connections per second. You can also interconnect neural networks of different architectures simultaneously with one or several of the boards from Telebyte Technology (Greenlawn, NY).
Phone: (800) 835-3298 or (516) 423-3232.
Circle 1291 on Inquiry Card.

NOTEBOOK CHATTER

A battery-powered Pentium notebook with speech input, the Chatterbook II (from $6439) has a 5000- to 60,000-word active vocabulary and dictation speeds of up to 100 wpm. From Natural Input Technologies (Cortland, NY), the Chatterbook II includes 24 MB of RAM (expandable to 40 MB); a removable 250-MB hard drive (expandable to 540 MB); both Type II and Type III PCMCIA slots; a built-in trackball; a monochrome, dual-scan passive-matrix or active color-matrix screen; and a wired or wireless headset.
Phone: (800) 295-6484 or (607) 758-5000.
Circle 1293 on Inquiry Card.

BOARD THE SBUS

A dual-processor SBus board for the Sun SparcStation 2, the SB32C2 ($2500) from Communication Automation & Control (Allentown, PA) provides 1 MB of zero-wait-state private SRAM and four CD-quality audio I/O channels. The board supports master and slave transfer modes and can sustain DMA transfers to and from the DSP's memory at speeds of 3.5 MBps. An 80-pin connector allows mezzanine boards to access the SB32C2's DSP serial ports, interrupt lines, DSP memory space, and codec-control lines.
Phone: (800) 367-6735 or (610) 776-6669.
Circle 1294 on Inquiry Card.

24-BIT SCANNER

The Vista-S6 ($945) is a 1200-dpi, 24-bit flatbed color scanner with a SCSI-2 interface, micro stepping motors, and 256-KB bus-caching buffers. Able to scan a full 8½- by 11-inch image in 7 seconds for gray-scale and in 21 seconds for color at 200 dpi, the scanner has an optical resolution of 600 by 300 dpi and a maximum resolution of 1200 by 1200 dpi with UltraView software interpolation. From Umax Technologies (Fremont, CA), the Vista-S6 includes descreening, color-calibration, and automatic-scan capabilities.
Phone: (800) 562-0311 or (510) 651-8883.
Circle 1295 on Inquiry Card.

SERVER PROTECTION

Targeted at devices such as network servers, the OnGuard LI-2400 UPS ($1999) from Clary (Monrovia, CA) includes a built-in microprocessor and an RS-232 interface that enable real-time communications across the network between the UPS and workstations, servers, or network management stations. SNMP- and Novell NMS–compatible, the unit features DOS or Windows menu-driven diagnostic software that provides real-time utility-line analysis, inspects the battery condition, and provides power-event and data logs.
Phone: (800) 442-5279 or (818) 359-4486.
Circle 1296 on Inquiry Card.

SOUND FOR A PRO

The Golden Sound Pro 16 Plus sound card ($299) includes a built-in Yamaha OPL4 wave-table sound-quality chip that supports all the major sound standards. From Toptek Technology (Baldwin Park, CA), the sound card includes 16-bit recording and playback, a built-in SCSI-2 CD-ROM interface, a data transfer rate of 10 MBps, speaker-out at 4 W per channel, selectable line-out or phone-out, and support for SCSI-1 and SCSI-2 CD-ROM drive interfaces.
Phone: (800) 874-4425 or (818) 960-9211.
Circle 1297 on Inquiry Card.

MODULAR POWER PROTECTION

A modular power-protection system, the Max AllPath 6 ($99) has six protected and filtered 130-VAC, 50-/60-Hz AC outlets. A master power switch provides control over five of the receptacles; the sixth remains live at all times. The device has a surge-protection rating of 330 V and can dissipate 672 joules of heat energy. Its peak impulse current capacity is 40,000 A, and it has a 15-A circuit breaker. Expandable via snap-in modules ($29 each), the system is currently available for use with modems, phones, and LANs; future modules will be available for BNC, 10Base-2, RS-232, ISDN, and leased-line connections.

Contact: Panamax, San Rafael, CA, (800) 472-5555 or (415) 499-3900.
Circle 1273 on Inquiry Card.


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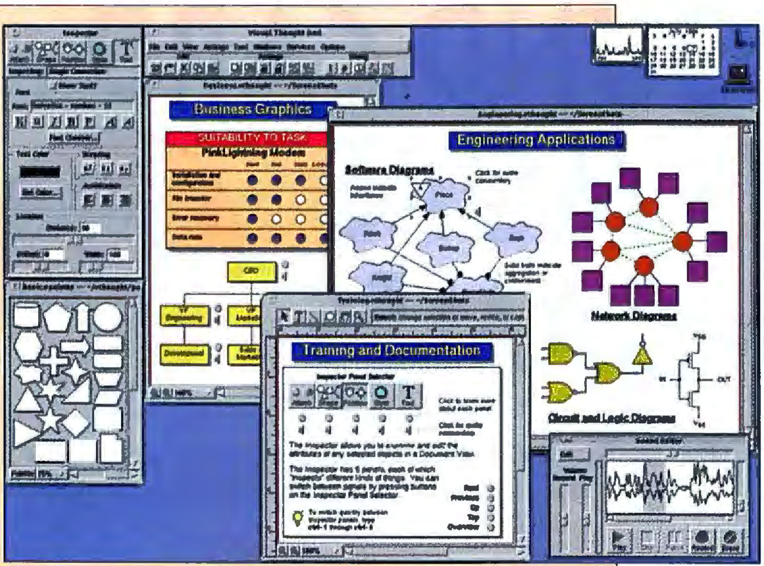
What's New Software



COMMUNICATE IDEAS GRAPHICALLY

A multipurpose drawing tool, Visual Thought employs object-oriented technology to create and edit diagrams and has the ability to draw shapes and make rubber-banding connections between objects. For Unix workstations running SunOS 4.1.3 with OpenWindows 3, Visual Thought is designed to get ideas onto the screen graphically, such as in presentation graphics, flowcharts, and diagrams. One hundred levels of multiple undo and redo let you play what-if games with drawings. A floating license costs $995; a node-locked license costs $595.

Contact: Confluent, San Francisco, CA, (415) 586-8700.

Circle 1298 on Inquiry Card.

KERNEL-LEVEL DEBUGGER

SingleStep++ ($2795), a multitasking version of Software Development Systems' (Oak Brook, IL) SingleStep for U.S. Software's SuperTask system, provides you with real-time kernel awareness for real-time embedded applications. Windows-compatible, SingleStep++ is an integrated package of debugging, program-building, code-generation, and analysis tools.

Phone: (708) 368-0400.

Circle 1302 on Inquiry Card.

GET HELP FOR YOUR NEST EGG

A complete financial-planning guide, Nest Egg Builder ($69.95) from Personal Vision (South Dennis, MA) has Q&A, Personal, and Analysis sections to help you set up a savings plan for special events, such as going to college, taking a vacation, or retirement. The Analysis section lets you create various scenarios for your net worth by changing variables such as retirement age and inflation rate, and you can see how much income you can expect from Social Security, pension funds, and personal savings.

Phone: (800) 764-2235 or (508) 760-2233.

Circle 1324 on Inquiry Card.

ZIP INTO VISUAL BASIC

A data-compression toolkit for Visual Basic for Windows, DynaZIP VBX ($199 per developer station) has its own built-in ZIP encoding and decoding logic. DynaZIP VBX lets you incorporate into your programs the ability to read, test, create, modify, and write industry-standard ZIP files. From Inner Media (Hollis, NH), DynaZIP VBX can read and write files compatible with version 2.04G of PKWare's PKZIP.

Phone: (800) 962-2949 or (603) 465-3216.

Circle 1304 on Inquiry Card.

EASY ACCESS TO INTERNET

A fully integrated and customizable Windows application for accessing the services and information available on the Internet, the OLE 2.0–compatible InterAp ($295) includes an E-mail system that conforms to the MAPI standard. NetScripts, a Visual Basic scripting language, lets you create macro agents that automatically retrieve information from Internet databases. The package is from California Software (Corona del Mar, CA).

Phone: (714) 729-4224.

Circle 1305 on Inquiry Card.

OS/2 DISK MANAGEMENT

EZRaid Lite for OS/2 ($195) uses disk mirroring, data stripping, and disk spanning to create software-managed disk arrays for OS/2 desktop systems. From Pro Engineering (Ottawa, Ontario, Canada), EZRaid Lite supports any disk interface, including IDE, SCSI, and ESDI.

Phone: (613) 738-3864.

Circle 1309 on Inquiry Card.

HARD DISK RECOVERY

A disaster-recovery software utility, PCResc-U ($39) from Elia-Shim Microcomputers (Tampa, FL) is based on a bootable rescue floppy disk that's created when your system is running. The utility records to the rescue disk such recovery information as CMOS setup, the master boot record of the first hard disk, the partition table, track 0 of the first hard disk, the boot record of the boot drive, the chain of partitions and boot sectors of all installed drives, and start-up files. Three PCResc-U modules allow you to create and execute the rescue disk as well as monitor the system for changes.

Phone: (800) 677-1587 or (813) 744-5177.

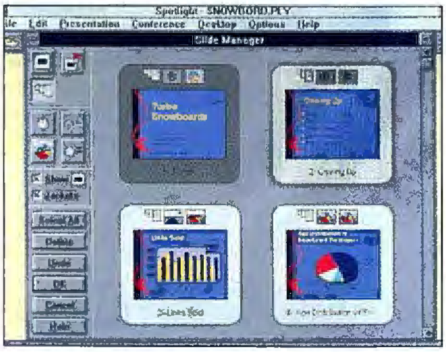
Circle 1307 on Inquiry Card.

PRESENTATION SPOTLIGHT ▼

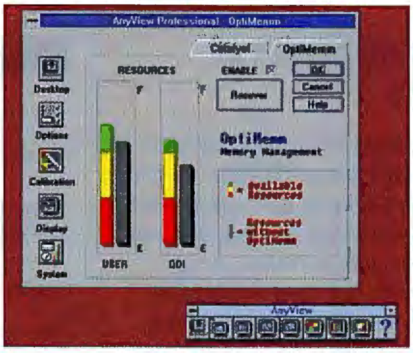
Harvard Spotlight for Windows ($129) from Software Publishing (Santa Clara, CA) lets you organize, rehearse, and deliver your Windows-based presentations more effectively. Designed to work with presentation-graphics packages, such as PowerPoint, Freelance Graphics, and Harvard Graphics, Harvard Spotlight helps you control the flow and delivery of your presentation with features such as Slide Locator, Presentation Notes, Current Audience Slide, Next Slide Preview, and Timing & Pacing information.

Phone: (800) 336-8360 or (408) 986-8000.

Circle 1308 on Inquiry Card.



CHANGE ANY VIEW ON YOUR SCREEN ▶



A Windows productivity tool, AnyView Professional ($99.95) manages system memory so that you can work in many applications simultaneously without having to constantly readjust your system. The Binar Graphics (San Rafael, CA) utility also accelerates graphics in Windows by up to 25 percent, provides on-the-fly color-depth switching and resolution changing, and calibrates the screen color to match your specifications.
Phone: (800) 228-0666 or (415) 491-4182.
Circle 1313 on Inquiry Card.

SUN SPARC UTILITIES

The Almond Utilities for Sun SPARC ($495) is the most recent of the Almond Utilities for Unix. From AlmondSeed Software (Mountain View, CA), the software diagnoses hard disk problems, manages files, and replaces some of the more unwieldy Unix system tools with its own tools. Among these tools are the Almond Disk Explorer, the Almond ScrubDisk, and the Almond Change Directory. The Almond Test Search and Almond File Find tool searches for user-specified text patterns in one or more files, locating files whose names match a specified pattern. The Almond UnRemove file-recovery tool enables you to recover accidentally deleted files.
Phone: (415) 968-5100.
Circle 1301 on Inquiry Card.

DEVELOP DCE APPLICATIONS

An application development tool set, HP Object-Oriented DCE/9000 ($2995 for the first developer; $995 for each subsequent developer) cuts DCE development time in half, according to Hewlett-Packard (Santa Clara, CA). The software is based on standard C++ and DCE, so applications you write with it can interoperate with standard DCE-based applications. In addition, you have a choice of programming languages.
Phone: (800) 637-7740 or (408) 447-1415.
Circle 1314 on Inquiry Card.

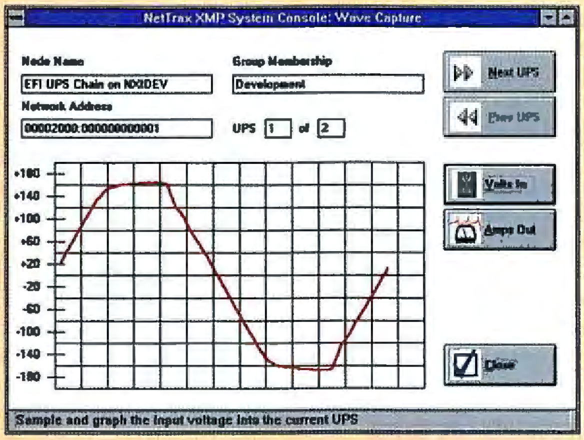
REMOTE CONTROL VIA SOCKETS

A remote-control, file transfer, and chat software package, Remotely Possible/Sockets (from $298) supports TCP/IP via the Windows Sockets interface. The Avalan Technology (Holliston, MA) software provides communications across computers, interconnected networks, and a variety of operating systems.
Phone: (800) 441-2281 or (508) 429-6482.
Circle 1310 on Inquiry Card.

AUTOMATE OFF-SITE DATA GATHERING

A DOS-based menu-interface program that automates off-site data collection and analysis, UAdmin ($995) from Raosoft (Seattle, WA) has a single control-level menu with straightforward English commands. The menu provides features such as customized disk creation, Counts Tables, and instant report generation.
Phone: (206) 525-4025.
Circle 1312 on Inquiry Card.

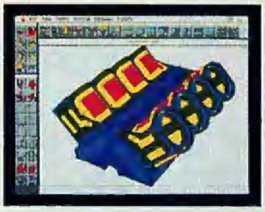
MANAGE NETWORKED UPSES



A NetWare- and Windows-based UPS power-monitoring and management program, NetTrax XMP (from $249.95) allows you to monitor and manage EFI UPSes on file servers and Windows workstations. When it's used in conjunction with Agent X ($89.95 per agent), the program expands to communicate with competing smart UPSes. Add NodeTrax ($99.95 per agent), and you can also monitor voltage regulators and surge protectors and manage dumb UPSes.
Contact: EFI Electronics, Salt Lake City, UT, (800) 877-1174 or (801) 977-9009.
Circle 1299 on Inquiry Card.

Software Update

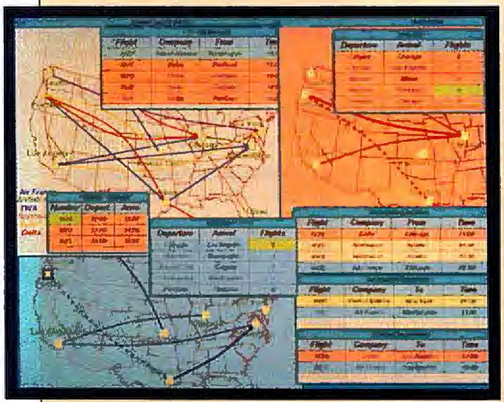
LapCAD for Macintosh 6.0, LapCAD Engineering (San Diego, CA), includes improved handling of solid elements, increased nodal capacity, and expanded IGES capability; supports nonuniform rational B-splines, including curves and surfaces; imports and exports the IGES Finite Element entities Node and Element; and is available to run in native mode on the Power Mac. From $195.
Phone: (619) 467-1947.
Circle 1325 on Inquiry Card.



Act 2.0, Symantec (Cupertino, CA), supports Apple PowerTalk, provides network support, prints calendars and address books, and includes native Power Mac support. $249.95.
Phone: (800) 441-7234 or (503) 334-6054.
Circle 1326 on Inquiry Card.

SQA TeamTest 3.0 for PowerBuilder, Software Quality Automation (Woburn, MA), adds a configurable PowerBuilder object-recognition model, expands its object-state test cases, lets you define a work flow for tracking a defect from its discovery to resolution, and improves management and measurement of test results. $2495.
Phone: (800) 228-9922 or (617) 932-0110.
Circle 1327 on Inquiry Card.

Widget Factory 2.0, Non Standard Logics (Boston, MA), features an enhanced GUI builder (XFaceMaker 3.0), generation of C++ classes from custom-designed graphics, a set of graphical objects that can be implemented as gadgets, and an improved drawing tool. $9150.
Phone: (617) 482-6393.
Circle 1328 on Inquiry Card.



Build a Dynamic Server of C++ Objects

An extension of the SmallTalk Model View Controller architecture, Ilog Server ($5000) is a tool for building dynamic servers of C++ objects. The tool provides a client-oriented interface between an object server and multiple clients, giving each client its own API. The client needs to be concerned only with the objects it manipulates, not with other clients sharing the same objects.

Contact: Ilog, Mountain View, CA, (415) 390-9000.

Circle 1300 on Inquiry Card.

Add Toolbars to PageMaker

SmartPad for PageMaker ($79) provides single-click access to many commonly used commands by incorporating shortcuts into toolbars that you can embed into the PageMaker window. The Softblox (Atlanta, GA) utility lets you quickly format and lay out your pages, insert graphics, and select drawing tools, among other functions. You can float toolpads on top of the PageMaker window, attach them outside the window, or embed them inside the window.

Phone: (404) 892-0202.

Circle 1315 on Inquiry Card.

Put Intelligent Agents on the LAN

Level5 Object Professional ($2995), Information Builders' (New York, NY) workbench for developing smart components for client/server applications, lets you build and deploy intelligent software agents that can be embedded in other applications. The agents can also be run over a LAN and distributed throughout an organization. You educate the OLE 2.0 Automation Object agents with your organization's business rules, policies, or procedures. Functioning as a server, any agent can support several applications and run different kernels of intelligence on demand.

Phone: (212) 736-4433.

Circle 1316 on Inquiry Card.

Business Advice from a Mentor

The How to Really Start Your Own Business interactive CD-ROM ($79.95) provides straightforward business advice from the founders of successful companies such as Pizza Hut, David's Cookies, and Celestial Seasonings. From Zelos (San Francisco, CA) and based on *Inc.* magazine's video of the same name, the Mac and MPC CD-ROM has a mentor panel of advisors who are chosen in response to your answers to a series of questions.

Phone: (415) 788-0566.

Circle 1320 on Inquiry Card.

Time Tracker

PK & Company's (Newbury Park, CA) Hot-Time ($29) time-tracking utility tracks billable hours by job number, project, client, or other criteria. The Hot-Time time card is stored in ASCII format, so you can edit it with any text editor. At the end of your tracking period, Hot-Time can print out the time card. You can use AutoCAD to directly launch the DOS and Windows utility with a hot key.

Phone: (805) 498-5532.

Circle 1318 on Inquiry Card.

Integration for Notes

Windows-based Project Gateway (starter kit, $895) integrates Microsoft Project and Symantec Time Line with Lotus Notes. From Marin Research (Mill Valley, CA), Project Gateway adds import and export capabilities to Notes and synchronizes project management application data with a Notes Database. The software automatically records project revisions and maintains effort and progress data by time periods.

Phone: (415) 389-5444.

Circle 1319 on Inquiry Card.

Windows Groupware

Office-Logic for Windows (from $495) is fully integrated groupware with WAN capabilities. The software's intuitive user interface provides access to seamlessly integrated E-mail, group and personal scheduling, a database, and a phone-messaging center. The customizable software from LAN-Aces (Houston, TX) requires no programming.

Phone: (713) 890-9787.

Circle 1323 on Inquiry Card.

Breeze Through Windows

Breeze ($54.95) lets you enhance the way you work in Windows. You can launch programs, switch to other applications, or access any of the supplied utilities with just a click of the right mouse button. You can also add a toolbar to the standard Windows GUI, textured frames to borders, and 3-D effects to title bars. Breeze is from CrossWind Development (Yorba Linda, CA).

Phone: (714) 892-8775.

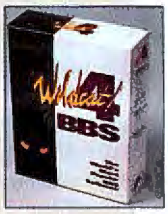
Circle 1340 on Inquiry Card.

Software Update

Rosenthal Uninstall 2.0, Rosenthal Engineering (San Luis Obispo, CA), selectively exempts files from being uninstalled and provides additional Windows support. $19.95.
Phone: (805) 541-0910.
Circle 1338 on Inquiry Card.

Working Model 2.0, Knowledge Revolution (San Mateo, CA), adds an enhanced simulation engine, improved editing and importing features, simulation objects, and support for DDE. $1495.
Phone: (415) 574-7777.
Circle 1330 on Inquiry Card.

Wildcat 4, Mustang Software (Bakersfield, CA), adds more than 250 enhancements, including GIF Thumbnailer; a spelling checker; on-line scrollback and capture; improved chat capability; a new programming language, wcCODE; multiple language support; an improved internal organizing system; and support for V.FC, V.32, and V.34 modems. $149.



Phone: (805) 873-2500.
Circle 1331 on Inquiry Card.

VideoShop 3.0, Avid Technology (Tewksbury, MA), provides PowerPC acceleration, QuickTime compatibility, an improved user interface, enhanced editing and tape logging, MIDI support, and Specular's LogoMotion. $395.
Phone: (800) 949-2843 or (508) 640-6789.
Circle 1332 on Inquiry Card.

Minitab 10, Minitab (State College, PA), offers DDE, 3-D surface and scatter plots, enhanced file support, expanded time-series features, a new mixtures-model feature, three new cluster-analysis commands, a tool palette and attributes palette, and a brushing tool. $895.
Phone: (814) 238-3280.
Circle 1337 on Inquiry Card.

What's New Software

LEARN A LANGUAGE ▲

An immersion-style, interactive CD-ROM program, The Rosetta Stone PowerPac ($99) introduces you to Spanish, French, German, and English, featuring 22 lessons in each language. From Fairfield Language Technologies (Harrisonburg, VA), the PowerPac program uses native speakers and includes voice-record and dictation modes. The Mac and Windows/MPC CD elicits student response and gives instantaneous feedback.

Phone: (800) 788-0822 or (703) 432-6166.

Circle 1321 on Inquiry Card.

TALK YOUR WAY THROUGH WINDOWS

The DragonDictate for Windows family of speech-to-text dictation systems consists of the 5000-word Starter Edition ($395), the 30,000-word Classic Edition ($695), and the 60,000-word Power Edition ($1695). The software-only products from Dragon Systems (Newton, MA) let you manage and control your applications and the Windows environment completely by voice. DragonDictate supports industry-standard sound boards and works directly in most Windows applications; it provides full mouse movement via voice commands and allows you to create voice macros of a single spoken word or a phrase.

Phone: (617) 965-5200.

Circle 1317 on Inquiry Card.

MULTIPLE APPLICATIONS FOR ONE

A single-user version of Novell DR Multiuser DOS, Novell DR Multiuser DOS Lite ($295) allows a single PC to run multiple applications simultaneously. The Concurrent Controls (San Francisco, CA) software supports multiple-session connectivity to a NetWare server from one network interface card. When you use the company's CCI Net peer-to-peer network option ($199), you can link multiple DR Multiuser DOS Lite systems together to support up to 255 nodes of the software.

Phone: (800) 487-2243 or (415) 873-6240.

Circle 1322 on Inquiry Card.

CREATE TABBED DIALOG BOXES

SftTabs 1.0 ($149) from Softel vdm (Wharton, NJ) lets Windows developers create tabbed and standard dialog boxes. The dialog editor offers a complete set of control-positioning tools, supports Windows SDK–style custom controls, and allows testing of all dialog boxes, including 3-D display. You can use the tabbed dialog boxes from any DLL-capable language, such as C, C++, or Pascal.

Phone: (201) 366-9618.

Circle 1303 on Inquiry Card.

E-MAIL SYNCHRONIZATION

Mosaic Works Agent@QuickMail for Macintosh ($995) automatically synchronizes CE Software's QuickMail addressing information with other E-mail directories on a network. From Hitachi Computer Products (America) (Santa Clara, CA), the software works in conjunction with the company's Mosaic Works Directory Server.

Phone: (408) 986-9770.

Circle 1306 on Inquiry Card.

Software Update

After Dark 3.0, Berkeley Systems (Berkeley, CA), adds 15 screen-saving modules. EcoLogic power management shuts down the CPU on newer Macs. $49.99.
Phone: (510) 540-5535.
Circle 1329 on Inquiry Card.

Ocelot2—The SQL 2.16, Ocelot Computer Services (Edmonton, Alberta, Canada), features increased support for the ODBC API and the ANSI SQL '92 syntax, as well as a Windows 32-bit library for use with the Win32 API. $1450; source code is available with a $200 annual maintenance contract.
Phone: (403) 421-4187.
Circle 1333 on Inquiry Card.

QAPlus/Win 6.0, DiagSoft (Scotts Valley, CA), adds the Electronic Technical Support Center, RAM testing and IRQ detection from within Windows, the capability to run a quick test or a comprehensive full test, CPU performance benchmark tests, and a RAM chip locator that helps find the position of faulty SIMMs. $99.95.
Phone: (408) 438-8247.
Circle 1334 on Inquiry Card.

Ad Oculos 2.0, European Software Connection (Lawrence, KS), includes enhancements such as a counting and measuring system, improved import/export of files, and an improved user interface. $470.
Phone: (913) 832-2070.
Circle 1335 on Inquiry Card.

HyperHelp 4, Bristol Technology (Ridgefield, CT), has enhanced FrameMaker support, improves its find-and-sort and printing capabilities, is user-expandable with DLLs, and adds a user-reporting capability and product updates. $5000.
Phone: (203) 438-6969.
Circle 1336 on Inquiry Card.

TOOLKIT FOR SPC APPLICATIONS

A VI (virtual instrument) library for SPC (statistical process-control) applications, the LabView SPC Toolkit ($495) contains VIs that integrate statistical analysis of processed data into the LabView data acquisition and control environment. The program's control-chart VIs can compute points to be plotted for a number of attributes and variables charts. The kit also includes VIs for process-capability analysis and Pareto analysis.

Contact: National Instruments, Austin, TX, (800) 433-3488 or (512) 794-0100.

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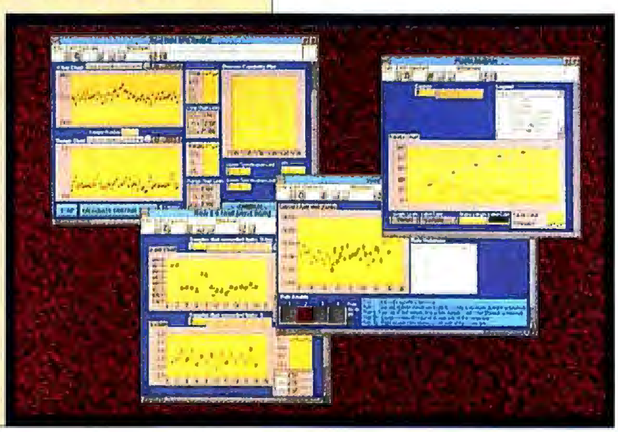

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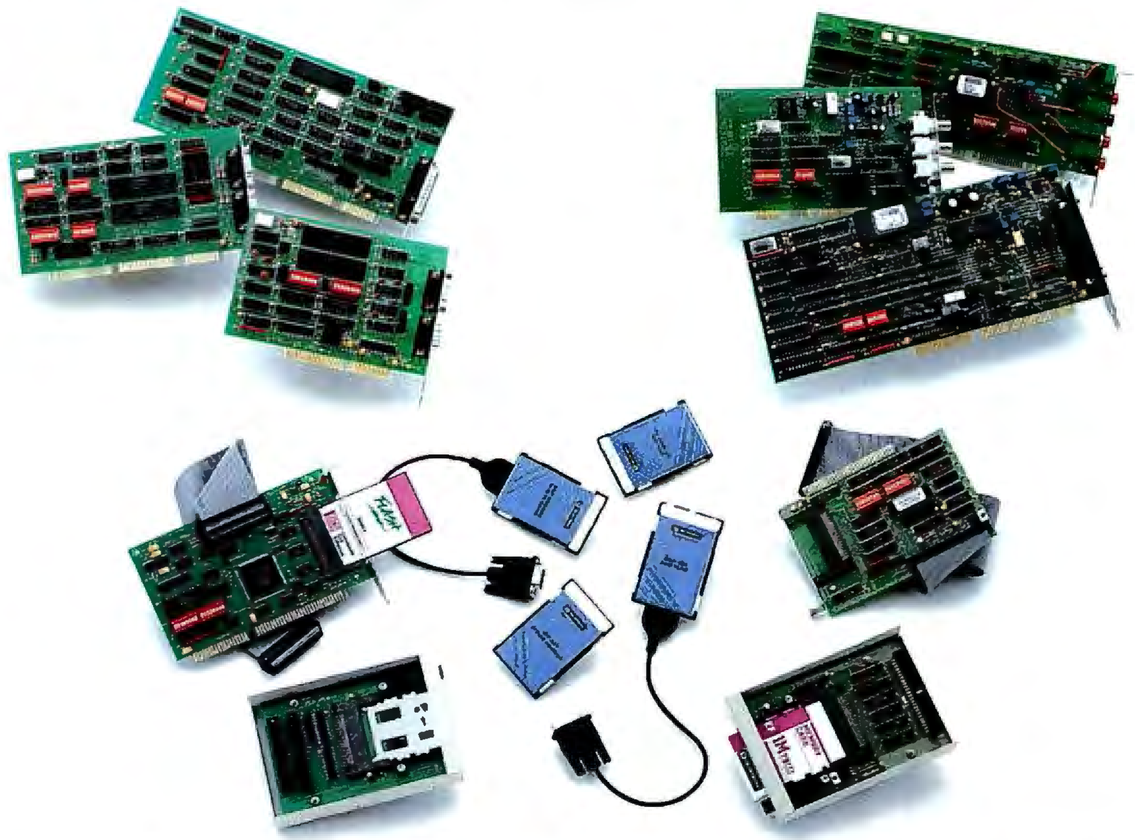

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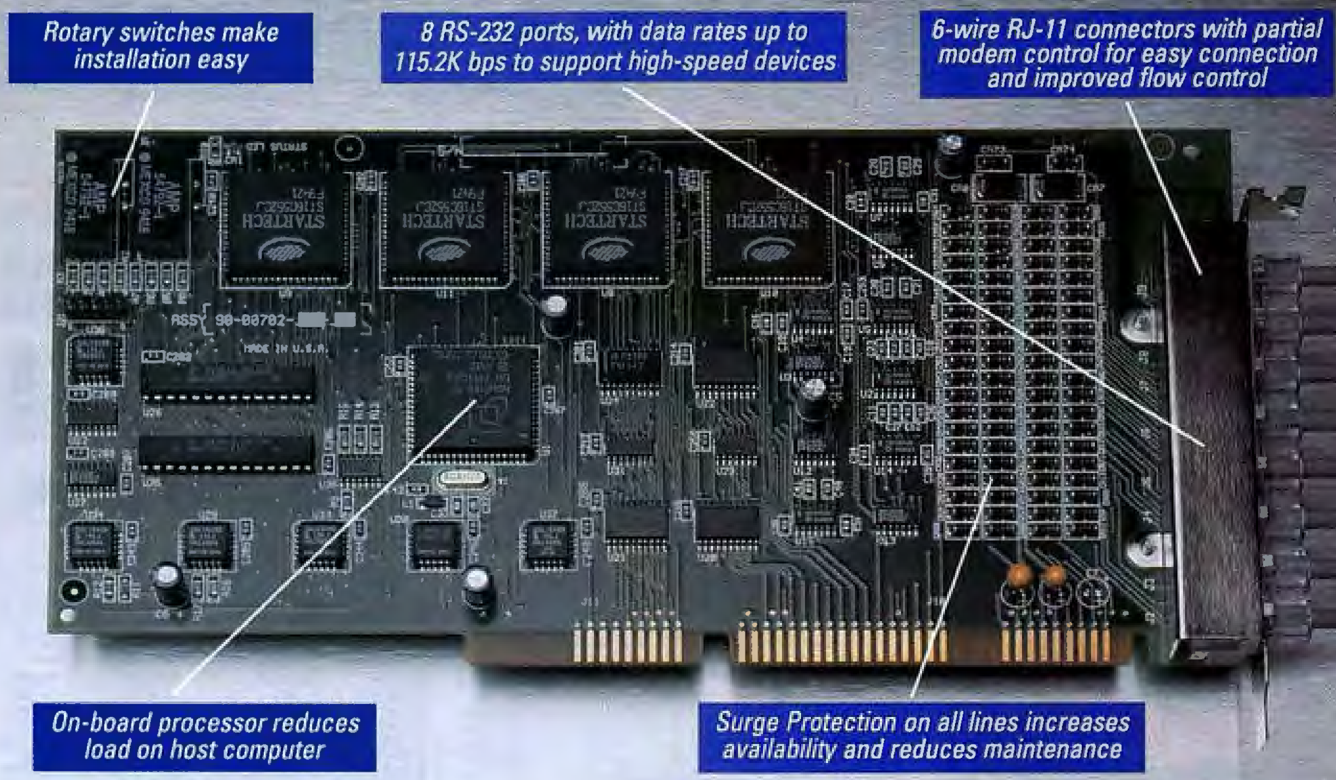

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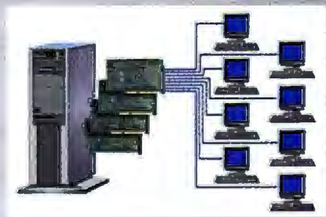

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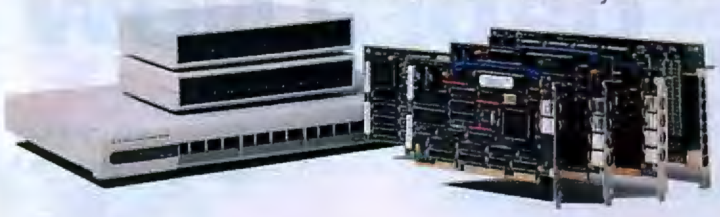

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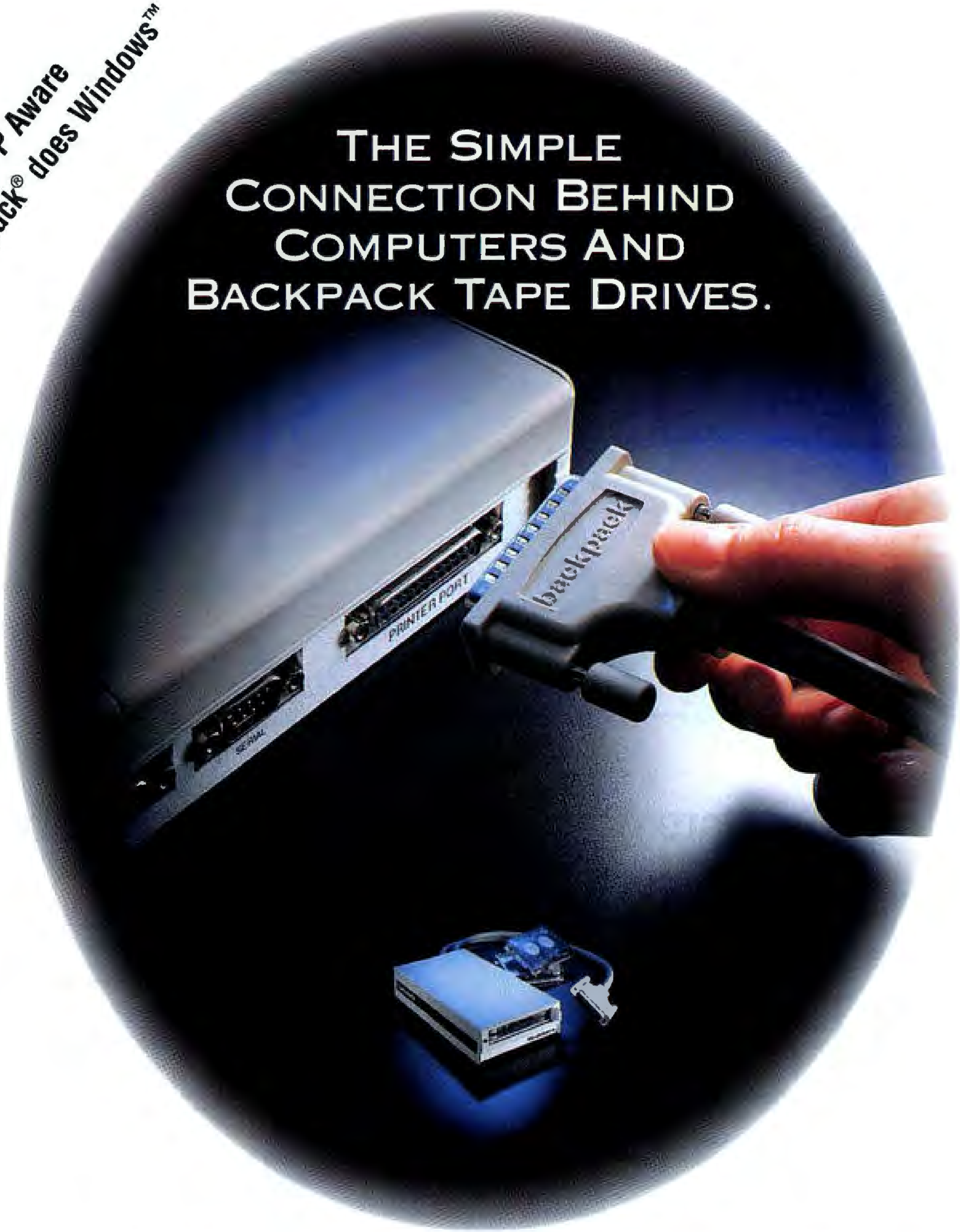

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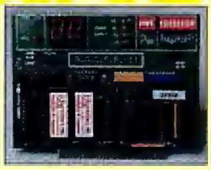

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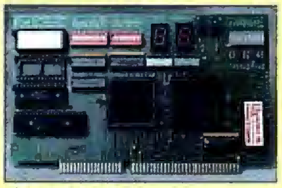

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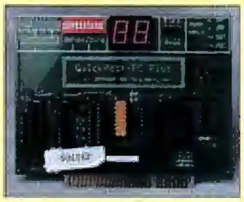

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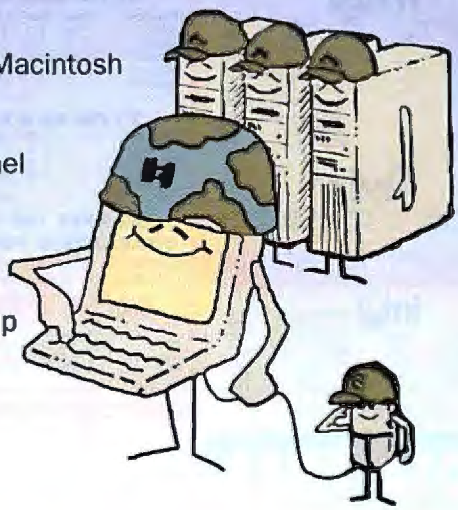

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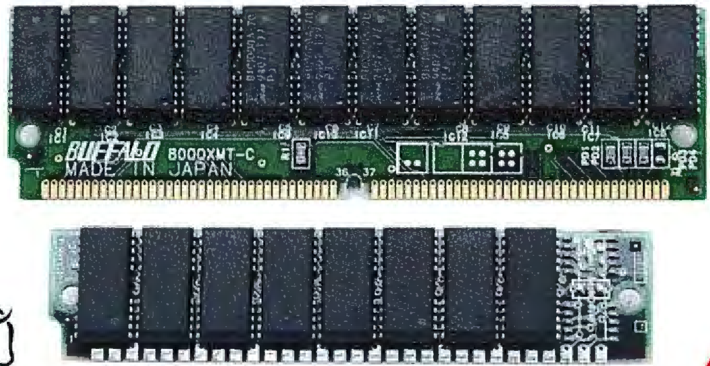

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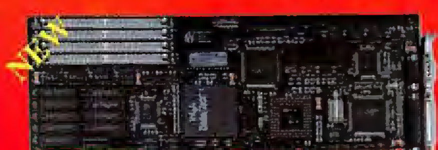

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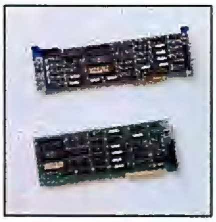

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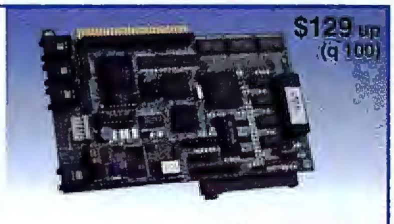

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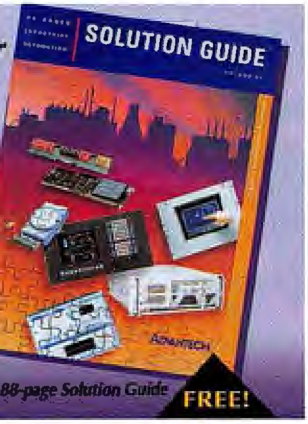

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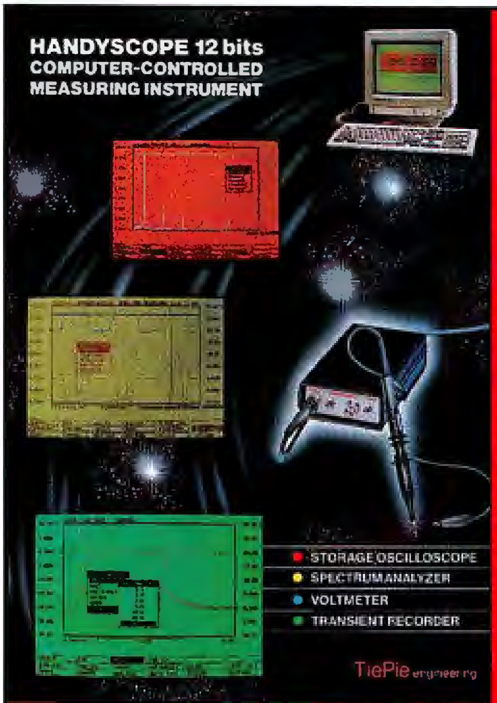

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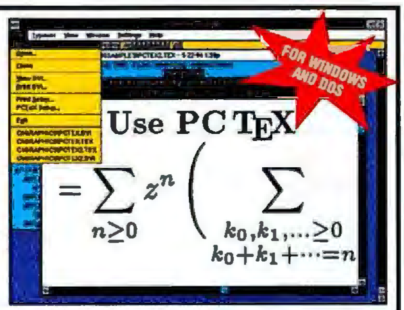

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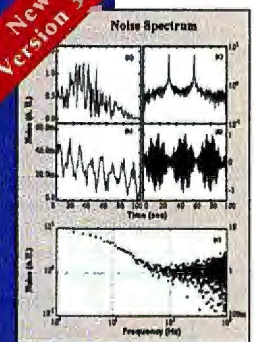

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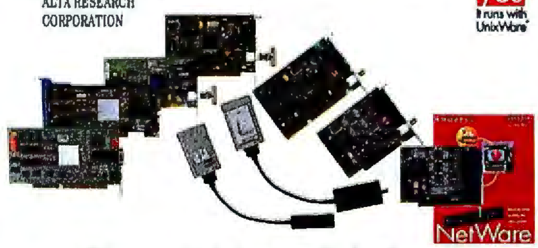

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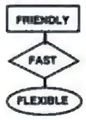

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Slouching Toward the Internet

In many ways, I feel that I am a barbarian at the gate

I am not a technical man. In fact, I am about as far away from being one as is possible in an industrial country at the tag end of the twentieth century. As an author of novels, however, I engage in the same pursuit as those who are involved in an understanding of things from a technical perspective. This similarity is a devotion to being precise. A computer programmer or other technically skillful human being may exhaust all possibilities, or gather all available information, before making a decision. A fiction writer's work is done intuitively and with the ability that E. M. Forster, one of the great English novelists, described as the gift to judge the whole by the part.

ED JUDICE © 1994

I came to computers slowly, resisting them because, as far as writing is concerned, a word processor's greatest strength, its ability to allow for infinite editing, lets you confuse movement for action. My first computer was a dinosaur called a Wangwriter. It sat on the floor like a heart-lung machine. When it was installed in the room where I work (in Vermont), I was told that it had to be kept at a constant 68°F.

I didn't want to hurt the feelings of the technician who told me this, but I heat my office with a wood stove, and, in general, I couldn't guarantee 68°F even in the summertime. I have done many stupid things in my life, and I am ashamed of them all, but getting up in the middle of the night to put wood in the stove to keep the computer warm wasn't going to be added to the list.

But, of course, I was hooked, and my understanding of computers advanced quickly, usually as a result of some new and unforeseen disaster, not to mention that I share the human fascination with making machines easier or more efficient to run. With the passage of time, it became clear to me that the things I had learned about computers were leading to one specific place: the Internet.

There are times when I have needed to know the patterns of colors of the wings of certain butterflies found only in specific regions of the Amazon Rain Forest, the details of complications in the medical treatment of gunshot wounds, the specifics of love potions that have been concocted over the years, and countless other details that reflect upon the activities of human beings. It is hard to suggest what enthusiasm and delight a novelist feels at the prospect of easily obtained information.

I have spent months learning how to manage the Internet's commands, its vagaries, and its blind alleys. At its best, the Internet seems like magic. Recently, in the space of 24 hours, I asked for and received information about what insects were on a trout stream in Austria. When I was there, I caught 20-inch brown trout on imitations of the species of insects I had learned of by way of the Internet. I was now certain that only very rarely does something new come into the world, and the Internet is one of these rare, new things.

Still, learning how to use it, even imperfectly, has taken too much time. In the room where I work, you'll find a pile of Internet manuals, the stack of them sitting there like proof incarnate of the fact that there is something amiss here. I am well aware that some people think that the very difficulty of the Internet is a benefit, keeping undesirables out. And while this may be true, it also has the whiff of elitism, not to mention a thinly disguised hostility to those who are less than adept with computers.

Sometimes I can get the Internet to work, and other times I can't. When I can't, I look in a manual, which always says, with a whiff of condescension, "Oh, that. That's easy. Here are the commands. Easy as pie." The next thing I know, I'm lost. The commands don't apply. Or they apply only to the specific gopher or search utility of the example of the manual. The manuals imply a coherence that doesn't seem to exist, and there seem to be more exceptions than rules.

The truth, though, is that the promise of the Internet is not false. And it is this promise that leads me on, learning a little more each day; but as I do, I am tantalized by the notion of more graceful access. I am aware that there are better front ends than the one I have, and that there are new (and yet untried) connections. Perhaps the solution is there, and I just haven't found it yet.

In many ways, I feel that I am a barbarian at the gate. From the other side of it, I can smell the sweet perfume of paradise, and yet I am condemned to fiddling with the lock. There are a lot of people like me, imperfectly hooked up to the Internet, impatient, waiting for what we know to be there, just beyond our reach: easy, complete access to information. ■

Craig Nova is the author of eight novels and the recipient of many awards and prizes, including an Award in Literature from the American Academy and Institute of Arts and Letters. You can reach him on the Internet at sextans@delphi.com.

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